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189,091	200	195,098	157	199,030	632	202,616	736	205,796	676	266,818	743	207,802	804
189,104	205	195,345	34	199,340	71	202,625	859	205,812	416	206,834	902	207,804	593
189,132	343	195,365	359	199,350	383	202,630	375	205,813	273	206,848	768	207,826	984
189,138	489	195,366	173	199,354	768	202,631	997	205,818	652	206,862	548	207,835	841
189,148	364	195,374	697	199,355	330	202,632	375	205,827	845	206,869	44	207,840	87
186,442	117	195,382	601	199,360	9	202,652	606	205,828	655	206,876	81	207,851	122
189,453	368	195,390	45	199,376	931	202,654	995	205,850	40	206,889	85	207,855	82
189,458	560	195,400	157	199,400	692	202,660	447	205,865	7	206,918	71	207,876	320
189,772	40	195,408	500	199,695	325	202,941	134	205,868	9	206,919	71	207,883	124
190,114	462	195,590	221	199,706	328	262,952	717	205,873	7	206,924	41	207,902	82
190,115	164	195,597	205	199,713	203	202,962	81	205,883	21	206,940	76	207,919	103
190,116	164	195,598	123	199,718	81	202,971	600	205,884	21	206,954	76	207,946	150
196,117	216	165,600	627	199,721	781	202,975	937	205,898	51	206,982	46	207,958	135
190,118	173	195,602	654	199,729	373	202,984	1010	205,906	3	207,000	49	207,977	100
190,119	166	195,610	752	199,734	155	202,985	980	205,915	91	207.014	46	207,995	123
190,131	327	195,619	128	199,743	140	203,285	493	205,926	20	207,040	111	208,014	134
190,147	309	195,943	621	260,070	270	203,300	650	205,955	16	207,041	84	268,019	85
190,165	338	195,947	259	200,074	388	203,301	687	205,984	20	207,062	40	208,046	81
190,721	262	195,950	123	200,087	115	203,310	566	205,985	20	207,073	84	208,076	115
190,722	100	195,990	828	200,000	919	203,324	117	206,010	52	207,090	52	208,114	597
190,723	459	195,963	687	206,482	743	203,336	691	206,021	22	207,113	51	208,117	325
160,727	455	196,217	122	200,508	576	203,340	839	206,029	9	207,116	76	208,140	662
191,005	237	196,237	165	200,511	848	263,346	11	206,045	3	207,142	333	208,154	889
191,008	34	196,239	231	200,523	1024	203,347	11	206,083	34	207,145	743	208,155	249
191,032	221	196,256	157	200,524	985	203,444	548	206,105	932	267,149	876	208,192	551
191,037	704	196,258	378	200,626	157	203,661	489	206,113	250	207,151	876	208,176	82
161,363	34	196,260	751	260,788	104	203,681	978	206,134	368	207,172	748	208,189	140
191,378	244	196,272	200	200,789	605	203,683	67	206,142	902	207,195	598	208,193	141
191,383	208	196,298	332	200,810	615	203,695	266	206,143	768	207,196	944	208,195	165
191,393	587	196,579	162	200,815	938	203,708	899	206,145	962	207,199	753	208,226	121
191,738	696	199,585	256	200,838	182	203,713	072	200,174	40	207,211	53	208,230	138

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208,235	142	209,642	238	210,465	266	211,730	882	213,447	593	214,917	577	216,922	665
208,247	118	206,650	176	210,508	300	211,739	374	213,454	606	214,940	776	216,623	628
208,253	156	209,652	209	210,517	262	211,740	374	216,476	501	214,963	742	216,929	669
208,265	126	209,855	238	210,526	291	211,742	829	213,466	422	215,028	592	216,940	629
208,267	124	209,366	165	210,540	240	211,748	665	213,493	482	215,039	572	216,946	662
206,282	138	206,376	251	210,542	265	211,752	369	213,495	469	215,044	601	216,949	707
206,310	124	209,378	165	210,545	291	211,771	400	213,521	456	215,049	561	216,950	678
208,626	118	209,379	586	210,628	257	211,772	413	213,524	752	215,069	586	216,951	684
208,657	128	209,380	820	210,652	263	211,760	388	213,536	926	215,073	543	216,052	684
208,382	128	200,421	602	210,654	245	211,701	379	213,626	522	215,095	543	216,953	684
208,689	129	209,441	216	210,661	291	211,802	669	216,626	503	215,097	587	216,959	657
206,397	128	209,453	210	210,663	261	211,814	416	213,631	507	215,113	565	216,968	665
206,420	129	206,458	209	210,660	412	211,617	820	213,638	522	215,207	559	216,971	626
208,443	100	200,480	256	210,691	245	211,824	598	213,661	503	215,222	566	216,974	629
208,449	110	209,528	225	210,692	306	211,625	551	213,711	526	215,231	561	216,676	663
208,469	142	209,547	211	210,698	314	211,831	909	213,737	522	215,242	561	216,978	054
208,471	140	209,561	217	210,703	326	211,832	568	213,743	507	215,320	919	216,962	654
208,479	128	209,569	213	210,707	257	211,857	979	216,754	501	215,348	985	217,003	706
208,492	320	209,570	170	210,708	295	211,870	822	213,765	507	215,374	848	217,025	662
208,503	573	209,571	205	210,719	717	211,912	375	213,777	497	215,400	601	217,026	669
208,516	802	209,577	238	210,728	033	211,923	390	213,818	501	215,439	601	217,041	663
208,522	749	209,674	225	210,734	868	211,943	400	213,835	627	215,463	607	217,053	682
208,547	621	209,667	221	210,742	740	211,944	384	213,836	527	215,470	607	217,065	607
208,551	707	209,694	211	210,748	655	211,959	360	213,837	527	215,405	601	217,068	706
208,555	664	209,697	224	210,772	586	211,972	392	213,866	538	215,496	588	217,065	684
206,563	978	209,703	819	210,774	583	211,978	366	213,886	683	215,566	587	217,113	657
208,564	538	209,706	462	210,777	951	211,982	389	213,908	742	215,595	583	217,117	690
208,569	165	209,707	476	210,809	403	212,012	366	213,939	608	215,615	567	217,130	707
208,572	138	209,722	731	210,824	339	212,029	360	213,940	608	215,701	563	217,150	682
208,573	138	209,730	822	210,831	311	212,030	369	213,946	503	215,752	665	217,154	622
208,576	196	209,742	752	210,855	283	212,034	360	213,962	533	215,796	605	217,166	977
208,578	173	209,757	980	210,862	315	212,035	360	213,970	531	215,802	601	217,247	907
208,579	180	209,773	225	210,865	331	212,045	335	213,975	524	215,810	596	217,269	657
208,566	125	209,794	244	210,870	300	212,053	365	213,984	569	215,812	583	217,277	712
208,623	159	209 811	208	210,890	328	212,065	376	213,985	764	215,813	596	217,279	676
208,632	159	209,829	238	210,909	327	212,068	374	213,986	764	215,824	604	217,282	690
206,649	180	209,849	251	210,950	357	212,083	360	213,991	537	215,841	587	217,287	706
• 208,656	159	209,857	238	210,972	286	212,106	364	213,999	514	215,645	602	217,319	675
208,682	134	200,872	251	211,005	339	212,121	340	214,020	510	215,851	593	217,322	679
206,684	577	209,885	247	211,027	339	212,136	386	214,022	517	215,860	593	217,323	720
206,685	191	209 887	247	211,030	306	212,144	393	214,062	511	215,872	602	217,363	681
208,720	662	209,916	251	211,032	310	212,145	369	214,075	497	215,880	629	217,376	717
206,722	654	209,937	247	211,033	286	212,171	387	214,079	508	215,887	602	217,377	675
208,733	476	209,955	245	211,036	339	212,184	375	214,112	508	215,805	794	217,391	679
208,744	182	209,958	239	211,096	075	212,185	379	214,124	527	215,929	589	217,414	671
208,751	212	209,961	265	211,101	858	212,188	364	214,177	524	215,935	602	217,428	663
208,757	164	209,975	262	211,111	1017	212,190	390	214,196	860	215,936	664	217,454	662
208,760	216	200,987	274	211,113	991	212,191	680	214,197	706	215,968	606	217,465	680
208,761	185	209,993	239	211,167	890	212,201	409	214,222	975	215,985	592	217,467	731
208,764	181	210,006	247	211,174	347	212,233	455	214,262	860	215,994	602	217,468	707
208,779	435	210,011	262	211,178	332	212,500	459	214,279	594	216,001	665	217,469	657
208,786	182	210,023	239	211,179	403	212,504	984	214,293	577	216,021	663	217,477	679
208,800	156	210,027	238	211,161	428	212,533	712	214,308	542	216,022	703	217,611	711
208,803	180	210,033	250	211,188	343	212,542	876	214,328	534	216,169	026	217,612	757
208,818	181	210,050	015	211,203	331	212,545	598	214,330	508	216,192	507	217,613	703
208,832	173	210,061	1019	211,210	338	212,551	622	214,340	522	210,198	637	217,614	771
208,835	181	210,085	662	211,215	340	212,585	423	214,344	526	216,228	602	217,633	714
208,879	219	210,101	239	211,219	326	212,597	480	214,356	527	216,307	708	217,634	727
208,880	186	210,102	257	211,223	329	212,642	405	214,358	511	216,325	626	217,645	703
208 904	159	210,108	251	211,234	329	212,663	408	214,360	517	216,347	741	217,685	707
208,911	191	210,114	286	211,245	314	212,671	405	214,446	497	216,368	654	217,715	768
206,928	226	210,118	202	211,246	582	212,725	428	214,477	527	216,378	625	217,741	770
208,929	173	210,120	247	211,267	326	212,742	405	214,478	526	216,381	584	217,747	608
208 962	158	210,131	210	211,294	343	212,749	416	214,483	511	216,389	637	217,756	769
208,972	171	210,133	239	211,307	351	212,751	428	214,507	509	216,415	620	217,758	709
208,676	163	210,147	244	211,322	346	212,763	415	214,516	505	216,450	597	217,768	728
200,014	184	210,153	256	211,340	351	212,768	419	214,521	497	216,456	625	217,770	902
209,025	601	210,154	258	211,368	326	212,770	410	214,526	522	216,462	637	217,774	698
209,028	822	210,193	250	211,370	332	212,803	481	214,532	522	216,463	621	217,791	714
209,034	844	210,217	248	211,371	321	212,811	405	214,544	549	216,464	652	217,817	717
209,043	751	210,232	271	211,409	326	212,818	408	214,567	533	216,478	848	217,631	876
209,063	949	210,233	245	211,431	579	212,852	454	214,572	736	216,484	1017	217,854	608
209,064	681	210,245	262	211,437	375	212,877	756	214,576	755	216,545	621	217,873	1005
200,065	081	210,307	239	211,441	1017	212,907	930	214,577	885	216,546	644	217,643	717
209,073	508	210,317	244	211,455	868	212,961	455	214,578	921	216,556	629	217,045	736
209,106	874	210,341	280	211,462	1018	212,970	462	214,579	759	216,577	621	217,063	751
209,114	176	210,343	258	211,467	077	212,978	455	214,583	918	216,579	625	217,060	704
209,124	180	210,347	248	211,478	749	212,979	480	214,630	713	216,580	602	217,070	714
209,125	213	210,356	244	211,494	605	212,986	469	214,668	587	216,602	676	217,973	709
209,128	210	210,363	257	211,516	391	212,990	479	214,675	548	216,617	638	217,976	711
209,135	205	210,366	384	211,517	384	212,998	466	214,677	562	216,622	741	217,988	829
209,138	213	210,369	387	211,524	393	213,003	506	214,679	565	216,648	708	217,991	717
209,148	159	210,376	230	211,528	364	213,014	475	214,699	514	216,675	022	217,908	704
209,157	202	210,382	549	211,530	382	213,016	434	214,733	550	216,680	696	218,012	717
209,158	196	210,388	600	211,536	388	213,040	500	214,735	565	216,691	702	218,014	731
209,163	238	210,307	879	211,537	365	213,046	456	214,736	543	216,695	637	218,034	705
209,169	164	210,399	530	211,540	388	213,088	467	214,756	590	216,708	655	218,053	704
209,171	173	210,410	522	211,541	368	213,100	546	214,765	500	216,733	625	218,054	720
209,186	176	210,419	032	211,542	360	213,190	482	214,779	517	216,756	680	218,075	702
209,188	213	210,437	490	211,548	382	213,195	501	214,822	573	216,761	664	218,119	711
209,192	213	210,438	490	211,556	360	213,214	950	214,823	563	216,766	637	218,127	713
209,200	212	210,459	983	211,562	399	213,295	460	214,828	572	216,771	676	218,154	719
209,211	163	210,462	708	211,599	374	213,331	456	214,836	615	216,789	622	218,250	929
209,218	196	210,464	855	211,664	366	213,343	475	214,864	505	216,834	877	218,321	992
209,253	237	210,466	286	211,667	365	213,353	508	214,866	577	216,853	998	218,339	777
209,270	185	210,480	311	211,691	874	213,354	404	214,871	550	216,011	676	218,348	746
209,312	156	210,484	290	211,720	675	213,363	501	214,872	601	216,918	665	216,347	746
209,341	182	210,493	315	211,726	373	213,436	480	214,882	553	216,921	662	218,353	739

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218,354	765	219,052	841	219,697	1010	220,390	877	221,102	915	221,760	972	222,658	985
218,364	757	219,057	819	219,719	794	220,393	900	221,107	895	221,770	950	222,676	972
218,373	752	219,058	778	219,730	818	220,395	882	221,124	855	221,843	937	222,791	086
218,380	742	219,059	778	219,748	842	220,413	868	221,234	900	221,848	950	222,702	974
218,691	740	219,061	752	219,749	841	220,505	865	221,250	899	221,852	982	222,718	980
218,399	766	219,062	737	219,753	704	220,548	908	221,256	891	221,853	011	222,785	986
218,401	760	219,968	992	219,768	827	220,556	858	221,279	920	221,857	983	222,922	985
218,414	733	219,076	818	219,772	819	220,576	875	221,296	905	221,860	959	222,923	983
218,430	740	219,078	818	219,787	815	220,645	1004	221,311	939	221,956	979	222,931	1003
218,447	735	219,085	742	219,792	815	220,664	899	221,334	956	221,975	936	222,947	1008
218,458	769	219,089	780	219,895	819	220,666	966	221,842	911	221,980	978	222,965	982
218,495	748	219,194	802	219,818	831	220,671	895	221,359	906	221,992	954	222,975	1026
218,512	778	219,236	772	219,830	824	220,676	859	221,380	900	221,999	934	222,987	1004
218,542	808	219,272	1030	219,846	782	220,684	899	221,388	898	222,001	939	223,011	1003
218,544	757	219,273	1030	219,853	840	220,697	886	221,418	902	222,003	933	223,015	980
218,556	737	219,277	1020	219,865	819	220,710	875	221,422	904	222,008	951	223,042	999
218 563	752	219,341	905	219,866	819	220,716	898	221,442	929	222,016	954	223,066	1006
218,568	824	219,346	793	219,898	825	220,718	880	221,526	932	222,031	036	223,082	980
218,632	967	219,347	841	219,995	978	220,720	875	221,526	934	222,033	975	223,101	994
218,699	777	219,348	780	220,006	874	220,721	850	221,529	049	222,977	1005	223,140	975
218,694	746	219,349	006	220,911	829	220,732	899	221,548	929	222,158	951	223,145	986
218,715	757	219,651	780	220,012	794	220,771	869	221,552	982	222,159	971	222,153	987
218,718	748	219,352	787	220,025	841	220,791	875	221,553	953	222,160	977	223,263	1020
218,720	748	219,359	773	220,039	819	220,807	829	221,559	1000	222,168	977	223,264	1029
218,723	735	219,369	749	220,094	837	220,823	917	221,565	966	222,181	991	223,279	099
218,742	736	219,381	838	220,100	875	220,829	859	221,598	929	222,221	974	223,280	999
218,747	749	219,384	801	220,116	854	220,837	874	221,599	945	222,253	997	223,297	1004
218,750	749	219,387	795	220,119	875	220,840	886	221,622	909	222,268	995	223,345	1003
218,793	756	219,395	779	220,137	905	220,858	855	221,634	951	222,270	974	223,356	1004
218,892	704	219,403	779	220,157	815	220,899	860	221,641	896	222,279	972	223,369	1014
218,807	735	219,404	779	220,176	815	220,924	985	221,643	936	222,386	994	223,387	1004
218,854	757	219,420	787	220,187	845	220,925	985	221,644	949	222,423	972	223,395	999
218,898	777	219,423	787	220,195	837	220,985	953	221,645	954	222,426	1014	223,481	1008
218,010	839	219,471	819	220,196	875	221,000	916	221,646	930	222,427	1014	223,486	1014
218,923	757	219,494	793	220,212	862	221,001	916	221,679	974	222,530	985	223,616	1013
218,925	740	219,505	816	220,216	862	221.009	1003	221,697	900	222,549	1925	223,627	1000
218,965	840	219,536	804	220,230	816	221,017	911	221,702	956	222,567	978	223,644	1018
218,966	875	219,562	797	220,341	880	221,052	1094	221,716	966	222.587	975	223,652	1004
218,967	704	219,570	773	220,358	869	221,058	910	221,742	983	222,602	987	223,656	1005
218,978	950	219,599	773	220,359	869	221,082	914	221.743	971	222,624	976	223,837	1013

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(Note,—The letter "R" indicates that a reissue of the patent is referred to.)

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1,246,665R	389	1,473,243	61	1,475,259	85	1,477,385	101	1,478,798	119	1,480,520	350	1,482,380	423
1,379,038R	503	1,473,257	78	1,475,291	46	1,477,394	82	1,478,822	301	1,480,525	174	1,482,408	321
1,392,886R	403	1,473,259	56	1,475,294	90	1,477,454	101	1,478,863	119	1,480,533	182	1,482,414	424
1,394,973R	58	1,473,285	25	1,475,314	118	1,477,476	100	1,478,864	124	1,480,561	351	1,482,416	414
1,395,820R	222	1,473,286	17	1,475,323	40	1,477,478	100	1,478,880	217	1,480,640	168	1,482,418	406
1,402,070	108	1,473,316	0	1,475,327	42	1,477,401	150	1,478,892	235	1,480,675	341	1,482,438	327
1,402,615	109	1,473,327	4	1,475,373	40	1,477,511	103	1,478,926	120	1,480,706	221	1,482,455	295
1,409,554R	350	1,473,337	73	1,475,396	73	1,477,512	101	1,478,043	143	1,480,743	340	1,482,479	306
1,429,550	20	1,473,347	63	1,475,422	91	1,477,517	176	1,478,985	209	1,480,767	160	1,482,480	301
1,434,619	10	1,473,350	47	1,475,449	63	1,477,629	138	1,478,986	209	1,480,779	222	1,482,483	302
1,436,251R	795	1,473,373	2	1,475,471	09	1,477,635	124	1,478,987	209	1,480,804	219	1,482,514	447
1,437,801	144	1,473,396	24	1,475,477	77	1,477,642	124	1,478,990	217	1,480,807	224	1,482,549	301
1,438,797	145	1,473,402	9	1,475,492	56	1,477,904	216	1,479,042	210	1,480,808	210	1,482,553	301
1,445,645	16	1,473,421	60	1,475,494	69	1,477,673	121	1,479,047	186	1,480,824	221	1,482,585	338
1,448,512	30	1,473,447	138	1,475,502	118	1,477,901	233	1,479,048	186	1,480,846	222	1,482,601	491
1,452,952	121	1,473,491	42	1,475,503	138	1,477,703	221	1,479,088	157	1,480,869	182	1,482,611	315
1,456,831	144	1,473,510	19	1,475,504	118	1,477,753	133	1,479,107	490	1,480,870	222	1,482,612	315
1,459,850	144	1,473,543	56	1,475,505	118	1,477,757	133	1,479,133	103	1,480,884	222	1,482,613	315
1,457,319	147	1,473,544	56	1,475,522	153	1,477,795	233	1,479,143	182	1,480,888	205	1,482,614	315
1,457,320	147	1,473,583	58	1,475,543	44	1,477,797	221	1,479,145	160	1,480,911	222	1,482,615	315
1,466,435R	356	1,473,916	8	1,475,545	57	1,477,803	105	1,479,172	158	1,480,928	334	1,482,616	315
1 469 958	13	1,473,641	8	1,475,563	57	1,477,804	233	1,470,173	158	1,480,969	160	1,482,626	440
1,469,959	11	1,473,965	83	1,475,574	71	1,477,805	105	1,479,270	160	1,480,973	336	1,482,677	327
1,469,990	13	1,473,685	155	1,475,580	115	1,477,810	382	1,479,271	160	1,481,003	331	1,482,684	322
1,469,994	154	1,473,722	21	1,475,638	42	1,477,821	138	1,479,203	200	1,481,012	351	1,482,717	451
1,470,024	34	1,473,723	21	1,475,663	62	1,477,823	118	1,479,327	180	1,481,031	339	1,482,740	432
1,470,027	35	1,473,734	3	1,475,739	101	1,477,829	124	1,479,330	225	1,481,039	171	1,482,792	295
1,470,039	10	1,473,750	112	1,475,762	61	1,477,837	96	1,479,347	180	1,481,040	334	1,482,793	205
1,470,552	23	1,473,784	21	1,475,804	72	1,477,860	124	1,479,368	218	1,481,088	334	1,482,795	332
1,470,554	10	1,473,806	9	1,475,843	61	1,477,870	141	1,479,387	180	1,481,106	332	1,482,804	447
1,470,555	10	1,473,818	155	1,475,881	48	1,477,922	101	1,479,394	187	1,481,107	332	1,482,812	406
1,470,556	11	1,473,825	155	1,475,901	84	1,477,938	104	1,479,418	230	1,481,140	166	1,482,825	331
1,470,597	2	1,473 829	94	1,475,938	140	1,477,951	233	1,479,419	213	1,481,197	328	1,482,887	302
1,470,637	24	1 473,831	8	1,475,942	62	1,477,955	85	1,479,507	221	1,481,210	221	1,482,899	448
1,470,765	13	1,473,879	94	1,475,059	67	1,477,964	149	1,470,511	134	1,481,221	322	1,482,920	433
1,470,883	21	1,473,887	87	1,475,973	60	1,477,965	133	1,479,540	158	1,481,241	475	1,482,933	327
1,470,885	20	1,473,800	58	1,475,9[illegible]	60	1,477,086	118	1,479,541	158	1,481,326	234	1,482,939	326
1,470,887	3	1,473,001	13	1,475,99[illegible]	139	1,478,015	211	1,479,542	181	1,481,357	338	1,483,056	340
1,471,059	142	1,474,012	8	1,476,001	134	1,478,017	224	1,479,582	182	1,481,373	217	1,483,060	291
1,471,201	9	1,474,029	112	1,476,091	85	1,478,027	88	1,479,653	166	1,481,374	217	1,483,084	289
1,471,213	35	1,474,035	115	1,476,106	100	1,478,036	217	1,479,662	181	1,481 309	325	1,483,087	452
1,471,260	150	1,474,062	42	1,476,152	109	1,478,039	211	1,470,695	234	1,481,410	325	1,483,111	322
1,471,276	13	1,474,063	58	1,476,153	109	1,478,061	211	1,470,731	138	1,481,422	210	1,483,152	448
1,471,326	24	1,474,120	84	1,476,219	85	1,478,062	222	1,479,747	163	1,481,420	239	1,483,155	310
1,471,342	15	1,474,129	27	1,476,233	153	1,478,088	142	1,479,757	208	1,481,427	244	1,483,160	291
1,471,347	27	1,474,135	47	1,476,235	123	1,478,102	165	1,479,776	166	1,481,428	245	1,483,187	245
1,471,410	18	1,474,136	48	1,476,242	109	1,478,104	163	1,479,785	182	1,481,482	225	1,483,194	440
1,471,513	374	1,474,147	47	1,476,243	42	1,478,105	163	1,479,790	210	1,481,627	241	1,483,107	419
1,471,563	21	1,474,157	20	1,476,251	61	1,478,106	163	1,479,822	166	1,481,648	341	1,483,217	448
1,471,502	36	1,474,357	9	1,476,283	57	1,478,137	129	1,479,827	200	1,481,671	273	1,483,221	302
1,471,641	22	1,474,381	110	1,476,284	61	1,478,180	124	1,479,833	210	1,481,678	224	1,483,229	311
1,471,645	8	1,474,395	47	1,476,292	46	1,478,186	118	1,479,848	182	1,481,697	222	1,483,233	412
1,471,646	8	1,474,433	56	1,476,303	61	1,478,203	01	1,479,851	164	1,481,723	205	1,483,241	301
1,471,647	8	1,474,475	47	1,476,330	102	1,478,206	119	1,479 852	174	1,481,747	222	1,483,256	201
1,471,655	137	1,474,476	47	1,476,331	82	1,478,215	101	1,470,859	181	1,481,761	262	1,483,263	416
1,471,751	16	1,474,479	17	1,476,374	104	1,478,237	222	1,479,874	353	1,481,779	353	1,483,270	340
1,471,854	10	1,474,502	90	1,476,431	96	1,478,247	209	1,479,039	356	1,481,782	222	1,483,298	302
1,471,987	35	1,474,503	90	1,476,432	96	1,478,205	101	1,479,955	213	1,481,828	301	1,483,327	340
1,472,011	16	1,474,507	87	1,476,523	56	1,478,337	83	1,479,082	174	1,481,845	301	1,483,348	326
1,472,008	3	1,474,559	82	1,476,524	45	1,478,340	138	1,479,907	180	1,481,849	353	1,483,368	433
1,472,281	62	1,474,560	90	1,476,530	100	1,478,341	138	1,479,998	160	1,481,873	245	1,483,411	420
1,472,294	57	1,474,567	115	1,476,637	42	1,478,347	104	1,480,016	213	1,481,893	281	1,483,412	420
1,472,208	76	1,474,574	90	1,476,645	57	1,478,366	100	1,480,045	209	1,481,907	378	1,483,413	420
1,472,314	41	1,474,587	10	1,476,685	112	1,478,367	100	1,480,050	181	1,481,924	281	1,483,414	420
1,472,316	76	1,474,616	40	1,476,705	120	1,478,375	138	1,480,060	181	1 481,931	322	1,483,415	413
1,472,317	42	1,474,626	42	1,476,714	121	1,478,410	163	1,480 064	210	1,481,942	286	1,483,424	322
1,472,324	77	1,474,629	85	1,476,744	165	1,478,413	166	1,480,001	210	1,481,947	263	1,483,447	414
1,472,331	72	1,474,647	17	1,476,873	174	1,478,418	163	1,480,110	181	1,481,957	257	1,463,461	295
1,472,332	72	1,474,670	47	1,476,890	05	1,478,420	156	1,480,148	209	1,481,970	239	1,483,463	332
1,472,333	40	1,474,674	29	1,476,934	200	1,478,438	166	1,480,152	209	1,482,012	291	1,483,468	514
1,472,334	49	1,474,746	71	1,477,014	88	1,478,430	138	1,480,166	200	1,482,076	252	1,483,469	514
1,472,401	3	1,474,750	69	1 477,041	170	1,478,444	166	1,480,183	325	1,482,087	382	1,483,507	423
1,472,574	3	1,474,766	63	1,477,047	200	1,478,463	233	1,480 212	181	1,482,088	282	1,483,519	416
1,472,609	2	1,474,772	115	1,477,058	166	1,478,498	233	1,480 230	182	1,482,091	358	1,483,546	489
1,472,691	78	1,474,830	90	1,477,076	164	1,478,526	230	1,480,251	224	1,482,143	480	1,483,554	374
1,472,710	63	1,474,831	95	1,477,086	95	1,478,543	209	1,480,267	182	1,482,227	282	1,483,567	467
1,472,778	77	1,474,843	71	1,477,087	153	1,478,549	217	1,480,271	166	1,482,229	282	1,483,587	434
1,472,700	56	1,474,899	47	1,477,088	196	1,478,550	217	1,480,289	212	1,482 245	274	1,483,627	420
1,472,791	77	1,474,928	10	1,477,009	101	1,478,550	166	1,480,291	333	1,482 276	301	1,483,630	415
1,472,828	56	1,474,933	47	1,477,103	124	1,478,570	163	1,480 301	340	1,482,306	353	1,483,722	301
1,472,868	47	1,474,940	42	1,477,107	133	1,478 588	235	1,480,317	358	1,482,317	353	1,483,738	291
1,472,882	9	1,474,982	9	1,477,113	200	1,478,614	213	1,480,310	336	1,482,322	240	1,483,742	302
1,472,935	20	1,474,983	9	1,477,127	82	1,478,631	181	1,480,361	322	1,482,327	257	1,483,757	322
1,473,060	21	1,475,000	80	1,477,130	95	1,478,660	119	1,480,368	210	1,482,336	343	1,483,796	340
1,473,095	311	1,475,028	47	1,477,132	193	1,478,690	233	1,480,372	210	1,482,340	343	1,483,797	291
1,473,119	8	1,475,155	56	1,477,153	149	1,478,607	181	1,480,376	187	1,482,342	245	1,483,798	289
1,473,122	15	1,475,156	56	1,477,321	100	1,478,708	138	1,480,379	160	1,482,343	353	1,483,835	410
1,473,192	21	1,475,157	56	1,477,328	82	1,478,714	130	1,480,382	160	1,482 357	303	1,483,852	420
1,473,208	21	1,475,158	56	1,477,348	100	1,478,730	224	1,480,309	209	1,482,358	303	1,483,856	435
1,473,217	12	1,475,215	70	1,477,872	182	1,478,738	181	1,480,439	182	1,482,360	286	1,483,858	311
1,473,218	12	1,475,243	41	1,477,876	158	1,478,750	160	1,480 463	160	1,482,367	334	1,483,875	336
1,473,219	12	1,475,244	42	1,477,384	101	1,478,700	181	1,480,473	186	1,482,386	415	1,483,929	322

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1,483,932	322	1,466,077	392	1,488,787	495	1,490,736	502	1,492,717.	671	1,494,613	626	1,496,757	621
1,483,933	322	1,486,091	568	1,488,815	489	1,490,743	498	1,492,718	671	1,494,674	604	1,496,778	662
1,483,990	407	1,486,097	492	1,488,829	464	1,490,753	496	1,492,810	558	1,494,677	584	1,496,780	592
1,483,999	428	1,486,137	428	1,488,830	464	1,490,769	422	1,492,818	561	1,494,698	690	1,496,792	641
1,484,002	406	1,480,141	547	1,488,844	577	1,490,774	530	1,492,866	554	1,494,735	665	1,496,810	665
1,484,004	415	1 486,214	475	1,488,862	456	1,490,826	544	1,492,871	558	1,494,816	660	1,496,833	651
1,484,014	410	1,486 243	410	1,488,869	549	1,490,846	550	1,492,904	523	1,494,830	668	1,496,845	638
1,484,018	434	1,486 245	451	1,488,895	460	1,490,862	503	1 492,920	558	1,494,835	596	1,496,879	638
1,484,029	356	1,480,256	426	1,488,910	469	1,490,945	502	1,492,921	558	1,494,841	554	1,496,899	584
1,484,038	448	1,486,265	423	1,488,914	468	1,490,975	549	1,492,964	572	1,494,879	667	1,496,978	637
1,484,078	326	1,486,292	509	1,488,915	468	1,491,021	577	1,492 969	593	1,494,943	667	1,496,979	637
1,484,088	343	1,486 297	429	1,488,953	543	1,491,026	498	1,492,973	561	1,494,989	544	1,496,980	637
1,484,091	321	1,480,353	405	1,488,964	422	1,491,036	460	1,492,997	534	1,495,005	626	1,497,011	680
1,484,116	335	1,486 358	380	1,489 008	557	1,491,076	578	1,493,000	693	1,495,034	657	1,497,028	669
1,484,117	335	1,486,359	469	1,489,009	543	1,491,110	558	1,493,012	562	1,495,075	544	1,497,083	749
1,484,118	335	1,486,370	428	1,489,021	557	1,491,111	558	1,493,039	523	1,495,077	600	1,497,098	625
1,484,167	331	1 486.373	492	1,489,023	562	1,491,131	562	1,493,062	683	1,495,094	551	1,497,128	665
1,484,190	327	1,486,387	456	1,469,026	468	1,491,166	533	1,493,090	557	1,495,196	544	1,497,137	707
1,484,225	409	1,486,468	493	1,469,053	733	1,491,224	559	1,493,100	557	1,495,138	789	1,497,138	707
1,481,249	314	1,486,473	614	1,489,099	423	1,491,228	553	1,493,111	565	1,495,151	622	1,497,146	693
1,484,254	424	1,486,521	360	1,469,118	475	1,491,237	511	1,493,126	562	1,495,187	869	1,497,100	608
1,481,250	409	1,466 546	523	1,489,121	475	1,491,250	578	1,493,182	732	1,495,243	593	1,497,167	628
1,484,257	409	1,486 551	456	1,480,144	490	1,491,205	527	1,493,183	688	1,495,244	638	1,497,168	622
1,484,258	409	1,486,592	380	1,489,160	552	1,491,275	503	1,493,191	678	1,495,270	647	1,497,173	672
1,484,260	497	1,486,613	390	1,480,181	450	1,491,277	534	1,493,205	523	1,495,308	622	1,497,179	690
1,484,346	403	1,486,618	380	1,489,183	422	1,491,290	503	1,493,206	498	1,495,314	696	1,497,193	690
1,484,445	327	1,486,635	403	1,480,213	434	1,491,296	450	1,493,207	553	1,495,350	694	1,497,201	633
1,484,465	330	1,486,046	492	1,469,225	590	1,491,313	536	1,493,208	553	1,495,363	022	1,497,231	705
1,484,513	286	1,486,047	492	1,489,240	563	1,491,380	490	1,493,209	553	1,495,410	507	1,497,238	022
1,484,587	295	1,486,726	390	1,489,243	430	1,491,381	476	1,403,210	553	1,495,461	602	1,497,251	732
1,484,612	327	1,486,757	467	1,480,247	544	1,491,300	576	1,493,297	549	1,495,498	632	1,497,252	732
1,484,653	340	1,480,781	493	1,489,315	464	1,491,392	561	1,493,320	512	1,495,501	626	1,497,253	732
1,484,670	339	1,486 794	588	1,489,328	477	1,491,465	578	1,493,347	503	1,495,504	637	1,497,262	824
1,484,718	366	1,486 799	367	1,489,330	464	1,491,486	511	1,493,388	540	1,495,525	625	1,497,263	749
1,484,733	467	1,486,955	477	1,489,349	450	1,491,498	562	1,493,454	682	1,195,538	079	1,497,265	837
1,484,734	467	1,486,961	380	1,489,347	475	1,491,510	502	1,493,455	691	1 495,543	590	1,497,272	656
1,484,745	366	1,486,990	477	1,489,354	465	1,491,518	460	1,493,458	664	1,495,551	047	1,497,310	602
1,484,780	477	1,487,020	403	1,489,360	475	1,491,561	614	1,493,525	071	1,495,555	632	1,197,321	706
1,484,781	477	1,487,046	467	1,489,361	430	1,491,567	598	1,403,545	554	1,495,563	639	1,497,333	625
1,484,782	477	1,487,071	490	1,489,362	430	1,491,588	468	1,493,554	663	1,495,568	680	1,497,397	075
1,484,783	477	1,487,111	429	1,489,378	411	1,491,652	534	1,493,564	729	1,495,573	589	1,497,413	656
1,484,784	477	1,487,124	429	1,489,380	450	1,491 653	476	1,493,577	592	1,495,580	641	1,497,417	717
1,484,818	334	1,487,125	429	1,489,395	543	1,491,672	468	1,493,579	588	1,495,614	629	1,497,439	732
1,484,826	343	1,487,132	429	1,489,417	566	1,491,740	616	1,493,611	558	1,495,623	651	1,497,477	727
1,484,922	366	1,487 133	429	1,489,418	566	1,491,779	616	1,493,623	686	1,495,624	651	1,497,513	703
1,481,932	335	1,487,134	429	1,489,420	550	1,491,794	549	1,493,067	587	1,495,632	598	1,497,544	703
1,484,958	460	1,487,135	429	1,480,429	475	1,491,863	523	1,493 068	587	1,495,655	632	1,497,546	605
1,485,003	495	1,487,136	429	1,489,497	557	1,491,913	523	1,493,795	558	1,495,681	633	1,497,554	637
1,485,018R	985	1,487,145	429	1,489,525	422	1,491,910	616	1,493,798	558	1,495,705	584	1,497,563	633
1,485,024	485	1,487 174	476	1,480,546	415	1,401,929	522	1,493,731	563	1,495,776	778	1,497,595	638
1,485 025	475	1,487,182	486	1,480,554	469	1,491,944	511	1,493,748	657	1,495,813	632	1,497,600	647
1,485 070	490	1,487,205	419	1,489,684	487	1,491,960	002	1,493.756	544	1,495,891	681	1,497,607	620
1,485,071	495	1,487,240	411	1,489,707	577	1,491,998	503	1,493.757	570	1,495,893	632	1,497,615	621
1,485,072	458	1,487,275	475	1,489,741	552	1,492,910	511	1,493.758	663	1,495,961	638	1,497,649	633
1,485 083	366	1,487,285	429	1,489,744	434	1,492,027	527	1,493,778	690	1,495,972	622	1,497,657	651
1,485 118	382	1,487,438	410	1,489,763	460	1,492,034	558	1,193,798	558	1,496,004	638	1,497,664	584
1,485 158	340	1,487,449	432	1,480,786	407	1,492,051	508	1,493,847	092	1,496,036	622	1,497,672	707
1,485,177	[illegible]	1,487 456	464	1,489,787	407	1,492,054	591	1,493,874	1005	1,496,053	589	1,497,690	633
1,485,235	361	1,487,521	380	1,480,790	480	1,492,063	512	1,493,880	550	1,496,054	589	1,497,699	680
1,485,333	485	1,487,541	411	1,489,814	465	1,492,086	523	1,493,930	682	1,496,061	626	1,497,720	628
1,485,334	351	1,487,554	389	1,489,830	430	1,492,087	523	1,493,945	578	1,496,064	669	1,497,727	632
1,485,377	492	1,487,647	420	1,489,816	456	1,492,094	505	1,493,967	609	1,496,065	669	1,497,747	656
1,485,378	492	1,487,764	509	1,489,877	411	1,492,110	591	1,493,992	562	1,496,084	667	1,497,751	720
1,485,379	402	1,487,768	592	1,489,905	458	1,492,121	524	1,493,993	562	1,496,085	592	1,497,808	628
1,485,380	402	1,487,806	420	1,489,915	450	1,492,122	524	1,493,996	558	1,496,152	632	1,497,815	719
1,485,406	395	1,487,842	487	1,489,940	479	1,492,155	592	1,494,011	600	1,496,198	655	1,497,817	732
1,485,436	475	1,487,845	367	1,490,012	476	1,492,165	534	1,494,029	558	1,496,229	621	1,497,884	727
1,485,451	364	1,487,846	367	1,490,020	809	1,492,168	600	1,494,031	562	1,496,230	613	1,497,889	678
1,485 461	341	1,487,869	591	1,490,021	557	1,492,184	503	1,494,059	563	1,496,231	638	1,497,995	655
1,485 473	467	1,487,880	393	1,490,055	459	1,492,192	522	1,494,071	502	1,496,232	638	1,498,001	656
1,485,475	456	1,487,893	400	1,490,073	480	1,492,193	511	1,494,085	553	1,490,257	633	1,496,021	698
1,485,488	422	1,488,002	380	1,490,207	524	1,492,194	511	1,494,090	565	1,496,260	026	1,498,030	746
1,485,502	335	1,488,009	460	1,490,208	583	1,402,241	524	1,494,092	544	1,496,264	632	1,496,031	632
1,485,505	327	1,488,047	429	1,490,213	602	1,492,273	503	1,494,096	552	1,496,268	655	1,498,069	704
1,485,507	495	1,488,055	367	1,490,309	529	1,492,282	523	1,494,125	550	1,496,269	637	1,498,071	717
1,485,540	474	1,488,079	360	1,490,325	550	1,492,283	523	1,494,127	538	1,406,293	664	1,498,097	622
1,485,565	460	1,468,101	482	1,490,330	529	1,492,286	523	1,494,130	558	1,496,209	638	1,498,166	632
1,485,635	340	1,488,210	534	1,490,354	548	1,492,392	524	1,494,191	550	1,496,359	656	1,498,229	732
1,485,673	492	1,488,239	370	1,490,357	548	1,492,305	503	1,494,218	009	1,496,370	690	1,408,274	693
1,485,696	350	1,488,248	501	1,490,358	566	1,402,367	652	1,494,254	561	1,496,372	680	1,498,313	698
1,485,697	350	1,488,278	459	1,490,372	526	1,492,391	597	1,494,375	626	1,496,392	692	1,498,315	629
1,485,698	350	1,488,281	464	1,490,396	515	1,492,412	600	1,494,393	718	1,496,410	679	1,498,316	705
1,485,699	350	1,488,294	464	1,490,433	515	1,492,476	565	1,494 400	782	1,406,431	820	1,498,350	657
1,485,700	397	1,488,311	515	1,490,463	502	1,492,488	511	1,494,426	672	1,496,430	845	1,498,372	658
1,485 701	397	1,488,324	406	1,490,469	527	1,492,489	512	1,494,434	085	1,496,440	639	1,498,387	721
1,485,702	397	1,488,325	469	1,490,499	669	1,492,497	583	1,494,435	685	1,496,457	580	1,498,389	719
1,485,706	477	1,488,355	374	1,490,520	570	1,402,498	583	1,494,439	690	1,496,467	671	1,408,393	711
1,485,745	388	1,488,386	389	1,490,523	554	1,492,502	523	1,494,469	593	1,496,526	639	1,498,403	644
1,485 757	496	1,488,411	505	1,490,530	557	1,492,567	561	1,494,470	593	1,406,527	639	1,498,417	628
1,485,790	332	1,488,422	407	1,490,542	501	1,492.578	675	1,494,471	593	1,496,528	639	1,496,514	662
1,485,794	335	1,486,480	477	1,490,546	422	1,492.636	412	1,494,472	593	1,496,605	641	1,408,528	703
1 485,814	370	1,408,481	477	1,400,586	422	1,492,656	544	1,494,473	593	1,406,600	641	1,408,664	711
1,485,816	467	1,488,553	475	1,490,627	557	1,402 601	671	1,494,474	593	1,496,607	641	1,498,635	787
1,485 844	509	1,488,571	577	1,490,646	463	1,492,664	667	1,494,475	503	1,496,609	625	1,496,630	767
1,485,900	368	1,468,605	411	1,490,690	523	1,492,665	667	1,404,476	593	1,496,641	584	1,498,637	787
1,485,026	343	1,488,608	464	1,490,703	567	1,492,685	679	1,494,479	616	1,406,640	820	1,498,639	804
1,485 940	570	1,488,730	577	1,490,728	507	1,492,712	557	1,494,535	618	1,496,675	693	1,498,641	808
1,486 002	492	1,466,746	476	1,490,732	524	1,492,713	557	1,494,536	797	1,496,742	026	1,408,798	703

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1,408,717	712	1,500,845	698	1,502,336	737	1,504,451	820	1,506,227	659	1,508,083	949	1,510,196	922
1,408,766	696	1,500,890	742	1,502,370	743	1,504,459	1024	1,506,228	850	1,508,089	928	1,510,216	943
1,498,708	718	1,500,915	705	1,502,421	830	1,504,460	782	1,506,246	874	1,508,101	914	1,510,242	950
1,498,781	808	1,500,954	718	1,502,422	830	1,504,492	820	1,506,269	830	1,508,106	929	1,510,271	916
1,498,782	608	1,500,057	719	1,502,425	637	1,504,493	620	1,506,281	876	1,508,130	930	1,510,284	900
1,408,707	784	1,500,993	712	1,502,455	754	1,504,549	829	1,506,301	870	1,508,164	951	1,510,342	909
1,498,833	712	1,500,994	712	1,502,482	812	1,504,557	819	1,500,316	1008	1,508,185	1030	1,510,353	1005
1,498,842	718	1,500,995	712	1,502,514	797	1,504,588	839	1,506,317	1009	1,508,211	949	1,510,358	911
1,408,865	718	1,501,014	779	1,502,547	831	1,504,624	780	1,506,322	1000	1,508,241	914	1,510,373	943
1,498,866	718	1,501,101	777	1,502,503	886	1,504,627	829	1,500,323	1000	1,508 243	914	1,510,433	1006
1,498,903	718	1,501,108	797	1,502,592	821	1,504,685	788	1,506,351	1023	1,508,283	930	1,510,434	1006
1,408,011	608	1,501,111	740	1,502,600	778	1,504,701	831	1,506,385	1017	1,508,331	983	1,510,442	900
1,498,913	781	1,501,140	737	1,502,042	792	1,504,702	831	1,506,444	899	1,508,355	043	1,510,469	1027
1,498,917	704	1,501,182	803	1,502,086	743	1,504,730	821	1,506,460	850	1,508,367	053	1,510,485	1020
1,498,924	756	1,501,183	792	1,502,793	740	1,504,772	821	1,506,501	1027·	1,508,374	951	1,510,610	1000
1,498,990	718	1,501,184	792	1,502,849	860	1,504,777	816	1,500,530	999	1,508,405	856	1,510,521	1013
1,499,001	808	1,501,202	794	1,502,805	855	1,504,778	816	1,506,531	999	1,508,409	863	1,510,526	1025
1,499,002	808	1,501,206	743	1,502,806	860	1,504,781	816	1,506,537	830	1,508,435	884	1,510,541	1016
1,499,020	718	1,501,207	743	1,502,807	855	1,504,813	1012	1,506,545	825	1,508,436	884	1,510,556	1000
1,499,025	708	1,501,274	808	1,502,911	774	1,504,820	780	1,506,609	876	1,508,448	1030	1,510,568	1000
1,499,033	704	1,501,275	808	1,502,941	770	1,504,837	780	1,500,633	870	1,508,451	1012	1,510,588	1000
1,499,042	788	1,501,321	755	1,502,945	870	1,504,860	779	1,506,650	099	1,508,455	1013	1,510,590	1018
1,499,068	718	1,501,336	800	1,502,950	804	1,504,861	770	1,506,732	1027	1,508,457	1000	1,510,508	1013
1,499,164	804	1,501,348	781	1,502,969	740	1,504,923	780	1,506,736	882	1,508,478	914	1,510,606	1027
1,499,285	717	1,501,356	793	1,502,983	704	1,504,980	813	1,506,772	914	1,508,483	004	1,510,636	1000
1,499,317	718	1,501,371	821	1,503,013	788	1,505,043	784	1,506,840	876	1,508,484	904	1,510,706	1020
1,499,354	740	1,501,383	822	1,503,044	862	1,505,044	784	1,506,877	1005	1,508,555	896	1,510,759	073
1,499,363	742	1,501,413	752	1,503,054	774	1,505,057	821	1,506,878	1005	1,508,556	914	1,510,793	1000
1,409,378	698	1,501,414	746	1,503,093	779	1,505,065	780	1,506,894	914	1,508,557	876	1,510,829	1014
1,499,414	753	1,501,415	747	1,503,113	757	1,505,078	1012	1,506,942	914	1,508,561	914	1,510,891	1012
1,490,481	774	1,501,419	747	1,503,133	774	1,505,100	675	1,500,946	006	1,508,563	926	1,510,918	1006
1,499,492	729	1,501,420	795	1,503,150	788	1,505,162	774	1,506,963	908	1,508,567	1017	1,510,956	1000
1,499,544	746	1,501,425	794	1,503,172	862	1,505,185	998	1,506,909	1012	1,508,569	1024	1,510,983	1004
1,409,567	704	1,501,436	747	1,503,177	862	1,505,202	670	1,507,076	915	1,508,578	860	1,511,003	1021
1,499,600	804	1,501,472	808	1,503,186	774	1,505,206	831	1,507,069	008	1,508,613	676	1,511,063	1017
1,490,011	787	1,501,403	784	1,503,193	789	1,505,281	794	1,507,105	908	1,506,617	898	1,511,074	1008
1,499,015	794	1,501,502	770	1,503,194	741	1,505,295	670	1,507,108	922	1,508,025	900	1,511,142	1017
1,499,626	804	1,501,513	737	1,503,229	875	1,505,323	875	1,507,120	1012	1,508,628	984	1,511,192	975
1,499,693	753	1,501,514	737	1,503,234	779	1,505,324	875	1,507,121	1027	1,508,686	930	1,511,194	1018
1,499,706	718	1,501,515	737	1,503,250	747	1,505,338	819	1,507,152	914	1,508,732	877	1,511,195	1018
1,499,749	770	1,501,527	603	1,503,304	777	1,505,330	819	1,507,201	908	1,508,758	877	1,511,196	1018
1,490,750	704	1,501,553	743	1,503,315	747	1,505,340	810	1,507,210	904	1,508,769	1019	1,511,197	1018
1,499,761	808	1,501,587	747	1,503,420	709	1,505,382	797	1,507,214	914	1,508,777	670	1,511,212	939
1,499,705	886	1,501,635	808	1,503,430	709	1,505,438	840	1,507,280	909	1,508,807	933	1,511,216	972
1,499,798	743	1,501,645	760	1,503,443	793	1,505,453	822	1,507,330	1009	1,508,028	864	1,511,323	983
1,499,801	752	1,501,646	774	1,503,481	788	1,505,479	822	1,507,337	1030	1,500,034	864	1,511,359	039
1,490,850	698	1,501,756	753	1,503,530	891	1,505,495	875	1,507,338	1027	1,509,035	883	1,511,380	978
1,499,872	704	1,501,760	747	1,503,547	803	1,505,490	780	1,507,340	1017	1,509,082	1027	1,511,418	963
1,499,896	737	1,501,769	741	1,503,564	787	1,505,517	821	1,507,346	1017	1,509,083	1027	1,511,461	967
1,499,908	778	1,501,775	764	1,503,603	788	1,505,534	904	1,507,379	1013	1,509,084	1027	1,511,472	958
1,400,922	795	1,501,791	757	1,503,604	784	1,505,551	904	1,507,397	914	1,500,085	1027	1,511,404	944
1,409,930	770	1,501,840	746	1,503,631	890	1,505,560	795	1,507,426	922	1,509,080	1027	1,511,535	072
1,500,013	782	1,501,865	746	1,503,644	883	1,505,568	782	1,507,452	876	1,509,087	1027	1,511,560	080
1,500,040	779	1,501,870	778	1,503,648	870	1,505,569	782	1,507,500	860	1,509,088	1027	1,511,561	980
1,500,041	779	1,501,873	756	1,503,657	802	1,505,603	795	1,507,521	855	1,509,138	915	1,511,623	995
1,500,060	708	1,501,875	774	1,503,702	790	1,505,634	816	1,507,545	870	1,509,156	950	1,511,628	984
1,500,066	740	1,501,876	774	1,503,750	795	1,505,648	670	1,507,559	936	1,509,172	905	1,511,646	980
1,500,080	808	1,501,877	779	1,503,751	793	1,505,663	837	1,507,560	909	1,509,195	972	1,511,664	977
1,500,096	746	1,501,881	821	1,503,772	749	1,505,660	705	1,507,565	927	1,500,196	033	1,511,741	039
1,500,124	735	1,501,887	752	1,503,835	779	1,505,606	683	1,507,581	950	1,509,227	050	1,511,754	059
1,500,126	746	1,501,894	890	1,503,892	803	1,505,718	670	1,507,594	054	1,500,273	905	1,511,771	968
1,500,128	735	1,501,900	752	1,503,897	743	1,505,750	838	1,507,624	917	1,500,275	933	1,511,784	053
1,500,202	779	1,501,911	742	1,503,007	858	1,505,751	838	1,507,659	1005	1,509,325	1005	1,511,786	954
1,500,219	753	1,501,914	700	1,503,937	662	1,505,752	838	1,507,664	1014	1,509,326	1005	1,511,800	033
1,500,220	753	1,501,915	601	1,503,956	802	1,505,767	830	1,507,665	1014	1,500,338	905	1,511,608	994
1,500,221	754	1,501,916	801	1,503,984	662	1,505,768	830	1,507,073	1003	1,509,355	957	1,511,829	985
1,500,222	754	1,501,924	784	1,504,036	747	1,505,798	821	1,507,674	1003	1,509,467	922	1,511,874	067
1,500,255	709	1,501,925	784	1,504,044	862	1,505,870	621	1,507,675	1003	1,509,553	933	1,511,912	1013
1,500,256	740	1,501,938	869	1,504,060	902	1,505,880	831	1,507,676	1003	1,500,554	933	1,511,929	944
1,500,265	740	1,501,952	737	1,504,061	902	1,505,912	782	1,507,677	1003	1,509,608	914	1,511,049	045
1,500,289	746	1,501,975	831	1,504,125	741	1,505,918	831	1,507,678	1003	1,509,624	914	1,511,961	972
1,500,303	756	1,502,004	774	1,504,134	862	1,505,934	784	1,507,679	1003	1,509,667	933	1,511,984	987
1,500,323	779	1,502,035	747	1,504,150	812	1,505,944	816	1,507,687	930	1,509,686	930	1,512,277	1018
1,500,366	742	1,502,070	830	1,504,164	741	1,505,990	1018	1,507,690	1012	1,509,668	950	1,512,299	1013
1,500,378	742	1,502,076	802	1,504,105	741	1,506,001	855	1,507,692	1005	1,500,774	914	1,512,414	1014
1,500,433	771	1,502,079	788	1,504,175	876	1,506,013	920	1,507,694	927	1,509,610	1005	1,512,490	1006
1,500,461	740	1,502,101	784	1,504,178	743	1,506,019	1000	1,507,709	942	1,509,872	978·	1,512,505	1000
1,500,500	708	1,502,129	793	1,504,206	837	1,506,053	876	1,507,719	029	1,500,920	977	1,512,687	990
1,500,545	764	1,502,149	690	1,504,207	637	1,506,060	830	1,507,740	050	1,509,947	950	1,512,776	999
1,500,594	778	1,502,166	737	1,504,225	800	1,506,081	920	1,507,858	950	1,510,070	905	1,512,801	1013
1,500,609	748	1,502,188	766	1,504,265	816	1,506,104	830	1,507,891	938	1,510,071	950	1,512,868	1013
1,500,618	762	1,502,213	746	1,504,208	794	1,506,115	699	1,507,892	938	1,510,074	954	1,512,870	1006
1,500,651	748	1,502,222	764	1,504,338	794	1,506,118	870	1,507,942	927	1,510,131	933	1,512,909	1030
1,500,715	793	1,502,260	737	1,504,339	820	1,506,164	822	1,507,067	942	1,510,132	962	1,513,280	1018
1,500,770	761	1,502,261	621	1,504,340	829	1,506,186	1004	1,507,908	942	1,510,140	011	1,513,370	1010
1,500,789	718	1,502,275	890	1,504,350	838	1,506,189	1016	1,506,015	1012	1,510,172	951	1,513,465	999
1,500,794	795	1,502,285	746	1,504,385	760	1,506,198	886	1,508,032	949	1,510,173	951	1,513,466	1018
1,500,644	720	1,502,321	752	1,504,437	1008	1,506,216	1000	1,508,061	943	1,510,195	922	1,513,615	1027

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286,527	403	377,229	355	381,339	29	382,924	265	384,772	440	386,874	421	388,792	707
302,570	403	377,354	282	381,341	17	382,971	437	384,790	370	386,889	414	388,793	797
302,840	286	377,400	133	381,348	17	382,983	95	384,846	328	386,891	644	388,794	797
303,051	293	377,410	45	381,350	353	382,984	95	384,955	651	386,908	320	388,795	797
303,910	403	377,451	832	381,351	448	383,028	282	384,965	379	386,934	322	388,800	760
304,340	403	377,473	328	381,405	96	383,098	279	384,982	370	386,935	617	388,814	414
330,673	35	377,487	393	381,413	24	383,184	290	385,027	452	386,939	617	388,845	769
341,072	816	377,586	133	381,418	90	383,189	482	385,040	591	386,996	452	388,849	379
341,073	816	377,587	355	381,420	22	383,190	449	385,073	403	386,998	591	388,902	634
346,112	502	377,588	355	381,422	25	383,192	485	385,153	366	387,011	578	388,925	508
349,079	41	377,580	355	381,444	42	383,210	262	385,165	389	387,066	283	388,942	490
340,320	62	377,654	393	381,449	78	383,315	407	385,210	452	387,086	437	388,961	490
352,046	829	377,814	355	381,450	102	383,316	294	385,214	424	387,107	490	388,996	334
352,432	48	377,816	355	381,461	24	383,317	294	385,222	411	387,100	451	388,998	414
353,497	48	377,817	355	381,479	487	383,319	203	385,240	390	387,144	286	389,022	527
354,218	60	377,861	398	381,499	68	383,320	294	385,302	341	387,207	314	389,034	429
355,098	58	377,990	401	381,503	16	383,321	294	385,305	390	387,230	389	389,066	406
356,230	41	378,009	115	381,516	68	383,322	294	385,338	428	387,273	442	389,070	421
357,182	119	378,130	430	381,519	05	383,323	294	385,371	326	387,276	395	389,072	419
357,268	384	378,138	355	381,526	21	383,417	302	385,373	323	387,278	389	389,086	434
358,623	392	378,155	355	381,527	21	383,420	493	385,374	379	387,284	294	389,141	423
358,626	328	378,213	401	381,551	155	383,430	251	385,376	616	387,291	370	389,143	424
391,864	133	378,292	461	381,575	68	383,431	299	385,413	388	387,292	365	389,151	809
362,350	403	378,550	23	381,577	21	383,433	421	385,476	421	387,293	395	389,160	421
363,166	134	378,600	83	381,632	52	383,434	294	385,494	392	387,375	740	389,191	421
363,470	389	378,713	356	381,660	36	383,435	294	385,500	331	387,397	340	389,165	629
363,604	301	378,802	354	381,094	379	383,436	294	385,506	389	387,398	340	389,189	561
365,115	366	378,989	650	381,700	17	383,477	567	385,556	590	387,438	496	389,206	415
365,209	119	370,026	482	381,712	334	383,480	578	385,557	420	387,444	365	389,232	411
365,587	420	379,204	69	381,713	77	383,510	356	383,558	295	387,445	326	389,233	410
395,909	301	379,298	66	381,715	95	383,511	356	385,624	297	387,453	769	389,238	421
366,535	423	379,319	314	381,723	503	383,515	256	385,644	288	387,471	389	389,241	434
366,790	123	379,355	106	381,762	17	383,528	449	385,651	341	387,474	358	389,282	411
367,311	845	379,419	347	381,781	25	383,534	432	385,708	357	387,524	283	389,296	419
367,608	119	379,436	153	381,798	52	383,535	341	385,712	205	387,576	400	389,298	810
368,600	138	379,698	436	381,812	17	383,536	295	385,760	026	387,577	366	389,299	819
369,424	35	379,699	451	381,866	17	383,537	388	385,761	366	387,582	283	389,324	801
369,425	35	379,752	401	381,886	20	383,538	537	385,768	415	387,503	360	389,353	556
369,634	124	379,832	141	381,915	2	383,539	493	385,860	327	387,594	333	389,360	800
369,763	133	370,880	401	381,016	413	383,540	578	385,878	286	387,597	640	389,393	410
369,826	421	379,881	402	381,057	448	383,565	265	385,893	301	387,687	436	389,402	406
370,476	181	379,895	85	382,004	95	383,567	304	385,933	396	387,762	769	389,403	449
371,380	331	379,940	452	382,011	402	383,621	270	385,934	396	387,770	379	389,404	709
372,296	90	370,950	402	382,041	95	383,666	275	385,056	329	387,807	282	389,405	810
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373,303	35	370,952	402	382,043	95	383,600	265	386,012	482	387,883	294	389,471	780
373,488	384	379,953	369	382,048	88	383,748	452	386,013	434	387,903	366	389,481	423
373,589	48	379,964	411	382,040	82	383,774	379	386,021	572	387,942	294	389,510	421
373,850	654	380,169	335	382,085	90	383,779	270	386,039	633	387,952	336	389,511	429
373,862	48	380,180	29	382,086	90	383,793	549	386,056	414	387,963	769	389,512	437
373,986	448	380,203	153	382,089	95	383,794	502	386,062	302	387,979	793	389,561	409
374,117	301	380,323	402	382,001	537	383,795	549	386,131	238	387,988	804	389,579	919
374,358	84	380,331	47	382,137	403	383,815	303	386,133	415	388,021	283	389,609	423
374,503	369	380,387	45	382,147	143	383,892	202	386,177	301	388,023	769	389,623	421
375,108	353	380,393	13	382,216	95	383,893	262	386,220	626	388,106	374	389,624	450
375,296	64	380,438	8	382,234	500	383,902	201	386,293	843	388,127	323	389,650	435
375,293	100	380,452	64	382,258	388	383,905	547	386,294	239	388,148	334	389,657	408
375,370	353	380,497	11	382,294	523	383,911	270	386,295	257	388,185	808	389,607	407
375,462	314	380,503	402	382,327	153	383 922	265	386,296	256	388,180	785	389,748	437
375,463	329	380,577	433	382,356	792	384,105	294	386,301	389	388,187	450	389,749	440
375,616	329	380,578	413	382,366	82	384,100	411	386,319	341	388,193	390	389,752	409
375,636	68	380,593	482	382,367	84	384,107	316	386,338	616	388,213	374	389,754	485
375,637	8	380,623	295	382,383	95	384,134	578	386,374	297	388,226	537	389,755	614
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375,641	52	380,784	106	382,429	104	384,147	527	386,395	238	388,283	424	389,774	550
375,715	354	380,884	155	382,451	534	384,157	534	386,306	334	388,289	392	389,778	654
375,716	287	380,885	155	382,459	316	384,178	279	386,517	257	388,293	809	389,810	485
375,753	189	380,886	155	382,460	207	384,217	282	386,518	293	388,321	800	389,813	708
375,792	314	380,887	155	382,463	251	384,221	405	386,519	245	388,343	374	389,815	810
375,703	320	380,888	155	382,467	415	384,223	294	386,563	286	388,344	374	389,816	810
375,871	95	380,891	31	382,496	102	384,224	389	386,596	257	388,370	334	389,834	409
376,002	384	380,899	16	382,506	103	384,225	537	386,597	590	388,382	591	389,866	588
376,013	400	380,917	4	382,513	296	384,250	616	386,598	580	388,396	421	389,868	428
376,074	336	380,918	448	382,514	200	384,251	616	386,602	301	388,467	366	389,878	786
376,075	336	380,919	402	382,527	297	384,266	380	386,606	336	388,469	437	389,880	811
376,076	384	380,942	290	382,545	388	384,280	530	386,612	305	388,511	538	389,881	811
376,077	336	380,971	155	382,554	316	384,288	387	386,614	257	388,534	809	389,896	589
376,079	384	380,999	16	382,556	96	384,205	397	386,615	617	388,535	433	389,928	548
376,213	104	381,000	60	382,558	295	384,351	537	386,616	493	388,545	421	389,946	410
376,348	401	381,042	398	382,575	270	384,354	442	386,617	618	388,547	367	389,948	811
376,287	354	381,044	17	382,606	01	384,355	842	386,618	591	388,548	429	389,992	433
376,470	354	381,049	301	382,646	91	384,364	283	386,619	617	388,540	428	389,994	415
376,471	329	381,054	95	382,664	297	384,376	387	386,632	327	388,600	420	390,076	437
376,472	354	381,055	256	382,665	295	384,561	320	386,679	617	388,609	334	390,004	528
376,474	115	381,113	4	382,693	449	384,562	256	386,686	282	388,628	010	390,123	511
376,606	297	381,144	13	382,714	449	384,576	347	386,687	452	388,629	800	390,145	514
376,635	354	381,162	31	382,749	104	384,587	616	386,688	449	388,062	305	390,163	579
376,698	354	381,177	293	382,792	282	384,588	616	386,691	616	388,669	769	390,164	579
376,743	641	381,178	17	382,814	423	384,634	287	386,708	641	388,704	384	390,165	579
377,007	354	381,179	420	382,815	204	384,642	625	386,733	604	388,706	334	390,284	523
377,119	401	381,180	414	382,904	356	384,675	392	386,743	450	388,718	430	390,333	811
377,198	379	381,181	402	382,906	297	384,688	616	386,760	617	388,724	416	390,303	422
377,199	133	381,270	402	382,911	449	384,689	616	386,821	392	388,789	421	390,304	420
377,227	482	381,292	448	382,913	440	384,717	801	386,862	774	388,791	421	390,305	421

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390,399	811	391,699	770	393,283	728	394,797	849	396,221	753	397,423	927	399,074	905
390,433	517	391,727	559	393,292	641	394,816	753	396,261	905	397,434	826	399,138	939
390,434	503	391,745	811	393,293	928	394,817	749	396,284	826	397,458	810	399,148	927
390,478	485	391,766	502	393,327	622	394,819	752	396,289	818	397,466	899	399,176	914
390,480	517	391,800	561	393,394	599	394,824	753	296,298	896	397,473	842	399,221	921
390,543	517	391,821	579	393,408	698	394,850	812	396,307	969	397,591	821	399,289	990
390,602	422	391,822	515	393,442	814	394,851	849	396,357	788	397,601	966	399,294	911
390,620	452	391,865	502	393,449	801	394,869	849	396,376	812	397,603	879	399,313	918
390,622	538	391,873	553	393,480	633	394 946	840	396,377	793	397,934	810	399,394	927
390,623	450	391,916	879	393,481	848	394,967	752	396,380	844	397,641	876	399,399	914
390,646	423	391,917	502	393,535	633	394,968	914	396,382	906	397,682	930	399,446	911
390,658	811	391,935	603	393,537	638	395,033	746	396,402	902	397,700	987	399,456	911
390,723	547	391,938	502	393,548	633	395,092	890	396,438	850	397,705	928	399,464	969
390,787	422	391,969	593	393,550	848	395,105	752	396,453	890	397,750	863	399,465	909
390,791	421	391,995	555	393,551	848	395,119	742	396,454	825	397,764	829	399,466	900
390,794	422	391,999	770	393,566	682	395,130	850	396,485	813	397,812	816	399,467	891
390,796	467	392,022	602	393,568	681	395,141	737	396,507	891	397,814	863	399,725	1014
390,797	596	392,023	602	393,589	680	395,285	754	396,508	891	397,824	879	399,732	909
390,798	450	392,036	512	393,625	788	395,357	746	396,509	863	397,828	967	399,741	902
390,836	487	392,038	578	393,627	704	395,359	793	396,510	879	397,848	845	399,823	909
390,840	506	392,045	498	393,633	849	395,393	793	396,512	792	397,860	821	399,845	951
390,842	548	392,067	812	393,636	718	395,395	793	396,545	820	397,886	967	399,877	967
390,847	460	392,089	512	393,693	590	395,396	793	396,550	809	397,898	831	399,906	943
390,848	450	392,094	633	393,694	678	395,418	740	396,607	826	397,901	943	399,901	999
390,849	626	392,095	589	393,697	919	395,419	747	396,664	966	397,902	943	399,903	927
390,850	459	392,130	618	393,702	662	395,422	842	396,676	826	397,927	826	399,953	930
390,861	502	392,142	589	393,728	706	395,433	747	396,677	826	397,933	943	400,057	983
390,862	502	392,193	584	393,756	679	395,434	747	396,687	850	397,937	956	400,138	984
390,886	793	392,206	589	393,762	771	395,435	890	396,691	830	398,007	778	400,185	905
390,897	579	392,236	589	393,790	813	395,490	747	396,695	788	398,009	967	400,216	1000
390,917	753	392,279	594	393,865	622	395,502	993	396,696	890	398,010	967	400,240	930
390,930	416	392,280	711	393,866	711	395,508	737	396,697	809	398,011	891	400,249	1027
390,931	509	392,289	512	393,880	749	395,509	737	396,752	788	398,025	951	400,269	984
390,936	522	392,336	648	393,947	707	395,510	747	396,784	891	398,058	837	400,297	972
390,945	482	392,360	593	393,963	753	395,520	759	396,788	737	398,063	930	400,301	943
390,997	485	392,371	593	393,964	753	395,563	802	396,811	1004	398,074	966	400,379	984
390,998	422	392,373	584	394,045	755	395,637	735	396,864	810	398,099	928	400,420	943
391,011	467	392,408	596	394,049	698	395,638	849	396,914	813	398,158	944	400,422	943
391,125	515	392,427	679	394,051	711	395,666	813	396,932	832	398,171	820	400,423	1012
391,131	468	392,428	679	394,083	813	395,752	845	396,942	788	398,204	891	400,424	944
391,216	456	392,442	651	394,104	831	395,754	747	396,943	829	398,209	874	400,425	943
391,217	467	392,452	761	394,107	687	395,766	832	396,956	919	398,256	879	400,461	933
391,235	479	392,455	596	394,116	849	395,824	830	397,012	826	398,307	818	400,462	1021
391,267	554	392,457	596	394,119	751	395 876	826	397,079	810	398,308	943	400,474	942
391,283	485	392,458	812	394,120	752	395,893	793	397,086	832	398,318	942	400,509	985
391,296	517	392,459	812	394,130	756	395,920	800	397,097	829	398,319	944	400 525	1009
391,300	811	392,470	680	394,193	680	395,940	813	397,135	900	398,320	942	400,570	1009
391,314	482	392,517	749	394,195	825	395,949	883	397,148	778	398,321	944	400,626	983
391,318	523	392,525	592	394,196	740	395,950	777	397,150	891	398,322	870	400,743	1009
391,346	733	392,598	752	394,199	760	395,957	826	397,151	810	398,405	943	400,769	1004
391,361	467	392,656	812	394,255	843	395,958	831	397,219	927	398,406	891	400,815	983
391,362	467	392,660	609	394,312	801	395,978	788	397,222	986	398,465	896	400,857	939
391,428	579	392,668	821	394,319	743	396,025	831	397,225	819	398,466	943	400,858	1009
391,499	553	392,705	604	394,360	804	396,029	993	397,241	789	398,486	952	400,859	1009
391,539	840	392,714	770	394,362	711	396,036	747	397,262	939	398,514	945	400,923	1909
391,553	526	392,797	587	394,366	707	396,048	842	397,275	810	398,555	962	401,010	986
391,563	561	392,798	665	394,435	698	396,070	826	397,292	950	398,573	943	401,011	987
391,591	523	392,813	809	394,488	849	396,093	845	397,310	966	398,578	944	401,046	1014
391,602	511	392,868	662	394,497	664	396,115	859	397,314	849	398,579	944	401,124	939
391,603	511	392,873	821	394,498	712	396,117	1004	397,315	879	398,640	899	401,145	977
391,617	567	392,907	812	394,500	675	396,118	778	397,316	849	398,642	908	401,160	1013
391,624	503	392,927	843	394,532	831	396,129	804	397,332	877	398,709	818	401,202	013
391,636	561	392,952	723	394,575	712	396,137	826	397,334	810	398,766	898	401,252	986
391,662	830	392,988	603	394,577	698	396,158	845	397,346	876	398,775	943	401,327	987
391,666	562	392,989	603	394,578	712	396,199	845	397,363	826	398,852	967	401,419	980
391,667	527	393,072	603	394,680	708	396,209	892	397,364	826	398,879	822	401,420	977
391,674	811	393,135	749	394,730	849	396,213	787	397,385	850	398,921	902	401,421	977
391,675	762	393,150	682	394,794	825	396,215	801	397,405	919	399,063	919	401,422	977
391,698	766	393,242	664	394,795	809								

List of Journals Abstracted, with Abbreviations Used, and Addresses of Publishers and Prices.

Journal.	Abbreviation.	Address of Publisher and Price.*
Agricultural Journal of India ..	Agric. J. India	W. Thacker and Co., 2, Creed Lane, London. 2s.
Agricultural Research Institute, Pusa, Reports and Bulletins	Rep. (Bull.) Agric. Res. Inst. Pusa	Supt. Govt. Printing, Calcutta. Price varies.
Allgemeine Zeitschrift für Bierbrauerei und Malzfabrikation	Allgem. Z. Bierbrau. ..	Michaelerstrasse 25, Vienna XVIII/1. $4 per annum.
American Journal of Pharmacy..	Amer. J. Pharm. ..	145, North Tenth Street, Philadelphia, Pa., U.S.A. 50 cents.
American Journal of Science ..	Amer. J. Sci.	New Haven, Conn., U.S.A. 50 cents.
Anales de la Asociación Quimica Argentina	Anal. Asoc. Quim. Argentina	Av. de Mayo, 1157, Buenos Aires. 60 c.
Anales de la Sociedad Española de Física y Química	Anal. Fis. Quim. ..	D. M. T. Gil Garcia, Corredera Baja de San Pablo, 59, Madrid. 20 pesetas per annum.
Analyst	Analyst	W. Heffer and Sons, Ltd., 4, Petty Cury, Cambridge. 3s.
Annalen der Chemie	Annalen	Verlag Chemie, Leipzig, Germany. $1.60 per vol.
Annalen der Physik	Ann. Physik	J. A. Barth, Leipzig. R.M. 20 per vol.
Annales de Chimie	Ann. Chim.	Masson et Cie., 120, Boulevard St. Germain, Paris, VIe. 45 fr. per annum.
Annales de Chimie Analytique ..	Ann. Chim. Analyt. ..	M. Crinon, 20, Boulevard Richard-Lenoir, Paris, 11e. 2 fr.
Annales des Falsifications ..	Ann. Falsif.	M. Filaudeau, 42 bis, Rue de Bourgogne, Paris, VIIe. 4 fr.
Annales de l'Institute Pasteur ..	Ann. Inst. Pasteur ..	Masson et Cie, 120, Boulevard St. Germain, Paris, 6e. 5 fr.
Annales de Physique	Ann. Physique	Masson et Cie, 120, Boulevard St. Germain, Paris, VIe. 45 fr. per annum.
Annales de la Science Agronomique Française et Étrangère	Ann. Sci. Agron. ..	Librairie Berger-Levrault, 136, Boulevard St. Germain, Paris, 6e. 5.25 fr.
Annali di Chimica Applicata ..	Annali Chim. Appl. ..	Via Quattro Novembre, 154, Rome, (1). L. 15.
Annali della R. Stazione Chimico Agraria Sperimentale di Roma	Ann. R. Staz. Chim. Agrar. Sperim. Roma	R. Stazione Chimico-Agraria Sperimentale di Roma, Rome.
Apotheker-Zeitung	Apoth.-Ztg.	Levetzowstrasse 16b, Berlin, N.W. 87.
Archief voor de Suikerindustrie..	Arch. Suikerind. ..	Suikersyndicaat te Soerabaja, Netherlands E. Indies.
Archiv für Experimentelle Pathologie und Pharmakologie	Arch. expt. Path. Pharm.	Verlag von F. C. W. Vogel, Leipzig. 26s. 6d. per vol.
Archiv der Pharmazie	Arch. Pharm.	Verlag Chemie, Berlin, Germany. $4 per annum.
Archives des Sciences Physiques et Naturelles	Arch. Sci. phys. nat. ..	Rue de Vieux-College, 4, Geneva, Switzerland. 6 fr.
Archivio di Farmacologia sperimentale e scienze affini	Arch. Farm. sperim. ..	Via Depretis, 92, Rome. Lire 4.
Atti della Reale Accademia Nazionale dei Lincei, Roma	Atti R. Accad. Lincei Roma	Tipografia della R. Accademia Nazionale dei Lincei, Rome. Lire 108 per annum.
Berichte der Deutschen Chemischen Gesellschaft	Ber.	Verlag Chemie, Leipzig, Germany. $15 per annum.
Berichte der Deutschen Pharmazentischen Gesellschaft	Ber. deuts. Pharm. Ges.	Incorporated with Archiv der Pharmazie.
Berichte des Ohara Instituts für landwirtschaftliche Forschungen	Ber. Ohara Inst. landw. Forsch.	Verlag der Ohara Schonokai, Kuraschiki Provinz Okayama. Price varies.
Biedermann's Zentralblatt für Agrikulturchemie	Bied. Zentr.	O. Leiner, Konigstrasse 26B, Leipzig, Germany. M. 24 per annum.
Biochemical Journal	Biochem. J.	Cambridge University Press, Fetter Lane, London, E.C. 15s.
Biochemische Zeitschrift ..	Biochem Z.	Verlag von J. Springer, Berlin, W. 9, Linkstrasse 23-24.
Bolletino Chimico-Farmaceutico	Boll. Chim. farm. ..	Via Cappuccio, 19, Milan, Italy. L. 1.80.
Brennstoff-Chemie	Brennstoff-Chem. ..	Verlag W. Girardet, Essen. G.M. 1.5.
Brewers' Journal..	Brewers' J.	L. M. Reed, Eastcheap Buildings, Eastcheap, London, E.C. 3. 3s.
British Journal of Photography..	Brit. J. Phot.	24, Wellington Street, London, W.C. 2. 3d.
Buletinul Societátei de Chimie din România	Bul. Soc. Chim. România	Boulevard Carol, 16, Bucarest.
Bulletin de l'Academie Royale de Belgique, Classe des Sciences	Bull. Acad. roy. Belg., Cl. Sci.	M. Lambertin, Rue Coudenberg, 58-62, Brussels.
Bulletin de l'Association des Chimistes de Sucrerie et de Distillerie	Bull. Assoc. Chim. Sucr.	156, Boulevard Magenta, Paris, 10e. 4 fr.
Bulletin of the Bureau of Bio-Technology	Bull. Bureau Bio-Technol.	Murphy and Son, Ltd., Sheen Lane, Mortlake, London, S.W. 14. 7s. 6d. per annum.

* The price for single copies is given where these are sold separately. In other cases it is only possible to buy the Journals in question in complete volumes.

JOURNAL.	ABBREVIATION.	ADDRESS OF PUBLISHER AND PRICE.
Bulletin de la Fédération des Industries Chimiques de Belgique	Bull. Fed. Ind. chim. Belg.	65, Rue du Canal, Brussels. 45 fr. per annum.
Bulletin of the Forest Experiment Station, Meguro, Tokyo	Bull. Forest Exp. Stat. Meguro	Bureau of Forestry, Dept. of Agriculture and Commerce, Tokyo.
Bulletin of the Institution of Mining and Metallurgy	Bull. Inst. Min. Met.	Cleveland House, 225, City Road, London, E.C. 1.
Bulletin of the Kentucky Agricultural Experiment Station	Bull. Kentucky Agric. Exp. Stat.	University of Kentucky, Lexington, Ky., U.S.A.
Bulletin of the Rubber Growers' Association (Incorporated)	Bull. Rubber Growers' Assoc.	2–4, Idol Lane, Eastcheap, London, E.C. 3.
Bulletin of the School of Mines and Metallurgy, University of Missouri	Bull. School Mines and Met. Missouri	Director of Mining Experiment Station, Rolla, Mo., U.S.A.
Bulletin de la Société de Chimie Biologique	Bull. Soc. Chim. biol. ..	Masson et Cie, 120, Boulevard St. Germain, Paris (VIe). 6 fr.
Bulletin de la Société Chimique de Belgique	Bull. Soc. chim. Belg. ..	M. J. Wauters, Palais du Midi (Galerie du Travail 7), Brussels.
Bulletin de la Société Chimique de France	Bull. Soc. chim. ..	Masson et Cie., 120, Boulevard Saint-Germain, Paris, 6e. 120 fr. per annum.
Bulletin de la Société d'Encouragement pour l'Industrie Nationale	Bull. Soc. d'Encour. ..	Secrétariat, Rue de Rennes, 44, Paris, 6e., France. 36 fr. per annum.
Bulletin de la Société Française de Photographie	Bull. Soc. Franç. Phot. ..	51, Rue de Clichy, Paris, 9e. 2 fr.
Bulletin de la Société Industrielle de Mulhouse	Bull. Soc. Ind. Mulhouse	Berger-Levrault et Cie., 5, Rue des Beaux-Arts, Paris. 60 fr. per annum.
Canadian Chemistry and Metallurgy	Canad. Chem. Met. ..	Westman Press, Ltd., 57, Queen Street West, Toronto. 40 cents.
Le Caoutchouc et la Gutta-Percha	Caoutchouc et Gutta-Percha	A. D. Cillard fils, 49, Rue des Vinaigriers, Paris, X. 40 fr. per annum.
Cellulosechemie	Cellulosechem.	Supplement to Papierfabrikant.
Centralblatt für Bakteriologie, Parasitenkunde, und Infektionskrankheiten	Centr. Bakt.	Verlag von G. Fischer, Jena, Germany.
Cereal Chemistry	Cereal Chem.	University Farm, St. Paul, Minn., U.S.A. $3.50 per annum.
Chemical Age	Chem. Age	Benn Bros., Ltd., 8, Bouverie Street, London, E.C. 4. 6d.
Chemical and Metallurgical Engineering	Chem. Met. Eng. ..	McGraw-Hill Co., 10th Avenue at 36th Street, New York. 25 cents.
Chemical News	Chem. News	Merton House, Salisbury Square, London, E.C. 4. 6½d.
Chemical Trade Journal	Chem. Trade J. ..	Davis Bros., Danes Inn House, 265, Strand, London, W.C. 6d.
Chemické Listy pro védu a prumysl	Chem. Listy	Tiskem. Ed. Beaufortа, V. Praze II., Jungmannova ul., 21., Czechoslovakia.
Chemiker-Zeitung	Chem.-Ztg.	Dr. W. Roth, Cöthen, Anhalt, Germany. R.M. 11 per quarter.
Chemisch Weekblad	Chem. Weekblad ..	D. B. Centen, O.Z. Voorburgwal 115, Amsterdam. 0.25 fr.
Chemische Umschau auf dem Gebiete der Fette, Oele, Wachse, und Harze	Chem. Umschau ..	Verlag der Wissenschaftlichen Verlagsges., Stuttgart.
Chemisches Zentralblatt	Chem. Zentr.	Verlag Chemie Ges., Berlin, Germany. $20 per annum.
Chimie et Industrie	Chim. et Ind.	49, Rue des Mathurins, Paris. 12 fr.
Collegium	Collegium	R. Würtenberger, Ober-Ramstadt, bei Darmstadt, Germany. R.M. 24 per annum.
Communications of the Netherlands Government Institute for advising the Rubber Trade and Rubber Industry	Comm. Netherlands Govt. Inst. for advising Rubber Trade	
Comptes-Rendus hebdomadaires des Séances de l'Académie des Sciences	Compt. rend.	Imprimerie Gauthier-Villars, Quai des Grands-Augustins, 55, Paris. 140 fr. per annum.
Comptes-Rendus des Travaux du Laboratoire Carlsberg	Comptes rend. Trav. Lab. Carlsberg	H. Hagerup, Copenhagen. Price varies.
Deutsche Zuckerindustrie ..	Deuts. Zuckerind. ..	Dessauerstrasse, 18, Berlin, S.W. 11. G.M. 32 per annum.
Engineering	Engineering	C. R. Johnson, 35 and 36, Bedford Street, Strand, London, W.C. 2. 1s. 2½d.
Engineering News-Record ..	Eng. News-Rec. ..	McGraw-Hill Co., Tenth Avenue at 36th Street, New York. 25 cents.
Farben-Zeitung	Farben-Ztg.	Krausenstrasse 35–36, Berlin, S.W. 19. G.M. 6.50 per quarter.
Fermentforschung	Fermentforsch.	Verlag von Urban u. Schwarzenberg, Berlin, Germany.
Feuerungstechnik	Feuerungstechn. ..	O. Spamer, Heinrichstrasse, 9, Leipzig-R., Germany. G.M. 4 per quarter.
Fuel Research Board Technical Papers	Fuel Res. Bd. Tech. Paper	H.M. Stationery Office, Kingsway, London, W.C. 2. Price varies.
Fuel in Science and Practice ..	Fuel	Colliery Guardian Co., Ltd., 30–31, Furnival Street, London, E.C. 4. 1s.
Gas Journal	Gas J.	W. King, 11, Bolt Court, Fleet Street, London, E.C. 4. 1s.
Gas- und Wasserfach	Gas- u. Wasserfach ..	R. Oldenbourg, Glückstrasse, 8, Munich. G.M. 25 per annum.

Journal.	Abbreviation.	Address of Publisher and Price.
Gas World	Gas World	8, Bouvorie Street, E.C. 4. 8d.
Gazzetta Chimica Italiana ..	Gazzetta	La Direzione della "Gazzetta Chimica," Via Quattro Novembre, 154, Rome. Lire 20.
Gesammelte Abhandlungen zur Kenntnis der Kohle	Ges. Abhandl. Kenntn. Kohle	Gebr. Borntraeger, Schöneberger Ufer, 12a, Berlin, W. 35.
Giornale di Chimica Industriale ed Applicata	Giorn. Chim. Ind. Appl.	Via S. Paolo, 10, Milan, Italy. L.10.
Glass Industry	Glass Ind.	50, Church Street, New York. 20 cents.
Gummi-Zeitung	Gummi-Ztg.	Geschäftsstelle der "Gummi-Zeitung," Krausenstrasse 35 36. Berlin, S.W. 19, Germany. G.M. 6·50 per quarter.
Helvetica Chimica Acta ..	Helv. Chim. Acta ..	Georg & Co., 10, Freiestrasse, Basel. 10 fr.
Imperial Institute Bulletin ..	Bull. Imp. Inst. ..	John Murray, Albemarle Street, London, W. 3s. 6d.
India-Rubber Journal	India-Rubber J. ..	Maclaren & Sons, 37 and 38, ShoeLane, London, E.C. 4d.
Industrial and Engineering Chemistry	Ind. Eng. Chem. ..	C. L. Parsons, 1709, G. Street, N.W., Washington, D.C., U.S.A. 75 cents.
International Review of Science and Practice of Agriculture	Int. Rev. Sci. Agric. ..	International Institute of Agriculture, Rome. 15s.per annum.
International Sugar Journal ..	Int. Sugar J.	2, St. Dunstan's Hill, London, E.C. 1s. 9d.
Journal of Agricultural Research	J. Agric. Res.	Superintendent of Documents, Govt. Printing Office, Washington, D.C., U.S.A. Price varies.
Journal of Agricultural Science ..	J. Agric. Sci.	University Press, Cambridge. 10s.
Journal of the American Ceramic Society	J. Amer. Ceram. Soc. ..	211, Church Street, Easton, Pa., U.S.A. 75 cents.
Journal of the American Chemical Society	J. Amer. Chem. Soc. ..	C. L. Parsons, 1709, G. Street, N.W., Washington, D.C., U.S.A. 75 cents.
Journal of the American Leather Chemists' Association	J. Amer. Leather Chem. Assoc.	American Leather Chemists' Assoc., Easton. Pa., U.S.A. $12 per annum.
Journal of the American Water Works Association	J. Amer. Water Works Assoc.	Mount Royal and Guilford Avenues, Baltimore, Md., U.S.A. $7 per annum.
Journal of the Association of Official Agricultural Chemists	J. Assoc. Off. Agric. Chem.	Box 290, Pennsylvania Avenue Station, Washington, D.C., U.S.A. 27s. per volume.
Journal of Biological Chemistry ..	J. Biol. Chem.	Rockefeller Inst. for Medical Research, Mount Royal and Guilford Avenues, Baltimore, Md., U.S.A. $5.25 per volume.
Journal of the Chemical Society of London, Transactions	Chem. Soc. Trans. ..	Gurney and Jackson, 33, Paternoster Row, London, E.C. 7s. 6d.
Journal of the Chemical, Metallurgical, and Mining Society of South Africa	J. Chem. Met. Soc. S. Africa	Scientific and Technical Club, 100, Fox Street, Johannesburg. 3s. 6d.
Journal de Chimie Physique ..	J. Chim. physique ..	Gauthier-Villars, 55, Quai des Grands-Augustins, Paris, 80 fr. per annum: the price of a single copy varies according to the size.
Journal of the College of Agriculture, Tokyo Imperial University, Japan	J. Coll. Agric. Tokyo ..	Director of the College of Agriculture, Tokyo Imperial University, Japan. Price varies.
Journal of the College of Science, Imperial University of Tokyo	J. Coll. Sci., Tokyo ..	Director of the College of Science, Tokyo Imperial University, Japan. Price varies.
Journal of Dairy Science ..	J. Dairy Sci.	Williams and Wilkins Co., Mount Royal and Guilford Avenues, Baltimore, Md., U.S.A. $1.25.
Journal of the Faculty of Engineering, Tokyo Imperial University	J. Fac. Eng. Tokyo ..	Maruzen and Co., Ltd., Tore Sanchome, Nihonbashiku, Tokyo.
Journal of the Franklin Institute	J. Franklin Inst. ..	The Actuary, The Franklin Institute, Philadelphia, Pa., U.S.A. 60 cents.
Journal of General Physiology ..	J. Gen. Physiol. ..	Rockefeller Institute for Medical Research, Mount Royal and Guilford Avenues, Baltimore, Md., U.S.A. $1.
Journal of the Indian Institute of Science	J. Indian Inst. Sci. ..	Indian Institute of Science, Bangalore. Price varies.
Journal of the Institute of Brewing	J. Inst. Brewing ..	Harrison and Sons, 44, St. Martin's Lane, London, W.C. 2. 4s.
Journal of the Institution of Electrical Engineers	J. Inst. Elect. Eng. ..	Savoy Place, Victoria Embankment, London, W.C. 2. 10s. 6d.
Journal of the Institution of Petroleum Technologists	J. Inst. Petrol. Tech. ..	The Institution, Aldine House, Bedford Street, Strand, W.C. 2. 7s. 6d.
Journal für Landwirtschaft ..	J. Landwirts.	P. Parey, Hedemannstrasse 10 u. 11, Berlin, S.W. 11.
Journal of the Optical Society of America	J. Opt. Soc. Amer. ..	J. B. Lippincott Co., Philadelphia.
Journal de Pharmacie et de Chimie	J. Pharm. Chim. ..	O. Doin et fils, Place de l'Odeon, 8, Paris. 1.75 fr.
Journal of Pharmacology and Experimental Therapeutics	J. Pharm. Exp. Ther. ..	Williams and Wilkins Co., Mount Royal and Guilford Avenues, Baltimore, Md., U.S.A. $6.5 per vol.
Journal of Physical Chemistry ..	J. Physical Chem. ..	Baker Laboratory, Ithaca, N.Y., U.S.A. $10 per annum ($8 to members of the Amer. Chem. Soc., Chemical Soc., and Faraday Soc.).
Journal für praktische Chemie ..	J. pr. Chem.	J. A. Barth, Salomonstrasse, 18 b, Leipzig, Germany. R.M. 16 per vol.

Journal.	Abbreviation.	Address of Publisher and Price.
Journal and Proceedings of the Royal Society of New South Wales	J. Proc. Roy. Soc. N.S.W.	5, Elizabeth Street, Sydney, N.S.W. 21s. per vol.
Journal of the Royal Society of Arts	J. Soc. Arts	G. Bell and Sons, York House, Portugal Street, London, W.C. 2. 1s.
Journal of Scientific Instruments	J. Sci. Instrum. ..	Cambridge University Press, Fetter Lane, London, E.C.4. 2s. 6d.
Journal of the Society of Dyers and Colourists	J. Soc. Dyers and Col. ..	Pearl Assurance Buildings, Market Street, Bradford, Yorks. 5s.
Journal of the Society of Glass Technology	J. Soc. Glass Technol. ..	S. English, Darnall Road, Sheffield. 10s. 6d.
Journal of the Society of Leather Trades' Chemists	J. Soc. Leather Trades' Chem.	W. R. Atkin, M.Sc., The University, Leeds. 2s. 6d.
Journal of the South African Association of Analytical Chemists	J. S. Afr. Assoc. Anal. Chem.	Box 5254, Johannesburg. 2s. 6d.
Journal of the Textile Institute..	J. Text. Inst.	J. D. Athey, 16, St. Mary's Parsonage, Manchester. 3s.
Journal of the Washington Academy of Sciences	J. Wash. Acad. Sci. ..	R. L. Faris, Coast and Geodetic Survey, Washington, D.C., U.S.A. 25 cents ; 50 cents for July, Aug. and Sept. numbers.
Keramische Rundschau ..	Keram. Runds.	Dreyestrasse, 4, Berlin, N.W. 21.
Kogyo-Kwagaku-Zasshi (Journal of Chemical Industry, Japan)	Kogyo-Kwagaku-Zasshi (J. Chem. Ind. Japan)	Kogyo-Kwagaku-Kwai, Iidamachi, Kojimachi-ku, Tokyo. 5 yen (10s. 3d.) per annum.
Kolloidchemische Beihefte ..	Kolloidchem. Beihefte ..	T. Steinkopff, Residenzstrasse 12B., Dresden-Blasewitz, Germany. G.M. 16 per vol.
Kolloid-Zeitschrift	Kolloid-Z.	T. Steinkopff, Residenzstrasse 12B., Dresden-Blasewitz, Germany. R.M. 18 per vol.
Kruppsche Monatshefte ..	Krupp's Monatsh. ..	Verlag F. Krupp A.-G., Essen. G.M. 12 per annum.
Landwirtschaftlichen Versuchs-Stationen, Die	Landw. Vers.-Stat. ..	P. Parey, Hedemannstr. 10 and 11, Berlin, S.W. 11.
Malayan Agricultural Journal ..	Malay. Agric. J. ..	Dept. of Agriculture, Kuala Lumpur, Federated Malay States. 50 cents.
Mededeelingen van het Central Rubberstation	Mededeel. Centr. Rubberstat.	
Melliand's Textilberichte ..	Melliand's Textilber. ..	Mannheim. 35s. per annum.
Memoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils de France	Mem. Compt. rend Soc. Ing. Civils de France	19, Rue Blanche, Paris. 60 fr. per annum.
Memoirs of the College of Science and Engineering, Kyoto Imperial University	Mem. Coll. Sci. and Eng. Kyoto	Maruzen Co., Ltd., Tokyo, Japan. Price varies.
Memoirs of the Department of Agriculture in India	Mem. Dept. Agric. India	W. Thacker and Co., 2, Creed Lane, London. Price varies.
Memorial des Poudres	Mem. Poudres	Gauthier-Villars et Cie., 55, Quai des Grands-Augustins, Paris. 35 fr. per vol.
Metall und Erz	Metall u. Erz	W. Knapp, Mühlweg, 19, Halle on Salle, Germany.
Mikrochemie	Mikrochem.	W. Müller, Stiftgasse, 21, Vienna, VII. $2 per annum.
Milchwirtschaftliches Zentralblatt	Milchw. Zentr.	M. and H. Schaper, Hanover. G.M. 3 per quarter.
Mining and Metallurgy ..	Min. and Met.	29, West 39th Street, New York, U.S.A. $1.
Mittheilungen des Institutes für Kohlenvergasung und Nebenproduktengewinnung	Mitt. Inst. Kohlenvergasung	Karl Schweighofergasse, 10, Vienna VII.
Mittheilungen aus dem Materialprüfungsamt zu Berlin-Dahlem	Mitt. Materialprüf. ..	Julius Springer, Linkstrasse 23–24, Berlin, W. 9, Germany. Price varies.
Monatshefte für Chemie und verwandte Teile anderer Wissenschaften	Monatsh.	Hölder-Pichler-Tempsky A.-G., Vienna, Austria. G.M. 12 per annum.
Moniteur Scientifique	Mon. Scit.	Dr. G. Quesneville, 12, rue de Buci, Faubourg St. Germain, Paris. 2 fr. 50.
New Zealand Journal of Science and Technology	N.Z.J. Sci. Technol.	Government Printer, Wellington, N.Z. 2s. 1d.
Nippon Kwagaku Kwai Shi (Journal of the Chemical Society of Japan)	Nippon Kwagaku Kwai Shi (J. Chem. Soc. Japan)	Chemical Society of Japan, College of Science, University of Tokyo, Japan.
Oesterreichische Chemiker-Zeitung	Oesterr. Chem.-Ztg. ..	Pestalozzigasse 6, Vienna, 1. 4500 K.
Paint Manufacturers' Association of the United States, Circulars	U.S. Paint Manuf. Assoc. Circ.	Dr. H. A. Gardner, Institute of Industrial Research, 19th and B. Streets, N.W., Washington, U.S.A.
Paper	Paper	Longacre Building, 1478, Broadway, New York. $5 per annum.
Papier-Fabrikant	Papierfabr.	Otto Elsner, Oranienstr. 140-142, Berlin, S. 42. M.0.60.
Perfumery and Essential Oil Record	Perf. Ess. Oil Rec. ..	6, Serle Street, London, W.C. 1s. 6d.
Petroleum	Petroleum	Verlag für Fachliteratur, Courbièrestrasse, 3, Berlin, W. 62. £3 per vol.
Pharmaceutical Journal ..	Pharm. J.	72, Great Russell Street, London, W.C. 1. 1s. 1d.
Pharmaceutisch Weekblad ..	Pharm. Weekblad ..	D. B. Centen, O.Z. Voorburgwal 115, Amsterdam. 15.50 fr. per annum.

JOURNAL.	ABBREVIATION.	ADDRESS OF PUBLISHER AND PRICE.
Pharmazeutische-Zeitung ..	Pharm.-Ztg.	Linkstrasse 23-24, Berlin, W. 9.
Pharmazeutische Zentralhalle ..	Pharm. Zentralh. ..	T. Steinkopff, Residenzstrasse, 12B, Dresden-Blasewitz. R.M. 4.50 per quarter.
Philippine Journal of Science ..	Philippine J. Sci. ..	Bureau of Science, Manila, Philippine Islands. 50 cents.
Philosophical Magazine and Journal of Science	Phil. Mag.	Taylor and Francis, Red Lion Court, Fleet Street, London, E.C. 5s.
Physical Review	Physical Rev.	American Physical Society, Corning, N.Y., U.S.A. 75 cents.
Physikalische Zeitschrift ..	Physikal. Z.	S. Hirzel, Königstrasse, 2, Lepizig. $3 per quarter.
Physiological Abstracts	Physiol. Abs.	H. K. Lewis and Co., Ltd., 136, Gower Street, London, W.C. 1. 5s.
Photographic Journal	Phot. J.	Harrison and Sons, 44-47, St. Martin's Lane, W.C. 2. 2s. 6d.
Proceedings of the American Society of Civil Engineers	Proc. Amer. Soc. Civ. Eng.	33, West 39th Street, New York City, U.S.A. $8 per annum.
Proceedings of American Society for Testing Materials	Proc. Amer. Soc. Testing Materials	McGraw-Hill Book Co., 239 W. 39th Street, New York. $6 per annum.
Proceedings of the Australasian Institute of Mining and Metallurgy	Proc. Austral. Inst. Min. Met.	48, Queen Street, Melbourne, Victoria, Australia.
Proceedings of the Cambridge Philosophical Society	Proc. Camb. Phil. Soc.	Cambridge University Press, Fetter Lane, London, E.C. 4. Price varies.
Proceedings of the Engineers Society of Western Pennsylvania	Proc. Eng. Soc. W. Pa.	William Penn Hotel, Pittsburgh, Pa., U.S.A. 50 cents.
Proceedings of the Institution of Civil Engineers	Proc. Inst. Civ. Eng. ..	The Secretary, Great George Street, London, S.W.
Proceedings of the Institution of Mechanical Engineers	Proc. Inst. Mech. Eng.	Storey's Gate, Westminster, S.W.
Proceedings of Koninklijke Akademie van Wetenschappen te Amsterdam	Proc. K. Akad. Wetensch. Amsterdam	Koninklijke Akademie van Wetenschappen, Amsterdam.
Proceedings of the National Academy of Sciences (U.S.A.)	Proc. Nat. Acad. Sci. ..	Eschenbach Printing Co., Easton, Pa. $5 per annum.
Proceedings of the Physical Society of London	Proc. Physical Soc. ..	Fleetway Press, Ltd., 3-9, Dane Street, High Holborn, London, W.C. 1. 6s. 3d.
Proceedings of the Royal Irish Academy	Proc. Roy. Irish Acad...	Hodges, Figgis and Co., Dublin. Price varies.
Proceedings of the Royal Society	Proc. Roy. Soc. ..	Harrison and Sons, 45, St. Martin's Lane, London, W.C. 2. Price varies.
Proceedings of the South Wales Institute of Engineers	Proc. S. Wales Inst. Eng.	Park Place, Cardiff. Price varies.
Proceedings and Transactions of Nova Scotian Institute of Science	Proc. and Trans. Nova Scotian Inst. Sci.	Halifax, Nova Scotia. 50 cents.
Proceedings of the University of Durham Philosophical Society	Proc. Univ. Durham Phil. Soc.	A. Reid and Co., Newcastle-upon-Tyne. 5s.
Pulp and Paper Magazine ..	Pulp and Paper Mag. ..	Industrial and Educational Publishing Co., Ltd., Garden City Press, St. Anne de Bellevue, Canada. 15 cents.
Recueil des Travaux Chimiques des Pays-Bas	Rec. Trav. chim.	Soc. Anon d'Editions Scientifiques D. B. Centen, Amsterdam. 16.50 fl. per volume.
Revue Générale des Colloïdes	Rev. gén. Coll.	Dunod, 92, rue Bonaparte, Paris, 6e. 55 fr. per annum.
Revue Générale des Matiéres Colorantes	Rev. gén. Mat. Col. ..	Rue de Rennes, 123, Paris, VIe, France. 6.5 fr.
Revue de Métallurgie	Rev. Mét.	5, Cité Pigalle, Paris, IXe. 12 fr.
Roczniki Chemji	Rocz. Chem.	Dr. J. Zawidzki, Polirechnika, Roszykowa, 75, Warsaw.
Schweizer Chemiker Zeitung	Schweiz. Chem. Ztg. ..	Rascher & Co., Rathausquai 20, Zürich 1, Switzerland. 2.50 fr. per quarter.
Science Reports of Tohoku Imperial University	Sci. Rep. Tohoku ..	The Maruzen Co., Ltd., Tokyo, Japan. Price varies.
Scientific Proceedings of the Royal Dublin Society	Sci. Proc. Roy. Dublin Soc.	Leinster House, Dublin. Price varies.
Sitzungsberichte der Preussischen Akademie der Wissenschaften	Sitzungsber. Preuss. Akad. Wiss.	Verlag der Akademie der Wissenschaften, Berlin. R.M. 9 per annum.
Soil Science	Soil Sci.	Williams and Wilkins Co., Mount Royal and Guilford Avenues, Baltimore, U.S.A.; Cambridge University Press, Fetter Lane, London, E.C. $10·50 per volume.
South African Journal of Industries	S. African J. Ind. ..	Government Printer, Box 373, Pretoria. 6d.
Sprechsaal	Sprechsaal	Verlag von Müller und Schmidt, Coburg, Germany.
Stahl und Eisen	Stahl u. Eisen	Verlag Stahleisen, Düsseldorf, Germany.
Technology Reports of the Tohoku Imperial University	Tech. Rep. Tohoku ..	Maruzen Co., Ltd., Tokyo, Japan.
Transactions of the American Electrochemical Society	Trasn. Amer. Electrochem. Soc.	Columbia University, New York City, U.S.A. $3 per vol.
Transactions of the American Institute of Chemical Engineers	Tr. Amer. Inst. Chem. Eng.	D. Van Nostrand Co., New York, and F. and N. Spon, Ltd., London.
Transactions of the Ceramic Society	Trans. Ceram. Soc. ..	Stoke-on-Trent, Staffordshire. 45s. per volume.

Journal.	Abbreviation.	Address of Publisher and Price.
Transactions of the Faraday Society	Trans. Faraday Soc. ..	Gurney and Jackson, 33, Paternoster Row, London, E.C. 4. Price varies.
Transactions of the Institute of Metals	Trans. Inst. Metals ..	Institute of Metals, 36, Victoria Street, Westminster, London S.W. 1
Transactions of the Iron and Steel Institute	Trans. Iron and Steel Inst.	28, Victoria Street, London, S.W.
Transactions of the North of England Institute of Mining and Mechanical Engineers	Tr. N. Eng. Inst. Min. Mech. Eng.	Newcastle-on-Tyne.
Transactions of the Royal Society of Canada	Trans. Roy. Soc. Canada	J. Hope and Son, Ottawa; B. Quaritch, London. 50 cents.
United States Bureau of Mines, Bulletins and Technical Papers	U.S. Bureau of Mines, Bull. and Tech. Papers	Bureau of Mines, Washington, D.C., U.S.A. Price varies.
United States Bureau of Standards, Bulletins and Technological Papers	U.S. Bureau of Standards, Bull. and Tech. Papers	Superintendent of Documents, Washington, D.C., U.S.A. Price varies.
United States Department of Agriculture Bulletins	Bull. U.S. Dept. Agric. ..	Department of Agriculture, Washington, D.C., U.S.A. Price varies.
West Indian Bulletin	West Ind. Bull.	Imperial Dept. of Agriculture, Barbados, W. I. 6d.
Wissenschaftliche Veröffentlichungen aus dem Siemens Konzern	Wiss. Veröffentl. Siemens Konzern	J. Springer, Linkstrasse, 23-24, Berlin, W. 9.
Wochenschrift für Brauerei ..	Woch. Brau.	P. Parey, Hedemannstrasse 10, Berlin, S.W. 11, Germany. G.M. 1·5 per month.
Zeitschrift für analytische Chemie	Z. anal. Chem.	J. F. Bergmann, Trogerstrasse, 56, Munich.
Zeitschrift für angewandte Chemie	Z. angew. Chem. ..	Verlag Chemie Ges., Bosestrasse, 2, Leipzig, Germany. $9 per annum.
Zeitschrift für anorganische und allgemeine Chemie	Z. anorg. Chem. ..	Verlag von L. Voss, Leipzig. R.M. 18 per volume.
Zeitschrift der Deutschen Oel- und Fett-Industrie	Z. Deuts. Oel- u. Fett-Ind.	J. Springer, Linkstrasse, 23-34, Berlin, W. 9. G.M. 0.6.
Zeitschrift für Elektrochemie und angewandte physikalische Chemie	Z. Elektrochem. ..	Verlag Chemie Ges., Leipzig, Germany. $8 per annum.
Zeitschrift für das gesamte Brauwesen	Z. ges. Brauw.	Verlag F. Carl, Nürnberg, Germany.
Zeitschrift für das gesamte Schiess- und Sprengstoffwesen	Z. ges. Schiess- u. Sprengstoffw.	A. Schrimpf, Munich. G.M. 26 per annum.
Zeitschrift für Instrumentenkunde	Z. Instrumentenk. ..	J. Springer, Linkstrasse 23-24, Berlin, W. 9. G.M. 3 per quarter.
Zeitschrift für Leder- und Gerberei-Chemie	Z. Leder- u. Gerb.-Chem.	O. Meissner's Verlag, Hermannstrasse, 44, Hamburg, Germany.
Zeitschrift für Metallkunde ..	Z. Metallk.	Verlag des Vereines Deuts. Ingenieure, 19, Beuthstrasse, Berlin, S.W. 19. Germany. G.M. 32·5 per annum.
Zeitschrift für Pflanzenernährung und Düngung	Z. Pflanz. Düng. ..	Verlag Chemie, Leipzig, Germany. Sect. A $3, Sect. B $4 per volume.
Zeitschrift für Physik	Z. Physik	J. Springer, Linkstrasse, 23-24, Berlin, W. 9, Germany.
Zeitschrift für physikalische Chemie	Z. physikal. Chem. ..	Akademische Verlagsges., Leipzig, Germany.
Zeitschrift für physiologische Chemie	Z. physiol. Chem. ..	W. de Gruyter & Co., Berlin, W. 10, Germany.
Zeitschrift für Spiritusindustrie ..	Z. Spiritusind.	P. Parey, Hedemannstrasse 10, Berlin, S.W. 11, Germany. G.M. 0·50.
Zeitschrift für Untersuchung der Nahrungs- und Genussmittel	Z. Unters. Nahr. Genussm.	J. Springer, Linkstrasse 23-24, Berlin, W. 9, Germany.
Zeitschrift des Vereins der deutschen Zucker-Industrie	Z. Ver. deuts. Zuckerind.	Vereins-Direktorium, Kleiststrasse 32, Berlin, W. 62, Germany.
Zeitschrift für wissenschaftliche Photographie, Photophysik, und Photochemie	Z. wiss. Phot. ..	J. A. Barth, Salomonstrasse, 18b, Leipzig.
Zeitschrift für die Zuckerindustrie der Czechoslovakischen Republik	Z. Zuckerind. Czechoslov.	Die Administration, Havlíčkovo Nam, 32, Prag II., Czecho-Slovakia. Kč. 5.
Zellstoff und Papier	Zellstoff u. Papier ..	Verlag C. Hofmann, Berlin, S.W. 11. R.M. 8·40 per annum.

List of Errata.

No. of Journal.	Page.	Column.	Line from top.	Line from bottom.	Corrigenda.
No. 1—Jan. 4 ..	B19	1	33	—	*For* " silvering " *read* " desilverising."
No. 2—Jan. 11 ..	B27	1	10	—	*For* " E. J. Martin " *read* " F. J. Martin."
,, ,, ..	B33	1	—	9	*For* " Salaman " *read* " Salomon."
,, ,, ..	B35	2	—	31	*For* " German " *read* " Germann."
No. 3—Jan. 18 ..	B50	2	2	—	*For* " not affected " *read* " markedly decreased."
,, ,, ..	B50	2	3	—	*After* " viscosimeter " *insert* " but in the experiments at 90° a similar effect was not observed."
No. 4—Jan. 25 ..	B74	1	6	—	*For* " Simmonet " *read* " Simonnet."
No. 5—Feb. 1 ..	23T	1	—	7	*For* " oxide " *read* " ethoxide."
,, ,, ..	23T	2	—	12 and 25	*For* " oxide " *read* " ethoxide."
,, ,, ..	24T	1	—	8	*For* " oxide " *read* " ethoxide."
,, ,, ..	B89	2	—	22	*For* " Hägglud " *read* " Hägglund."
,, ,, ..	B95	2	13	—	*For* " 382,083 " *read* " 382,983."
No. 8—Feb. 22 ..	B142	2	—	8–9	*For* " H. Bechhold " *read* " D. Gerngross."
No. 10—Mar. 7 ..	B179	2	23	—	*For* " Mann " *read* " Mann."
No. 11—Mar. 14 ..	B206	2	—	33–34	*For* " Blizzard " *read* " Blizard."
,, ,, ..	B216	1	—	2	*For* " 209,411 " *read* " 209,441."
No. 12—Mar. 21 ..	63–64T	—	—	—	The illustrations given on an inset in the issue for Aug. 29 should be substituted for Figs. 2, 3 and 4.
,, ,, ..	B222	2	10	—	*For* " W. E. Vosburgh " *read* " W. C. Vosburgh."
,, ,, ..	B224	1	—	33	*For* " tanks " *read* " inks."
No. 13—Mar. 28 ..	B254	2	2	—	*For* " Kraub " *read* " Kraut."
No. 14—Apr. 4 ..	82T	2	28	—	*For* " ferric sulphide " *read* " FeS_2."
,, ,, ..	84T	2	15	—	*After* " air-dried " *insert* " and then exposed to air saturated with moisture."
,, ,, ..	85T	1	17	—	*For* " carbon " *read* " coal."
,, ,, ..	85T	1	—	—	In Table IV (B), in the column headings, *for* " O_2 " *read* " CO_2."
,, ,, ..	87T	1	17	—	*For* " four " *read* " three."
,, ,, ..	B270	1	—	10, 11 and 8	*For* " sulphate " *read* " silicate."
,, ,, ..	B274	1	—	22	*For* " purification " *read* panification."
,, ,, ..	B276	1	9	—	*For* " J. Murayama " *read* " Y. Murayama."
,, ,, ..	B278	2	—	9	*For* " Pappochia " *read* " Papocchia."
No. 15—Apr. 11 ..	B283	1	—	19	*For* " Mehan " *read* " Metan."
,, ,, ..	B286	1	—	24	*For* " Rushby " *read* " Rusby."
No. 16—Apr. 18 ..	B305	2	13, 14, 18, 20, 22, and 23, 24	—	*For* " potassium nitrate " *read* " sodium nitrate."
,, ,, ..	B306	1	14	—	*For* " higher aldehydes " *read* " carbohydrates."
,, ,, ..	B315	1	28	—	*For* " Thin . . . bichro- " *read* " Light-sensitive film or layer and process for making it."
No. 18—May 2 ..	B341	1	35	—	*For* " T. H. Levin " *read* " I. H. Levin."
,, ,, ..	B353	2	—	9	*For* " Renne " *read* " Runne."
,, ,, ..	B354	1	18	—	*For* " 4-aminoanthraquinolines " *read* " 4-aminoquinolines."
,, ,, ..	B354	1	19	—	*For* " Bohrn " *read* " Dohrn."
No. 20—May 16 ..	B397	2	—	31, 32 and 33	*For* " Worth " *read* " North."
No. 21—May 23 ..	B420	2	—	34	*For* " Hempel " *read* " Hampel."
No. 22—May 30 ..	B429	1	11	—	*For* " 1,487,124–5 " *read* " 1,487,111."
,, ,, ..	B447	1	—	14	*For* " bacha " *read* " buchn."
No. 23—June 6 ..	B467	1	8	—	*For* " I. Rosenstein " *read* " L. Rosenstein."
No. 24—June 13 ..	B482	2	2	—	*For* " Tucker " *read* " Jucker."
No. 25—June 20 ..	B501	2	16	—	*For* " Gantley " *read* " Gartley."
No. 26—June 27 ..	B540	2	27–28	—	*For* " the ethylene . . . acid " *read* " cuprous sulphate in sulphuric acid (*cf.* J., 1922, 957A), prepared by adding gradually sulphuric acid, *d* 1·84, to cuprous oxide mixed with a very small quantity of water."
No. 27—July 4 ..	B546	1	22	—	*For* " 60,000 " *read* " 6000."
No. 28—July 11 ..	B566	2	2	—	*For* " Schimadzu " *read* " Shimadzu."
No. 34—Aug. 22 ..	B690	1	24	—	*For* " 1,114,439 " *read* " 1,494,439."
,, ,, ..	B694	1	—	37	*For* " Vailleunier " *read* " Vuilleumier."
No. 39—Sept. 26 ..	B777	2	11	—	*For* " 218,690, 9.1.23 " *read* " 218,339, 4.1.23."
,, ,, ..	B781	1	—	4	*For* " 1,448,913 " *read* " 1,498,913."
No. 40—Oct. 3 ..	299T	1	—	4	*For* " *o*-toluidine-β-naphthalenesulphonate " *read* " *o*-tolidine β-naphthalene-sulphonate."
,, ,, ..	300T	1	5	—	*For* " 0·716 " *read* " 0·7016."
,, ,, ..	300T	1	—	7	*For* " 220° " *read* " 230°."
,, ,, ..	301T	1	6	—	*For* " 7% " *read* " 99·7%."
,, ,, ..	B797	1	30	—	*For* " F. J. Fish, jun. " *read* " F. K. Fish, jun."
,, ,, ..	B804	2	17	—	*For* " Felherim " *read* " Felheim."
No. 41—Oct. 10 ..	B830	2	12	—	*For* " Kemel " *read* " Kemet."
No. 43—Oct. 24 ..	B863	1	—	3	*For* " solution of ferric chloride " *read* " colloidal solution of ferric hydroxide (prepared by adding ferric chloride solution to boiling water)."
No. 45—Nov. 7 ..	324T	2	—	14	*For* " of " *read* " (*cf.*"
,, ,, ..	324T	2	—	10	*For* " negligible (Herschel " *read* " negligible, Herschel."
No. 46—Nov. 14 ..	B925	1	23	—	*For* " Prengsheim " *read* " Pringsheim."
No. 49—Dec. 5 ..	343T	1	12–15	—	*The sentence should read:* " The mono-substituted derivatives are chiefly those containing substituents in (para) position 5, the predominance of this type arising from . . ."
,, ,, ..	B973	1	—	14	*For* " tar, and oil . . . 48 " *read* " upon its rate of absorption of oxygen. G. Coles and "
,, ,, ..	B982	1	33	—	*For* " [glass] . . . J. H. " *read* " splinterless and reinforced glass. J. Cox."
No. 50—Dec. 12 ..	349–352T	—	—	—	All the values for the thickness of the air films and the calculated values of μ (the ratio Tair Toxide) should be multiplied by 10.
,, ,, ..	351T	2	—	12	*For* " 2·53 " *read* " 23·8."
,, ,, ..	351T	2	—	11	*For* " 0·63 " *read* " 6·3."
,, ,, ..	B992	2	15	—	*For* " Coohaas " *read* " Coolhaas."
No. 51—Dec. 10 ..	355T	2	26	—	*The equation should read:* " (A + A' + A " . . .)."
,, ,, ..	356T	1	4	—	*For* " blow " *read* " run."
,, ,, ..	358T	1	1	—	*For* " $-q\cdot a'-b'+d'+e'$ " *read* " $-q=-a'-b'+d'+e'$."
No. 52—Dec. 26 ..	358T	1	24	—	*For* " 12,840$p/(p+q)$ " *read* " 128,400$p/(p+q)$."
,, ,, ..	356T	2	2	—	*For* " Burton " *read* " Buxton."

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THE ANALYSIS OF ORGANIC RUBBER VULCANISING ACCELERATORS.*

By T. Callan, M.Sc., Ph.D., and
N. Strafford, B.Sc., A.I.C.

Plinavis. sses. 29,50 introduction of organic accelerators of —Complete many organic compounds which were 14,572 (19 obscure chemical substances merely of 31,444 (19 interest have come into wide commercial n of the h work has been carried out and recorded to the comparative vulcanising powers of various accelerators, but very often only the trade name of the accelerator used is stated, and no clue s given as to its composition, so that it is often lifficult to co-ordinate the results of different workers, particularly as the same chemical substance may occur commercially under various proprietary names. The practice of using accelerators sold under a trade name, without any indication of the class of compound to which they belong or degree of purity, has undoubtedly checked progress in the use of accelerators in the rubber industry. It is therefore very desirable that there should be reliable methods available for the identification and quantitative determination of the many widely different substances used as accelerators, since there is very little published information likely to be of assistance.

It would be impossible to present a scheme which would embrace the whole of the multitudinous substances, both inorganic and organic, which have been proposed or tried as rubber accelerators. Of this considerable number, however, only relatively few are met with commercially, and the object of this paper is to deal with the identification and quantitative analysis of a few of the more widely used organic accelerators. We shall therefore confine ourselves in the present paper to the following: —Sodium phenolate and naphtholate, aldehyde-ammonia, nitroso compounds, the aryl-substituted guanidines and biguanides, thiocarbanilide, the dithiocarbamates and corresponding thiuram disulphides, which includes probably most of the accelerators now used in commercial quantities.

We do not propose to treat of the more familiar substances such as aniline etc. Commercial organic accelerators often contain considerable amounts (up to 90%) of inorganic substances such as calcium, magnesium, and zinc oxides, kaolin, etc., added either as active constituents or merely as diluents, so that a preliminary examination is generally necessary before proceeding to the actual identification or determination of the organic constituent.

* Read at a joint meeting of the Manchester Section and the Manchester Section of the Institution of the Rubber Industry on Dec. 7, 1923.

Preliminary test.

A little of the sample is heated in a porcelain or silica crucible (not platinum). The odour of the evolved vapours is noted; this may be distinctly "aromatic" or "ammoniacal," whilst certain sulphur compounds give a peculiarly unpleasant fœtid odour. If there is any appreciable ash it is generally advisable to examine this prior to proceeding with the examination of the original substance, as the removal of inorganic substances is essential before proceeding with the identification of the organic constituent. In order to effect this a portion of the sample is first successively extracted for a short time only with the following solvents in the order named by boiling under a reflux condenser on a water bath: (1) petroleum ether, b.p. 40°–60°, (2) ether, (3) benzene, (4) alcohol, (5) water. Complete extraction is not to be aimed at, but rather the extraction is to be continued only sufficiently long to allow of the selection of an appropriate solvent for purification of the bulk of the sample.

Petroleum ether often removes traces of tarry and oily impurities and in some cases traces of free sulphur, and this preliminary purification often facilitates subsequent identification. The appropriate solvent having thus been selected, the main bulk of the sample is extracted and the organic constituent recovered from the filtered solution by evaporation.

Having thus obtained a quantity of the organic constituent free from diluents, the first operation should be to determine the presence or absence of nitrogen, sulphur, and metals such as zinc, sodium, etc. Nitrogen and sulphur are best detected by fusing with sodium by the ordinary methods, and other elements tested for by driving off the organic matter by gentle ignition and subsequent examination of the residue by the ordinary methods of qualitative analysis. The results of these tests make it possible to relegate the substances to one or other of the following groups, those members with which the present paper deals being given below: —

(1) *N and S absent.*	Sodium phenolate. Sodium naphtholate.
(2) *N only present.*	Nitroso compounds. Guanidines. Biguanides. Aldehyde-ammonia.
(3) *S only present.*	Thio-acids.
(4) *N and S present.*	Thiocarbanilide and its homologues. Alkyl-ammonium and metallo-dithiocarbamates. Thiuram disulphides.

Group I.—Nitrogen and sulphur absent.

Sodium phenolate and sodium naphtholate. These are readily soluble in water, and owing to hydrolysis their solutions react strongly alkaline to litmus or Brilliant Yellow paper. If in addition the sample contains free caustic soda, a red coloration is obtained on spotting a solution on to Titan Yellow (Thiazol Yellow G) paper. To distinguish between the two, an aqueous solution is acidified with dilute sulphuric acid, when in the case of the naphtholate an immediate precipitate of naphthol is produced, whilst the phenolate solution remains clear (unless the solution is very concentrated, when an oily layer of phenol is produced) and on adding bromine water a copious white precipitate of tribromophenol is produced.

Quantitative determination of sodium phenolate. Sodium phenolate may be rapidly and accurately determined by titration with standard potassium bromate.[1] 2—3 g. of the sample is dissolved in water and made up to 500 c.c. To 25 c.c. of this solution are added 15 c.c. of hydrochloric acid and 10 c.c. of 20% potassium bromide solution. The solution is then titrated with $N/5$ potassium bromate until a test spot on starch iodide paper shows the presence of a slight excess of free bromine. The end-point is very sharp. (1 c.c. of $N/5$ bromate = 0·003867 g. of sodium phenolate.) 100 c.c. of the same solution of the sample is then titrated with $N/10$ hydrochloric acid, using phenolphthalein as indicator. If this titre is equivalent to the bromate titre, the sample is neutral sodium phenolate; if it is higher than the bromate titre the sample contains free alkali and the amount of this present can be calculated from the difference in the titres. If the acid titre is less than the bromate titre, free phenol is present.

Sodium phenolate is frequently met with containing water of crystallisation. A sodium phenolate of excellent appearance, sold as an accelerator, tested 75·0% both by bromate and acid titration, the remainder being water of crystallisation which was not lost on drying *in vacuo*. The water of crystallisation cannot be determined satisfactorily by drying at 100° C., as a certain amount of decomposition takes place.

Sodium β-naphtholate.—This is best determined by titrating with a standard solution of diazotised *p*-nitroaniline according to the method described by Vaubel,[2] the end-point being, however, best obtained by spotting the reaction mixture on to filter paper and continuing the addition of the diazo solution until the rim of the spot gives a faint coloration with a drop of the original naphtholate solution.

Group II.—Nitrogen only present.

In this group are included basic amino-compounds such as aniline, naphthylamine, *m*- and *p*-phenylenediamines, piperidine, etc., nitroso compounds, *e.g.*, *p*-nitrosodimethylaniline, arylguanidines and biguanides, aldehyde-ammonia, etc. The simpler amines are generally easily recognisable and can be determined by well established methods,[2] and so will not be dealt with here in detail. In general, the primary aromatic monoamines are easily detected by (1) the carbylamine reaction, and (2) the fact that when dissolved in dilute mineral acid they react with sodium nitrite, forming diazo solutions which give a red colour on spotting on filter paper into an alkaline solution of β-naphthol. *m*-Diamines give deep brown solutions on treatment with nitrous acid, whilst *p*-diamines on adding first aniline hydrochloride solution followed by potassium bichromate give an intense blue coloration. *p*-Phenylenediamine can be rapidly and accurately determined by the method of Callan and Henderson (J., 1919, 408 T).

(*a*) *Nitroso compounds* (*p*-nitrosodimethylaniline, *p*-nitrosophenol, α-nitroso-β-naphthol). Of these, nitrosophenol is the only one which gives Liebermann's "nitroso" reaction.

p-Nitrosodimethylaniline is a green power moderately soluble in water, the solution being deep yellowish-brown. It is generally sold for use as an accelerator in the form of a wet paste.

p-Nitrosophenol is a dark brown powder slightly soluble in water: the solution is pale greenish-yellow, and on adding sodium hydroxide turns a deep brown.

α-Nitroso-β-naphthol is brown in colour, slightly soluble in water giving a light brown coloured solution, which turns bright yellowish-green on adding sodium hydroxide. Its solution in dilute alcohol or acetone gives a dark brown precipitate of an iron complex on adding a ferric salt solution.

p-Nitrosodimethylaniline can readily be distinguished from the other two by the fact that on reduction with zinc and dilute acid it forms *p*-aminodimethylaniline (*as*-dimethyl-*p*-phenylenediamine), which gives Methylene Blue on adding a little hydrogen sulphide solution and a few drops of ferric chloride solution.

Quantitative determination of nitroso compounds.

Each of the above substances may readily and accurately be determined by treating with excess of a standardised solution of titanous chloride[3] or sulphate.[4] It is, however, important that the solution of a known weight of sample, to which has been added excess of the titanous solution, should be slowly heated to about 60°—70° only. If the solution is rapidly heated to the boiling point (as is permissible with nitro compounds), decomposition appears to take place and low results are obtained. This is particularly noticeable with nitroso-β-naphthol. After heating for a few minutes at 60°—70°, the solution is cooled and the excess of titanous solution determined by titration with standard iron alum in the usual way.

Clauser[5] has published a method which is specific for nitroso compounds (*e.g.*, in admixture with nitro compounds). It depends upon the fact that phenylhydrazine reacts on nitroso compounds in acetic acid solution, liberating one molecule of nitrogen per mol. of nitroso compound.

We have investigated this method exhaustively in the case of *p*-nitrosophenol and find that it is tedious

[1] Callan and Henderson, J., 1922, 161-164 T.
[2] Vaubel, "Quantitative Bestimmung organischer Verbindungen," Vol. II.
[3] Knecht and Hibbert, "New Reduction Methods in Volumetric Analysis," p. 75 (1918 ed.).
[4] Callan, Henderson, and Strafford, J., 1920, 86 T.
[5] Ber., 1901, 34, 891.

to carry out and requires considerable practice and manipulative skill to get anything like concordant results. Even with the greatest care the results are liable to vary within 5%, as shown by the results in the following table (Table I.). It cannot, therefore, be recommended for technical analysis.

TABLE I.

Experiments on determination of nitrosophenol by Clauser's method.

Strength by titanous sulphate, 98·2%.

No.	Wt. taken. g	c.c. N_2 collected (corrected to N.T.P.)	% Nitrosophenol calc. from vol. N_2.
1	0·1158	20·1	95·4
2	0·1436	24·1	92·1
3	0·1418	24·9	94·5
4	0·1585	26·9	93·3
5	0·1643	27·9	93·1
6	0·1666	27·3	90·0

) *Arylguanidines.* This group includes some of most widely used accelerators, *e.g.*, diphenylnidine $(C_6H_5{\cdot}NH)_2C{:}NH$, and triphenylguanidine $H_5NH)_2C{:}N{\cdot}C_6H_5$. Previous to these subces coming into commercial use as rubber accele-ors, they were comparatively obscure organic micals, and reliable information as to their identifion and determination is scanty.

hey are usually prepared by condensing thio-anilide or its homologues with ammonia or a nary aromatic amine in presence of lead com-nds. Thus with thiocarbanilide and ammonia in product is *sym*-diphenylguanidine, whereas gives *sym*-triphenylguanidine :

$$_5{\cdot}NH)_2C{:}S + NH_3 = (C_6H_5{\cdot}NH)_2C{:}NH + H_2S.$$
$$_5{\cdot}NH)_2C{:}S + C_6H_5NH_2 = (C_6H_5NH)_2C{:}NC_6H_5 +$$

mber of other aromatic amines, *e.g.*, *o-* and lines, have been used commercially in place of so that numerous isomeric and homologous nes are met with commercially, *e.g.*, phenyl-*o-* and phenyl-*p*-tolylguanidines, di-*o-* and di-*p-* guanidines, phenyl-di-*o*-tolyl- and phenyl-di-yl-guanidines, tri-*o*-tolyl- and tri-*p*-tolyl- guanis, etc.

urther, a commercial accelerator may be (and n is) a mixture of isomers, probably from having prepared from commercial products; for ple, a tri-*o*-tolylguanidine may contain a con-ble proportion of the para isomer, due to the dine used in its manufacture containing ine, and though giving after recrystallisation ul white product apparently pure, its melting-y be low and indefinite and not correspond oted in the literature.

ying the general reactions of the arylwe shall indicate the methods which we useful in determining the constitution of uanidines.

General properties of the arylguanidines.

arylguanidines form colourless crystals or white owders, almost insoluble in water but easily soluble n alcohol. They are organic bases, and easily dissolve on warming with dilute acids. Caustic soda re-precipitates the bases from these solutions as a occulent precipitate.

A characteristic property is the sparing solubility of ertain of their salts—*e.g.*, the nitrates, picrates, perhlorates, and thiocyanates. This solubility varies with the different members—for example, the thiocyanate and perchlorate of triphenylguanidine are considerably less soluble than the corresponding salts of diphenylguanidine. The arylguanidines are sufficiently strong bases to allow of accurate titration with standard acid under suitable conditions, and the determination of the neutralisation equivalent is of very considerable value in identifying and determining these substances: 0·5—1·0 g. is dissolved in neutral alcohol and titrated with $N/10$ hydrochloric acid, using Bromophenol Blue as indicator. The colour change at the end-point, from blue to yellowish-green, is very distinct. The arylguanidines are mono-acid bases, so that one gram-molecule requires 10,000 c.c. of $N/10$ HCl for neutralisation. Diphenylguanidine has been proposed as a standard in acidimetry and alkalimetry,[6] but its value in this respect is, in our opinion, very questionable, as most samples of diphenylguanidine contain traces or more of triphenylguanidine from which it is very difficult to free them. Triphenylguanidine would be a much more suitable substance for this purpose, as it has a higher molecular weight and can readily be obtained in a very high degree of purity by recrystallisation from benzene or toluene.

In order to identify fully an accelerator which, possessing properties similar to those outlined above (alcohol-soluble base giving sparingly soluble nitrate and picrate etc.), is suspected to be a guanidine, the following determinations made on the recrystallised product are necessary: (1) Neutralisation equivalent, (2) molecular weight, (3) melting point, (4) picrate value.

Neutralisation equivalent. This is determined on the recrystallised substance in the way already described. In the absence of alkaline substances, such as calcium oxide or carbonate etc., a determination also on the original substance affords a means of determining the amount of organic base actually present in the sample.

Molecular weight. Rast[7] has published a method for the determination of molecular weights which we have found extremely valuable as a means of identifying not only guanidines but other organic accelerators as well, as the method is simple and can rapidly be carried out without special apparatus. The method depends upon the fact that camphor used as a solvent in the determination of molecular weights by the depression of the freezing-point method has a large freezing-point depression (40° for a concentration of 1 g.-mol. per kg of solvent). A Beckmann thermometer may consequently be dispensed with and the determination of the freezing-point depression carried out with an ordinary melting-point apparatus. The method was originally described for micro-molecular-weight determinations, using only a few milligrams of the substance, but we have found it advisable to take rather larger quantities. About 0·1 g. of the substance is weighed out accurately into a small specimen tube, 10—15 times the weight of camphor added and accurately weighed, and the mixture carefully melted, the tube being closed with a stopper during the melting to prevent loss by volatilisation. The melt is rapidly cooled, the top

6 C. A. Carlton, J. Amer. Chem. Soc., 1922, 44, 1469-1471.
7 Ber., 1922, 55, 1051-1054.

layer scraped away and rejected, and the remainder removed from the tube and well mixed. A portion is then transferred to a melting-point tube with a very small bulb at the bottom, and the melting point determined in any ordinary type of melting-point apparatus, using a thermometer reading from about 140° to 190°. The melting-point taken is when the last crystal disappears from the liquid melt.

Table II gives the results obtained with a number of accelerators. In certain cases the determination was made before the identity of the substance had been established. The approximate molecular weight thus obtained, taken in conjunction with the neutralisation equivalent, is most valuable in identifying a particular guanidine.

TABLE II.

Melting point of camphor, used 171.8.
Depression for 1 g. mol. in 1000 g. of camphor 40.

Substance.	Wt. taken, g.	Wt. of camphor, g.	M.p., °C.	Depression, °.	Molecular wt. Determined.	Molecular wt. Theory.
Diphenylguanidine	(1) 0.0896	0.9082	156.0	18.8	211	211
	(2) 0.0824	1.0041	159.8	15.0	219	211
Triphenylguanidine	(1) 0.1018	1.0022	160.0	14.8	284	287
	(2) 0.1257	0.9913	157.0	17.8	285	287
Artificial mixture containing 51.2% D.P.G., 48.8% T.P.G.	0.1287	1.2006	158.0	16.8	251	240
Phenyltolylguanidine	(1) 0.0631	0.4986	152.7	22.1	229	225
	(2) 0.1098	0.8268	150.0	21.8	240	225
o-Tolylbiguanide	(1) 0.0882	0.9760	156.0	18.8	196	191
	(2) 0.0708	0.6880	149.2	15.6	189	191
p-Phenylenediamine	0.0773	1.5045	157.0	17.8	11[illegible]	108
Piperidinium piperidyl dithiocarbamate	(1) 0.0864	1.0086	172.4	2.4	166.[illegible]*	246
	(2) 0.0716	1.0012	172.8	2.0	1910*	246

* Some decomposition took place during the melting.

Melting point. The melting point is often of considerable value, especially in the case of mixed guanidines. Such mixed guanidines may be of two types, *e.g.*, a mixture of diphenyl- and triphenyl-guanidines having different molecular weights and a mixture of isomers such as phenyl-*o*-tolylguanidine and phenyl-*p*-tolylguanidine. Such mixtures are indicated by the change in melting point on recrystallisation, but in only the first class of mixture is there a change in molecular weight and neutralisation equivalent, so that the latter determinations, taken in conjunction with the melting point before and after recrystallisation, affords a reliable method of discriminating between these two types of mixed guanidines.

TABLE III.

Melting points of various guanidines.

sym.-Diphenylguanidine	
Pure	149°
Commercial A (British manufacture)	142°–144.5°
" B (American ")	144°–144°
" C (" ")	146°–149°
" D (" sold as "pure")	147°–147.5°
sym.-Triphenylguanidine	
Pure	146°
Commercial A (British manufacture)	144.6°–145°
" B (")	143.5°–144.5°
Tri-*o*-tolylguanidine (pure)	130.5°
Phenyltolylguanidine	
Commercial	127°–129°
After recrystallisation	129.5°–130°
Di-*p*-tolylguanidine (recrystallised)	170.5°

Picrate value. The picrates of the arylguanidines are very sparingly soluble in water, and under the conditions given below can be practically quantitatively precipitated. As the information in the literature about the solubility of the picrates is very scanty, we have determined the solubility of the picrates of some of the better-known guanidines. This was determined in each case by shaking the recrystallised picrate with distilled water in a stoppered bottle in a thermostat; a portion of the liquid was removed from the bottle at intervals and filtered, and 100 c.c. of the clear filtrate titrated with titanous sulphate to obtain the picrate content, the shaking being continued until a constant value was obtained for this titre, and from it the solubility of the picrate was calculated.

TABLE IV.

Solubilities and melting points of picrates of various substituted guanidines.

	Melting point (uncorr.).	Solubility in water at 20° C. 1 pt. dissolves in
sym.-Diphenylguanidine picrate	170.3°	5100 parts
sym.-Triphenylguanidine picrate	182.0°*	12,050 parts†
Phenyltolylguanidine picrate	157.5°	3750 parts
Tri-*o*-tolylguanidine picrate	171.0	8740 parts

* Dabis (J. Amer. Chem. Soc., 1900, **22**, 184) gives m.p. as 180°. Mulliken ("Identification of Organic Compounds," Vol. II., No. 882) gives 180°–181°.

† Prelinger (Monatsh., **13**, 98) gives the solubility as: 1 part dissolves in 12,200 parts of water at 15°.

The sparing solubility of the picrates as means of obtaining a pure derivative from an commercial guanidine, and it is often advisabl to prepare the picrate and determine its compos tion, and hence the molecular weight of the guanidine, by the method given below rather than to determine the molecular weight of the recrystallised product by the camphor method, or by the neutralisation equivalent, which might result in fractionation of a mixture of guanidines during the recrystallisation process. Moreover, the weight of picrate obtained is a direct measure of the guanidine present.

The following is the method of precipitation w has been worked out and which gives practic quantitative yields with the guanidines met w commercially. 0.3–0.4 g.* of accelerator is weigh out accurately into a 100-c.c. beaker and dissolve by warming with 10 c.c. of water and 3–4 c.c. of *N* hydrochloric acid, any insoluble matter being filter off and washed with a little hot water. The filtra and washings are diluted to 20 c.c., cooled to abo 40° and 50 c.c. of cold 1% aqueous picric acid added with stirring. The mixture is allowed to stand for at least 3 hours, with occasional stirring, and then filtered through a tared Gooch crucible and washed with cold water in small portions of 2–3 c.c. at a time until the filtrate no longer reacts [illegible] to litmus paper. As a rule 20 c.c. of water is [illegible]t, but in certain cases the precipitate is very vol[illegible]ns (*e.g.*, tri-*o*-tolylguanidine picrate) and in such cases the precipitate should be gently pressed together with a glass rod so that the pump may remove all traces of mother liquor, and the wash-water increased to 30 c.c. After draining at the pump, the crucible and contents are dried at 100° until constant in weight.

Picric acid content of picrate. 0.1 g. of the dried picrate is weighed out accurately into a 250-c.c. flask, 7 c.c. of concentrated sulphuric acid added to dissolve the picrate, and then 10 c.c. of water. The solution is cooled and 50 c.c. of titanous sulphate solution, containing approximately 3% of $Ti_2(SO_4)_3$,

* If the accelerator is suspected to be a biguanide (see later) 0.15—0.2 g. only should be taken.

to be a biguanide should be determined by the camphor method and its neutralisation equivalent determined by titration with standard acid and Bromophenol Blue. The nitrogen content should then be determined by Dumas' method and the number of atoms of nitrogen per molecule thus obtained. N_5 being obtained for a biguanide as against N_3 for an arylguanidine.

The following results were obtained with a commercial sample of *o*-tolylbiguanide: Melting point 140°–144°, strength as $C_9H_{13}N_5$ by titration 93·5%, moisture 4·96%. The sample was then recrystallised from water and the air-dried crystals found to contain 4·67% of water ($C_9H_{13}N_5+\frac{1}{2}H_2O$ requires 4·50%). The water-free product (dried at 100°) gave the following analytical data :—

	Molecular weight			Nitrogen.	
M.p.	By camphor method.	From neutralisation equiv.	Theory.	Determ. (by Dumas) %	Theory. %
145–146* ..	(1) 189 (2) 196	191	191	35·9	36·6

* Bentel (Annalen, **310**, 336) gives 144

o-Tolylbiguanide differs from the guanidines in giving a picrate which contains 2 mols. of picric acid to 1 mol. of base. Thus four preparations of the picrate contained 70·50%, 70·88%, 70·48%, and 70·61% of picric acid respectively—theory for a dipicrate requiring 70·57%. The second molecule of picric acid is, however, only loosely combined as on recrystallising from alcohol partial decomposition takes place. Thus a sample of acid picrate containing 70·61% of picric acid contained only 68·4% after recrystallising from alcohol. We have so far had no opportunity of examining other biguanides to see if the property of forming dipicrates is common to this class of compounds.

Aldehyde-ammonia. This substance is readily identified and does not need much mention here. It melts at 96° and is soluble in water, the solution being strongly alkaline. The aqueous solution can be titrated quantitatively with standard acid, using Methyl Red as indicator. Acetaldehyde is liberated by the reaction and may be tested for in the usual ways.

Commercial samples frequently contain a small amount of free lime. This, if present, may be determined by extracting a known weight of the sample with hot benzene (in which aldehyde-ammonia is fairly readily soluble). The residue is filtered off, suspended in water, and titrated with $N/10$ hydrochloric acid, using phenolphthalein as indicator to give the free lime content, and continuing the titration using Methyl Orange to determine any calcium carbonate which may be present.

Group III.—Sulphur only present.

The chief representatives of this class are dithioacids, *e.g.*, dithiobenzoic acid. We have, however, not had the opportunity of examining commercial accelerators belonging to this class and do not propose therefore to treat of them.

Group IV.—Nitrogen and sulphur present.

This group includes certain well-known accelerators such as thiocarbanilide and derivatives of dithiocarbamic acid.

Thiocarbanilide (diphenylthiourea) $(C_6H_5NH)_2CS$. This product is prepared commercially by the direct condensation of aniline and carbon disulphide. Other aromatic amines, *e.g.*, *o*- or *p*-toluidine, may be employed and a series of substituted thiocarbanilides thus obtained. Thiocarbanilide itself is a white, neutral substance which does not give a picrate. It is almost insoluble in water, but easily soluble in warm alcohol and crystallises from it on cooling in the form of white glittering leaflets, m.p. 151° C.

Thiocarbanilide may be quantitatively determined[10] by titration with potassium bromate, one molecule absorbing 4 atoms of bromine: 0·3—0·4 g. of the sample is dissolved in 20 c.c. of glacial acetic acid and 20 c.c. of water, 10 c.c. of 20% potassium bromide solution and 5 c.c. of concentrated hydrochloric acid are added. The solution is warmed to 25–30° and titrated with $N/5$ bromate solution till a test spot gives a reaction on starch iodide paper persisting for 2–4 minutes after the last addition of bromate solution (1 c.c. of $N/5$ bromate = 0·0057 g. of thiocarbanilide). Commercial samples occasionally contain a trace of aniline, which also absorbs bromine. This may be determined as follows:—20 g. of the sample is shaken with 100 c.c. of cold dilute hydrochloric acid (1 : 4), the liquid is filtered and the filtrate and washings are diluted to about 200 c.c., and after adding 5 c.c. of 20% potassium bromide solution, titrated with $N/5$ bromate solution at the room temperature. Any aniline thus found should be allowed for in the determination of thiocarbanilide by bromate titration. Commercial samples also generally contain small amounts of substances which contain more sulphur than thiocarbanilide: consequently a determination of the sulphur content is often of value in judging the quality of a sample. Traces of free sulphur may be also present: such may be detected by extracting in a Soxhlet apparatus with carbon disulphide in the usual way.

Determination of total sulphur in thiocarbanilide. Thiocarbanilide and its substituted derivatives are readily decomposed by ignition with an intimate mixture of lime and dry sodium carbonate (4 : 1): under suitable conditions the sulphur is quantitatively retained by the mixture, and may be determined as barium sulphate in the usual way. The ignition is conveniently carried out in a silica tube of approximately the dimensions of a test-tube. A layer of the pure mixture of lime and sodium carbonate is first put in the tube to a depth of about ½ in., and then there is added about 0·2 g. of thiocarbanilide which has been intimately mixed with about 2–3 g. of the mixture of lime and sodium carbonate; finally the tube is lightly filled with the mixture of lime and sodium carbonate to within about 1½ in. from the top, about 8 g. of the mixture being required in all. The tube is supported in an inclined position and then gradually heated, starting at the top. When the top is hot, the lower portion is gradually heated with another Bunsen burner, and finally the whole tube is raised to a red heat. The total time of heating is about ½ hour.

After cooling, the contents of the tube are extracted with water, 20 c.c. of saturated bromine

[10] Callan and Henderson, J., 1922, 161 T.

added with the usual precautions[9] and the solution boiled gently for 10 minutes in an atmosphere of carbon dioxide. After cooling, the excess of titanous sulphate is determined by titration with a standard iron alum solution in the usual way. The iron alum solution is best standardised against pure, recrystallised picric acid. The following table (Table V.) gives the results obtained with a number of pure and commercial guanidines by the above method. The last column (mol. wt. of base calc. from composition of picrate) is of considerable interest, as it gives the mean molecular weight of all guanidines present.

TABLE V.

Picrate values.

	Mol. wt.	Melting point, °C.	Wt. taken, g.	Wt. of picrate, g. (a) found	(b) calc.	Melting point of picrate, °C.	% Base in substance calc. from wt. of picrate	% Picric acid in picrate by titanous sulphate found.	% Picric acid in picrate, calc.	Mol. wt. of base, calc. from picrate
Diphenylguanidine										
Pure	211	149	0.3279	0.6808	0.6838	170.0°	99.5	52.09	52.05	211
Commercial										
A (British manufacture)		142°–144.5°	0.4092	0.8053		164.5–165.5°	95.7*	51.47		215
B (American ,,)		141–144	0.3254	0.6386		162–162.5	94.1*	51.81		213
C (,,)		136°–139°	0.3527	0.6500		163.5–166.5	88.4*	49.01		248
Triphenylguanidine										
Pure	287	146	0.4222	0.7576	0.7591	181–181.5	99.8	44.47	44.38	286
Commercial (British manufacture)		141.5–145°	0.4004	0.7114		179.5–181	98.8†	44.12		290
90% pure triphenylguanidine, 10% pure diphenylguanidine	277	136.5	0.3406	0.6174	0.6221	176.5–178	99.3	45.08	45.26	279
90% pure diphenylguanidine, 10% pure triphenylguanidine	216.7	142.5	0.3113	0.6352	0.6403	166–167	99.2	51.75	51.38	211
Tri-o-tolylguanidine, pure	329	130.5°	0.3692	0.6248	0.6261	173–173.5°	99.8	41.26	41.04	326
Tritolylguanidine, commercial		125.5–127.5	0.2730	0.4661		168.5–170	100.5‡	41.56		322
Phenyl-o-tolylguanidine, pure	225	129.5°–130	0.3840	0.7632	0.7718	154–154.5	98.5	50.77	50.44	222
,, commercial		127–129°	0.3376	0.6650		154°–154.5°	97.3	50.77		222
Di-o-tolylguanidine, pure	239	171	0.2970	0.5802	0.5813	175°	99.8	49.23	48.93	236
,, commercial		161.5–162.5°	0.3060	0.7106		169.5–171.5	101.6§	48.41		244

* Calculated as diphenylguanidine Mol. wt. 211
† ,, ,, triphenylguanidine ,, ,, 287
‡ Calculated as tritolylguanidine Mol. wt. 329
§ ,, ,, ditolylguanidine ,, ,, 239

In the case of certain commercial diphenylguanidines the values obtained are higher than required by the diphenyl-derivative, and we were in fact able to isolate triphenylguanidine from these products by fractional recrystallisation of the hydrochloride. It should be noted that if a sample of triphenylguanidine contains diphenylguanidine the direct titration by means of standard acid and Bromophenol Blue gives a fictitiously high value for the basic content calculated as triphenylguanidine—thus a mixture containing 88.6% of triphenyl- and 8.4% of diphenylguanidine and 3.0% of inert matter would titrate as 100% triphenylguanidine. Such a mixture, however, would be at once indicated by the molecular weight of the mixed picrates obtained. It is within our own knowledge that samples of accelerator believed to be diphenylguanidine, and tested as such in the vulcanising process, were in fact mixtures containing a considerable amount of triphenylguanidine.

The most commonly used guanidines are *sym*-diphenyl- and *sym*-triphenyl-guanidines.

Diphenylguanidine. A good commercial sample should have a melting point not lower than 142° and should contain at least 94% of alcohol soluble base calculated as diphenylguanidine when titrated with $N/10$ hydrochloric acid using Bromophenol Blue as indicator, and should completely pass a 60-mesh sieve. Practically all commercial samples contain a proportion, up to 10%, of triphenylguanidine and, as previously mentioned, this has the effect of reducing the apparent strength as given by the titration with standard acid. Other common impurities are lead salts and a by-product of manufacture, tetraphenylbiguanide, both of which are insoluble in hot toluene, in which diphenylguanidine readily dissolves.

Triphenylguanidine. A good commercial sample should titrate at least 96% with standard acid, using Bromophenol Blue as indicator, should have a melting point not lower than 143°, and should contain not more than 1% insoluble in hot toluene. It should completely pass a 60-mesh sieve. The following qualitative test will be found very useful in order to differentiate rapidly between diphenylguanidine and triphenylguanidine.

To 5 c.c. of a 1% solution of the base dissolved in a slight excess of dilute hydrochloric acid, 1 c.c. of 10% ammonium thiocyanate solution or 20% perchloric acid is added. Under these conditions pure diphenylguanidine gives no precipitate whilst triphenylguanidine gives an immediate heavy white precipitate. Commercial samples of diphenylguanidine usually give a turbidity or precipitate, the amount of which affords a rough indication of the quantity of triphenylguanidine present.

(*c*) *Arylbiguanides* (*guanylguanidines*). At least one member of this class, *o-tolylbiguanide*

$$NH_2{\cdot}C({:}NH)NH{\cdot}C({:}NH){\cdot}NH{\cdot}C_6H_4CH_3 + \tfrac{1}{2}H_2O,$$

is now on the market as a vulcanising accelerator under a trade name. The phenyl- and tolyl-biguanides are white substances, moderately soluble in cold and easily soluble in hot water, and crystallise from water in glittering plates. Their aqueous solutions are strongly alkaline to litmus, and on addition of a drop of copper sulphate solution give an immediate pinkish flocculent precipitate. They are thus readily distinguished from the arylguanidines. The molecular weight of a substance suspected

[9] Knecht and Hibbert, *loc. cit.* Callan, Henderson, and Strafford, *loc. cit.*

water is added, and the solution heated for about 20 minutes to oxidise any sulphide. The liquid is then made slightly acid with hydrochloric acid, boiled till the bromine is removed, filtered, and the filtrate and washings precipitated at the boiling point with barium chloride solution in the usual way. A blank determination must be carried out on the same amounts of reagents to allow for any sulphate present. It is noteworthy that the camphor method for determining the molecular weight fails in the case of thiocarbanilide, and hence the method cannot be employed in distinguishing thiocarbanilide from its higher substitution products, *e.g.*, ditolylthiourea. The following are examples of results obtained with pure samples :—

Substance	Wt. taken, g	Wt of camphor taken, g	M p.	Depression, °C	Molecular wt Determined.	Molecular wt Theory.
Thiocarbanilide	0·1018	0·9917	152·3	22·5	183	228
	0·0885	1·0860	156·0	18·8	174	228
	0·0510	0·7444	158·2	16·6	167	228
Di-o-tolylthiourea	0·0838	0·8130	152·7	22·1	187	256
Di-p-tolylthiourea	0·0600	0·6040	153·2	21·6	184	256

A good commercial sample of thiocarbanilide should have a melting point not lower than 147·5° and should test at least 94% by the bromate titration; it should not contain more than a trace of aniline and inorganic matter (ash), and should completely pass a 30-mesh sieve.

Substituted thiocarbanilides. Di-o-tolylthiourea. $(CH_3{\cdot}C_6H_4{\cdot}NH)_2{:}CS$. This substance crystallises from alcohol in fine white needles of m p. 155°. It cannot be titrated by means of potassium bromate, as, although absorption takes place, no definite end-point can be obtained.

Di-p-tolylthiourea. This is only very sparingly soluble in alcohol, and is best recrystallised from benzene. The recrystallised substance melts at 175°. The sulphur content of these two compounds may be determined by the method described under thiocarbanilide. A sulphur determination on the recrystallised product is of great help in characterising a substance suspected to be thiocarbanilide or a substituted thiocarbanilide.

Derivatives of dithiocarbamic acid. The alkyl derivatives of dithiocarbamic acid, $NH_2{\cdot}CS{\cdot}SH$, are frequently used as accelerators and various derivatives are met with commercially, the NH_2 group of the parent substance being substituted by methyl, ethyl, or piperidyl groups, whilst the acidic hydrogen may be substituted by metals such as zinc, or aliphatic amines may be added on to give substituted ammonium salts. These substances are very readily prepared by the direct union of carbon disulphide and an amine, and as most amines react readily a considerable number of derivatives are possible, but only the following are generally met with commercially: dimethylammonium dimethyldithiocarbamate $(CH_3)_2N{\cdot}CS{\cdot}S{:}NH_2(CH_3)_2$; diethylammonium diethyldithiocarbamate $(C_2H_5)_2N{\cdot}CS{\cdot}S{\cdot}NH_2(C_2H_5)_2$; zinc dimethyldithiocarbamate $[(CH_3)_2N{\cdot}CS{\cdot}S]_2Zn$, and the corresponding zinc diethyl derivative and piperidinium piperidyldithiocarbamate (piperidinium pentamethylenedithiocarbamate).

As a class these substances are readily recognised by the fact that they liberate carbon disulphide on warming with dilute sulphuric acid, the sulphate of the corresponding amine being simultaneously formed. After distilling off the carbon disulphide, the residual solution is made alkaline and the liberated base recovered by distillation, and identified by converting into the corresponding platinichloride and determining the platinum content of this by ignition. Piperidine is readily recognised by its odour and by reconverting into the dithiocarbamate derivative by treating with carbon disulphide and determining the melting point of the product (172°) after recrystallising from alcohol.

These substances are such powerful accelerators that they are usually sold commercially in the form of mixtures containing a considerable amount of diluent such as kaolin. The determination of the amount of active constituent therefore becomes a matter of considerable importance, and hence the following method has been devised. It is based on the fact that these substances decompose quantitatively on distillation with dilute acid into carbon disulphide, which can be distilled off and determined by absorption in alcoholic potash and titration of the xanthate produced[11] and the amine which can be subsequently liberated by caustic alkali and determined by distilling into excess of standard acid, *e.g.*,

$$N(C_2H_5)_2{\cdot}CS{\cdot}S{\cdot}NH_2(C_2H_5)_2+H_2SO_4 = CS_2+[NH(C_2H_5)_2]_2{\cdot}H_2SO_4.$$

$$[N(C_2H_5)_2CS{\cdot}S{\cdot}]_2Zn+2H_2SO_4 = 2CS_2+[NH(C_2H_5)_2]_2{\cdot}H_2SO_4+ZnSO_4.$$

About 1 g. of the substance (or a correspondingly larger amount in the case of the diluted mixtures) is weighed out into a long-necked round-bottomed flask which can be connected by means of ground glass joints to a large-bulbed U-tube.[12] This is in turn connected to a smaller one, and both are charged with approximately 2*N* alcoholic potash, the large one holding about 25 c.c. and the smaller one about 3 c.c.; 25 c.c. of 30% sulphuric acid is run in to the flask through the centre tube, which passes almost to the bottom of the flask, and the mixture is brought to the boiling point and kept gently boiling for about 30 minutes, a gentle current of air being continuously drawn through the apparatus. The carbon disulphide which is liberated is readily absorbed by the alcoholic potash, forming potassium xanthate, which may be titrated with *N*/10 iodine solution in presence of sodium bicarbonate after neutralising the free alkali with dilute acetic acid:

$$CS_2+C_2H_5OH+KOH = KS{\cdot}CS{\cdot}OC_2H_5+H_2O$$

$$2HS{\cdot}CS{\cdot}OC_2H_5+2I = S_2(CSOC_2H_5)_2+2HI.$$

1 c.c. *N*/10 iodine = 0·0001 g.-mol. CS_2 = 0·0001 g.-mol. of a dithiocarbamate.

After the removal of the carbon disulphide, the alkaline solution in the absorption tubes is replaced by 20 c.c. of *N*/1 sulphuric acid, the residual solution in the flask made alkaline with caustic soda, and the liberated amine distilled off, a slow current of air being continuously aspirated through the apparatus. The excess of standard acid in the absorption tubes is finally titrated with *N*/5 sodium hydroxide, using Methyl Red as indicator.

[11] Radcliffe, J., 1909, 229. Castine, Comptes Rend., 98, 1588.
[12] *Cf.* Robertson, "The Determination of Halogens in Organic Compounds," Chem. Soc. Trans, 1915, 107, 902-907.

From the above equations it will be seen that alkylammonium alkyldithiocarbamates when treated as described above give two mols. of amine for each mol. of carbon disulphide and hence give an acid titre twice that of the iodine titre, whereas in the case of a metallic salt the two titres are identical.

In the case of metallic salts the substance, after removal of any inorganic diluent by extracting with benzene, should be gently ignited and the ash examined for metals, particularly zinc. The determination of such a metal in the recrystallised product gives at once the molecular weight of the compound and affords a valuable means of identification. The following are the results we have obtained with various dithiocarbamates and commercial samples of accelerators belonging to this class

TABLE VI.

Sample	Wt taken.	C.c. N/10 iodine	C.c. N/10 acid	% Strength from CS_2 titre	% Strength from amine titre	% Zinc. Determined	% Zinc. Calc.
Piperidinium piperidyl dithiocarbamate	0·9528	38·60	77·30	99·7	99·8		
Zinc dimethyldithiocarbamate	1·0204	66·55	66·60	99·6	99·7	21·4	21·4
Zinc diethyldithiocarbamate	0·4144	22·90	22·90	99·9	99·9	18·0	18·1
Artificial mixture containing 38·3% zinc dimethyldithiocarbamate, 61·7% kaolin	1·0320	37·6	37·5	35·2	35·1		
Artificial mixture containing 40·0% zinc dimethyldithiocarbamate, 30·0% zinc oxide	1·2020	31·0	31·1	40·0	40·0		
Zinc alkyldithiocarbamate isolated from a commercial accelerator	0·3916	23·50	23·50	107·5* 90·8†	107·5* 90·8†	18·9	18·1* 21·4†

These results indicate that this sample is apparently a mixture of 59% diethyl and 41% dimethyl or monoethyl derivatives.

* Calc. as zinc diethyldithiocarbamate.

† Calc. as zinc dimethyl- or monoethyl-dithiocarbamate.

The alkyl dithiocarbamates are readily converted into the corresponding thiuram disulphides by treatment in alcoholic solution with iodine, which is rapidly absorbed with precipitation of the thiuram disulphide.

$$2R_2N{\cdot}CS{\cdot}SH{\cdot}NHR_2 + I_2 = R_2N{\cdot}CS{\cdot}S{\cdot}S{\cdot}CS{\cdot}NR_2 + 2R_2NH{\cdot}HI$$

We have investigated the reaction in the case of several dithiocarbamates which are soluble in alcohol, and find that it proceeds quantitatively when $N/10$ iodine solution is used at ordinary temperature, and hence affords a convenient volumetric method of analysis. Thus 0·9091 g. of piperidinium piperidyldithiocarbamate dissolved in 25 c.c. of alcohol required 36·95 c.c. of $N/10$ iodine, corresponding to 100% piperidinium piperidyldithiocarbamate. The titration mixture should be diluted somewhat with water towards the end of the titration in order to obtain a sharp end-point with starch indicator.

Thiuram disulphides. As stated above, these are formed by the oxidation of the corresponding dithiocarbamates. They are obtained as well-defined crystalline substances on recrystallising from alcohol, piperidylthiuram disulphide having m.p. 132° and tetraethylthiuram disulphide 70°.

The thiuram disulphides are less reactive than the dithiocarbamates and differ from them by being only very slightly attacked by heating with dilute acids, and in not absorbing iodine. Since they are quantitatively formed from the dithiocarbamates by oxidation, it was thought that it might be possible to reduce them quantitatively back to the corresponding dithiocarbamic acid, which could then be determined by the method previously described. Various reducing agents in alkaline and acid solution were tried, *e.g.*, sodium and alcohol, aluminium and caustic soda, zinc and magnesium with sulphuric acid, stannous chloride, titanous salts, etc. In several cases the reduction proceeded too far, with the formation of hydrogen sulphide, and in others the reaction was incomplete or too slow to be of practical use. Magnesium filings with sulphuric acid in aqueous-alcoholic solution was, however, found to give very satisfactory results, the reaction proceeding smoothly and quantitatively. Under these conditions the dithiocarbamic acid as produced splits up immediately into carbon disulphide and the sulphate of the amine, both of which can be determined as previously described in the case of the alkyldithiocarbamates.

$$R_2N{\cdot}CS{\cdot}S{\cdot}S{\cdot}CS{\cdot}NR_2 + 2H = 2R_2N{\cdot}CS{\cdot}SH = 2R_2NH + 2CS_2.$$

The following are the details of the method as finally adopted: 0·3–0·4 g. of the thiuram disulphide is weighed out accurately into a similar flask to the one previously prescribed for the analysis of dithiocarbamates, dissolved in 40–50 c.c. of alcohol, 1 to 2 g. of magnesium filings added, and the flask connected to the U-tubes containing $2N$ alcoholic potash. About 50 c.c. of 25% sulphuric acid is then gradually added in portions of a few c.c. at a time and the mixture slowly raised to the boil, a slow current of air being continuously aspirated through the apparatus. After about 50 minutes the yellow solution becomes colourless, indicating the completion of the reaction. The heating is continued for about 15 minutes longer to ensure complete removal of the volatile products. The solution in the absorption tube is then titrated with iodine as previously described, and the liquid in the flask made alkaline, the liberated amine distilled over into excess standard acid and determined in the usual way. From the equation previously given it will be seen that 1 g.-mol. of a thiuram disulphide on reduction gives 2 g.-mols. of carbon disulphide and 2 g.-mols. of the amine; hence 1 c.c. of $N/10$ iodine = 0·00005 g.-mol. and 1 c.c. of $N/10$ acid = 0·00005 g.-mol.—*e.g.*, 1 c.c. of $N/10$ iodine or $N/10$ acid = 0·0148 g. of tetraethylthiuram disulphide (mol. wt. 296), or 0·0160 g. of piperidylthiuram disulphide (mol. wt. 320).

The following are the results obtained with various samples of thiuram disulphides.

TABLE VII.

Substance	Wt. taken, g.	c.c. N/10 iodine.	c.c. N/10 acid	Strength calc. from CS_2 titre.	Strength calc. from amine titre.
Piperidylthiuram disulphide	(1) 0·3225	20·1		99·7	—
	(2) 0·3495	21·8	21·8	99·9	99·9
Tetraethylthiuram disulphide	(1) 0·3540	24·0	24·0	100·1	100·1
	(2) 0·4001	27·15	26·95	100·4	99·6
Commercial accelerator consisting of tetraethylthiuram disulphide diluted with kaolin	1·2343	26·0	24·6	31·2	29·6

In conclusion, we desire to express our thanks to the British Dyestuffs Corporation (Blackley), Ltd., in whose Central Analytical Laboratory the work was carried out, for permission to publish the results embodied in this communication.

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TRANSACTIONS

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A MODIFICATION OF THE GROSVENOR HUMIDITY CHART.

BY G. J. GREENFIELD, A.I.C.

The usual method of stating the "humidity" of air or other gases is as "grains (ounces or pounds) of water vapour per cubic foot," but owing to the change of volume of a gas with temperature, this method gives no constant basis on which to calculate. Also, since air is described as being, say, 50% saturated when the water vapour exerts one-half of its saturation pressure at the given temperature, it follows that there is more air in a cubic foot at 50% saturation than at 100% saturation; *e.g.*, at 60° F., one cubic foot contains at 100% saturation, 0·0008264 lb. of water and 0·075068 lb. of dry air, and at 50% saturation, 0·0004132 lb. of water and 0·075609 lb. of dry air (data from Kempe's "Engineer's Yearbook" for 1921, p. 1590). Thus "percentage humidity" is not really a comparable percentage, and even at a constant temperature there is no constant basis for calculations.

To provide such a basis, W. H. Grosvenor* proposed a very simple measure of humidity, namely, "pounds of water vapour per pound of dry air." The advantage of this is obvious, for a pound of dry air is a constant amount, irrespective of changes of temperature, pressure, or humidity. Calculations made on this basis become very simple indeed. It is curious that since the publication of this paper, very little attention has been paid to it. So far as the author is aware, no mention of the system has been made in any publication, excepting in "Principles of Chemical Engineering" (by Walker, Lewis, and McAdams, pub. McGraw-Hill, 1923), in which the system is fully described.

The following definitions are made:—

Absolute humidity (h) is the number of pounds of water vapour carried by one pound of dry air.

Percentage humidity is the number of pounds of water vapour carried by one pound of dry air at a definite temperature, divided by the number of pounds of vapour which one pound of dry air would carry if it were completely saturated at the same temperature. It is to be emphasised that this is not the same as "percentage relative humidity," discussed above.

Humid heat (s) is the quantity of heat necessary to raise the temperature of one pound of dry air, plus such water vapour as it contains, by 1° F. (or 1° C.).

Specific volume is the volume occupied by one pound of air, when dry.

Humid volume is the volume occupied by one pound of dry air, plus such water vapour as it contains.

The proposed modification.

This system, and the chart accompanying it, are useful enough in calculations affecting dryers, humidifiers, etc., where water vapour is carried by air. Clearly the above definitions can be read as applying to any other gas, and the chart may be used, if its humidity ordinates are elongated in the ratio (mol. wt. of air) : (mol. wt. of the gas). The "adiabatic cooling curves" cannot be used for any other gas than air.

In many industrial processes, *e.g.*, the production of coal gas, producer gas, etc., the production is measured by a meter in cubic feet, but the molecular weight varies from day to day. In order, therefore, to use the original chart, a gas sample would have to be analysed every time an observation was taken, in order to compute the average molecular weight. However, from the temperature and pressure at the meter, it is easy to calculate the flow of gas in pound-molecules per hour, irrespective of the molecular weight.

The proposed modification, therefore, is to express the humidity of a gas as pounds of water per pound-mol. of dry gas, instead of per pound of dry gas. In the accompanying chart, the lines for 100%, 80%, etc. humidity, and for specific volume and humid volume, have been calculated directly from Grosvenor's original figures, by multiplying by the molecular weight of air, which, also calculated from his figures, has been taken as 28·98. The lines for humid heat, and the adiabatic cooling lines, must differ with the molecular specific heat (MCp) of different gases. For exact work with a particular gas of given composition, these lines would be recalculated from the formulæ,

Molecular humid heat (S) = MCp + 0·48H.

Adiabatic cooling lines, slope $\left(\frac{dH}{dT}\right) = -\frac{S}{r_w}$

(r_w = latent heat of steam, per lb. at the wet bulb temperature in question. For a discussion of these equations, and a description of the uses of adiabatic cooling lines, see "Principles of Chemical Engineering," *loc. cit.*) On this chart, a value of 7·25 has been taken for the molecular specific heat. That this is a fair average value for all industrial gases is shown by the following table, in which the analyses are derived from "The Calorific Value of Gas," by J. H. Coste, except those for coal gas, which were taken at a coke works under the author's supervision, widely different ones being chosen in this case for contrast. The specific heats of the constituent gases are taken from data in the above book, and also from an article by Lewis and Randall (J. Amer. Chem. Soc., 1912, 1128). "Illuminants" have been counted as ethylene.

The necessity for this modification of Grosvenor's system occurred to the author during some observa-

Gas.	Percentage composition H_2	O_2	N_2	CO	CO_2	CH_4	C_2H_4	MCp at 20° C.
Coal gas	47·5	1·6	20·2	2·0	2·0	24·7	2·0	7·59
Do.	64·2	0·6	2·1	4·6	2·0	24·1	2·4	7·59
Water gas	54·3	0·3	0·4	40·0	2·0	3·0	—	6·91
Dowson gas	19·8	—	48·8	23·8	6·3	1·3	—	6·96
Carburetted water gas	34·0	0·4	5·2	23·0	0·6	20·8	16·0	8·09
Do.	32·3	0·3	4·3	31·3	4·5	17·7	9·5	7·79
Blast-furnace gas	5·4	0·1	55·7	29·8	6·8	2·2	—	7·00
Mond gas	24·8	0·8	40·0	13·2	12·9	2·3	—	7·13
Air	—	20·9	79·1	—	(0·04)	—	—	6·80

* Trans. Amer. Inst. Chem. Eng., 1908, 1, 184.

A

tions on the efficiency of some gas coolers on a coke-oven plant. The gas in question, after passing through a "serpentine" air cooler, enters a series of water coolers at about 60° C. The quantities observable are the gas and water temperatures entering and leaving each cooler, and the rate of flow of gas (by a meter situated after all the coolers) but not the rate of flow of water. In order, therefore, to calculate the rate of transfer of heat from gas to water, it is necessary to know the heat content of the gas, and its humidity. That the gas is saturated at all points in the system is shown by the fact that liquor issues from the seal pot of every cooler. To apply the Grosvenor chart would entail a gas analysis for every set of observations. By the use heat, in C.h.u. per pound-mol. of dry gas (=S). (One Centigrade heat unit, C.h.u., is the quantity of heat necessary to raise one pound of water by 1° C.)

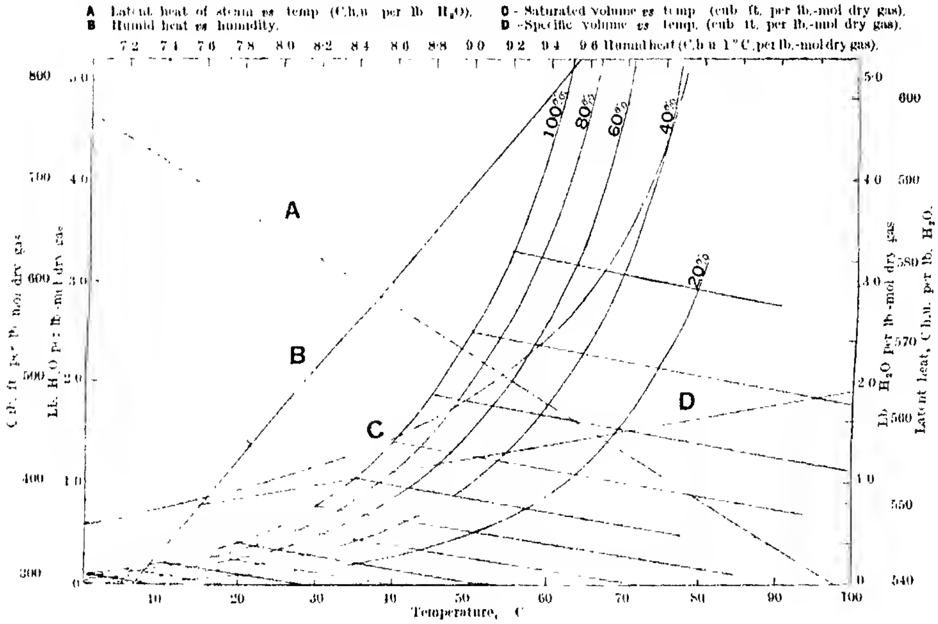
Then heat content = GST (C.h u. per hour passing the point in question).

Or (2) choosing a suitable value for the probable MC_p of the gas considered, read off the latent heat of steam at the temperature T, from the chart ($=r$) and

Heat content $= GT(MC_p + rH)$.

The latter method is more accurate, but involves slightly more trouble. Other examples of the use of the chart will be apparent. It must be remembered

Humidity chart, modified from the Grosvenor chart.



of the modification here presented, no gas analyses are necessary. The procedure is as follows:—

If V = recorded gas flow, in cub. ft. per hour.
T = gas temperature at meter.
p = absolute gas pressure at meter (mm.).
v = humid volume at T° C., from the chart,

then $Vp/760$ = cub ft. per hour at 760 mm. and T° C., and therefore $Vp/760v$ = lb.-mols. dry gas per hour = G (say).

From the recorded gas temperature at any observation point, the water vapour per pound-mol. of dry gas is read from the chart (=H). The heat content of the gas at that point can then be determined by one of two methods. The heat content with which we are concerned is the sensible heat of the gas above 0° C., plus the latent heat of the water vapour present.

(1) Accepting the value, 7·25, for MC_p, read from the plot of humid heat versus humidity, the humid that the chart applies to a total pressure of 760 mm., and for any other pressure, p mm., the humidity read from the chart must be multiplied by the factor, $760/p$. This is only an approximation, and is not accurate when the partial pressure of water vapour is not small compared with 760 mm. The adiabatic cooling lines have been included in the chart for the sake of completeness, but their only probable use is in cases of drying of substances by hot flue gases, since wet-bulb temperatures of coal gas, producer gas, and other industrial gases would usually be vitiated owing to the presence of dust and other suspended impurities.

As has been shown, the chart is applicable to all important gases, although it is not intended to supersede the original one for the many operations in which air is the carrier, such as drying, air conditioning, etc., in which the original will probably be at least equally convenient.

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CALCIUM SULPHATE CEMENT.*

BY C. L. HADDON, M.SC., A.I.C., A.INST.P., AND M. A. W. BROWN, B.SC.

The principal objects of this research were :—

(1) To determine the number of allotropic modifications of anhydrous calcium sulphate.

(2) To explain differences in setting properties of calcium sulphate from different sources.

(3) To examine the acceleration of setting by other sulphates.

(4) To investigate the nature of intercrystalline adhesion from the evidence obtainable from calcium sulphate cement.

Calcium sulphate exists in three forms which differ from one another in their water of crystallisation. They are :—

(1) The anhydrous salt, $CaSO_4$, which occurs in nature as anhydrite, and is the principal constituent of flooring plaster.

(2) The hemihydrate, $2CaSO_4,H_2O$, which is the important constituent of plaster of Paris.

(3) The dihydrate, $CaSO_4,2H_2O$, which occurs as gypsum in nature, and is the normal form of calcium sulphate in precipitates.

Van't Hoff[1] distinguished two forms of anhydrous calcium sulphate, one of which he called "soluble anhydrite," but his conclusions have been adversely criticised.[2] Practically all later workers[3] have distinguished two or more forms, the evidence being the variation in solubility and setting properties of flooring plaster according to its mode of preparation and varying solubility. Keane[2], on very little experimental evidence, concluded that only one allotropic modification of calcium sulphate exists, the difference in setting rates being due to difference in grain size. Desch[4] also saw no reason for the existence of more than one modification.

The original explanation of the setting of flooring plaster and plaster of Paris by Le Chatelier[5] was that the plaster dissolved, and the less soluble dihydrate was precipitated as interlocking needles, which gave the final cement its mechanical strength. It was shown by one of the present authors[6] that not more than half the mechanical strength is due to this interlocking—a possibility which had been earlier and independently suggested by Desch.[4] Le Chatelier's main evidence was that in alcoholic solutions he was able to precipitate such crystals, but Von Weimarn[7] has since shown that the nature of a precipitate depends on the degree of supersaturation, and also upon the solubility of the precipitate, every possible type of precipitate of the same substance being obtainable, from a gelatinous mass to well-defined crystals, by varying these conditions.

Ostwald and Wolski[8] investigated the setting of plaster of Paris from the colloidal standpoint. They found that :—(1) On mixing with water it forms a colloidal solution of greatly increased viscosity. On deposition of crystals, the viscosity falls. (2) Grain size has an enormous effect on maximum viscosity. (3) The age of the ground material affects the maximum viscosity, which decreases until it becomes constant with material at least one month old. He explains this as due to agglomeration of particles.

Neugebauer[3], in experiments on so-called "soluble anhydrite" of varying water content, found that aluminium sulphate—a powerful accelerator of setting—did not increase the maximum viscosity, but caused it to be reached earlier. He did not continue any experiments once the maximum was passed. He was unable to find any increase in viscosity as regards flooring plaster, and explained its setting properties as due to its lime content.

Weissenberger[3] examined the colloid chemistry of anhydrite, but employed a wrong method, which will be discussed later. His experimental evidence thus needs revision and his conclusions are valueless.

Rohland[3] examined the effect of dissolved salts on the setting rates, and enunciated the law that "salts which increase the solubility of calcium sulphate increase the setting speed and *vice versa*." This has been disproved in certain cases by one of the authors,[6] and will be discussed later.

Davis[9] has shown by the occurrence of a period of induction in the dehydration of dihydrate that two modifications of $CaSO_4,2H_2O$ exist, and one of the present authors has confirmed this by showing that when certain accelerators are used there is first an increase followed by a decrease to a constant level when the strength of briquettes, under equal conditions of wetness, is plotted against time.

Solubility.

The solubility of the alleged allotropic modifications of anhydrous calcium sulphate must differ except at the inversion point, and if the variations in setting speeds are due to this, the difference in solubility must be considerable. The solubility was therefore determined.

Solubility figures for anhydrous calcium sulphate are liable to the following errors :—(1) Very fine particles are appreciably more soluble than normal particles, and with sparingly soluble substances supersaturated solutions are formed ;[10] (2) anhydrous calcium sulphate absorbs moisture from the air to form hemihydrate (see later). Marignac found the

* Read at a meeting of the Newcastle Section on Jan. 16, 1924.

solubility of the hemihydrate at ordinary temperatures to be about 10 g per litre; (3) from (2) it seems probable that very finely divided anhydrous salt on coming into contact with water will absorb it to form the more soluble hemihydrate at a speed sufficiently rapid to affect solubility determinations; (4) anhydrous calcium sulphate dissolves very slowly and considerable time is necessary for saturation.

In order to eliminate these errors, the most important of which is (2), the salt, in certain instances, was shaken several times with water, and separated by centrifuging. It was then washed with mixtures of alcohol and water containing gradually increasing percentages of alcohol, and dried in a current of warm air. Quantities of 0·5 and 1·0 g were placed in two 100-cc. flasks containing water saturated with respect to dihydrate. The flasks were placed in a thermostat for 5 hours and frequently shaken to maintain a turbid solution. The solutions were then filtered, the first few c.c. being rejected, and the calcium sulphate determined either as barium sulphate or volumetrically as oxalate. There was no appreciable hydration in any case examined. "Soluble anhydrite" with a large water content showed much hydration, but the figures are not included here. When the impurity (*i.e.*, hemihydrate, etc.) is small, if A solubility using 0·5 g. quantities and A + x that using 1 g quantities, then A − x is the solubility of anhydrous calcium sulphate.

If the impurity is higher, this method yields unsatisfactory results as the more highly supersaturated solutions precipitate dihydrate. The degree of setting thus caused was ascertained in every case by determining the loss on ignition of the carefully dried insoluble residue

The solubility figures shown in Table A were obtained The flooring plaster christened Earle's cement was some very pure flooring plaster made by ignition at 500° C. The "soluble anhydrite" was prepared by heating pure dihydrate to 180° C. for 12 hours, and thoroughly washing and centrifuging to remove hemihydrate.

TABLE A.

Solubility

Temperature 25° C. $CaSO_4$, grams per litre

	0·5 g (A)	1 g (A + x)	True solubility (A − x)
"Soluble anhydrite"	2·45	2·38	2·32
Earle's cement	2·38 2·13	2·51 2·50	2·28
Flooring plaster	2·39	2·48	2·30
Pure dihydrate ignited at 700° C	2·29 2·28	2·29	2·29
Anhydrite	2·31	2·31	2·28

The two samples of Earle's cement were washed and centrifuged at different times. The last two samples were not thus treated. The anhydrite had probably absorbed a little moisture to form hemihydrate. This is strong evidence of the existence of only one allotropic modification of anhydrous calcium sulphate.

Similarly the solubility of anhydrous calcium sulphate in 5% $CuSO_4,5H_2O$ solution was found to be 2·08 g. per litre (the mean of five determinations with Earle's cement and anhydrite). Corresponding figures for the solubility of the dihydrate were 2·09 and 1·88 g. of $CaSO_4$ per litre, showing in each case a greater solubility of the anhydrous salt of 0·20 g. per litre. In other experiments with "soluble anhydrite" which had absorbed moisture, this proportional increase in solubility was found to hold true in calcium chloride solutions; *i.e.*, when the inversion point is not appreciably affected, the solubilities of different hydrates of the same salt bear a constant relationship to one another in solutions of different salts in water.

It appears to the authors that, except when solutions are so concentrated as seriously to affect the inversion point of gypsum, each modification of calcium sulphate yields the same substance in solution; therefore, other salts should affect each modification in the same way No published data appear to exist on this subject, except contradictory data by different workers on the solubility of the allotropic modifications of phosphorus in different solvents, where the conditions are not strictly parallel.

As 0·5% of combined water corresponds to 8% of hemihydrate, it might be anticipated that when cement is made the concentration in solution would be that of hemihydrate. It was found that even with large proportions of water to plaster the setting rate is sufficient to keep the quantity in solution below 5 g. per litre. This will be referred to later. Some "soluble anhydrite" which had absorbed 5% of moisture showed a maximum solubility of 6·15 g. per litre.

Borax, which retards the setting of plaster, appreciably increases the solubility of gypsum.

It is obvious that Rohland's theory is untenable. The more rapid solution of plaster in sulphate solutions was shown by shaking 0·5 g. of plaster in 50 c.c. of water and copper sulphate solution respectively, thoroughly shaking, allowing to stand for 5 minutes, and rapidly filtering The copper sulphate solution contained 2·14 g. per litre of calcium sulphate as against 1·76 g for water Similarly, it was found that the electrical conductivity became constant more rapidly with dilute copper sulphate solutions than when water alone was used

In another experiment 6-g. quantities of Earle's cement (which then showed a loss on ignition of 0·63%) were shaken with 100 c c. of water and of 2·5% copper sulphate solution respectively; 25-c.c. quantities were abstracted, filtered, and an aliquot portion analysed The results are shown in Table B.

TABLE B.

Time	Water only	2½% Copper sulphate sol
30 minutes	2·05 g per litre	2·55 g per litre
2½ hours	2·21 g ,, ,,	2·83 g. ,, ,,
5 hours	2·40 g ,, ,,	2·82 g. ,, ,,
Loss on ignition after 5 hours	0·70%	1·32%

These results show that copper sulphate causes more rapid solution, and the greater difference of these solubility figures from the saturation figures of anhydrous calcium sulphate, coupled with the much greater amount of dihydrate formed, show that it also causes more rapid precipitation of dihydrate.

In order to discover if the action of the copper sulphate was to cause peptisation of the solid particles, which would thus dissolve more rapidly, the rate of solution being proportional to the surface,

some elutriation experiments were carried out. The *modus operandi* is described later. Accurate results wero impossible as solution of the hemihydrate affected the particle size and somo dihydrate appeared to be deposited when copper sulphate solution was the elutriating medium. The results show that measurable peptisation does not occur; hence this is not the explanation.

The generally accepted theories of solution stato that the solubility of a salt is decreased by the presence of another salt with a common ion except when a double salt is formed, when the solubility increases. In the case of $CaSO_4,2H_2O$, the solubility continues to diminish with the presence in solution of increasing quantities of a second calcium salt, but when SO_4'' is the common ion, an anomalous solubility curve results in practically every case.

Published solubility figures show that increasing quantities of sodium, potassium, ammonium, magnesium, and copper sulphates continuously decrease the solubility of calcium sulphate to a minimum of about 1·5 g. per litre, when from 10 to 30 g. per litre of the second salt is present. Further increases of the concentration of the second salt result in a gradually increasing solubility of calcium sulphate, till in certain instances its solubility becomes considerably greater than in water. This phenomenon is probably connected with the strong accelerating action of sulphates, but no theory of solution appears to offer any thoroughly satisfactory explanation of either phenomenon.

The dissociation theory of Arrhenius might be extended to explain the solubility phenomenon by stating that while the sulphate ion of the second salt decreases solubility, the undissociated molecule increases it, and the undissociated calcium sulphate in solution, as a result, is present under such conditions that passage into and out of solution is facilitated. A saturated solution of calcium sulphate is about 50% dissociated in water, thus the accelerating effect of other sulphates is more rapid than would be explained by assuming that the setting speed varies as the concentration of undissociated molecules of calcium sulphate in solution.

The formation of hemihydrate.

One of tho distinctive properties of so-called "soluble anhydrite" is its ability to absorb moisture from the atmosphero till it contains about 6 or 7%.[11] The same property is shown by ovory modification, as shown in Table C.

TABLE C.

	Loss on ignition. When first made.		
		After time stated.	
Pure $CaSO_4,2H_2O$ heated to 200° C. for 12 hours and kept in stoppered bottle	1·69%	2·56%	3 months later
Second sample similarly made and kept in bottle with cork stopper	1·50%	5·16%	2 months later
Earle's cement kept in stoppered bottle	0·15%	1·135%	18 months later
Pure $CaSO_4,2H_2O$ ignited to 750° C. and kept in stoppered bottle	Nil.	0·27%	12 months later

Thus the lower the temperature of preparation the higher is the rate of absorption, but as shown later, the particle size increases with rise of temperature; so it may be deduced that the rate of absorption varies inversely as the size of the particle, and probably directly as the total surface energy. That this water is present as hemihydrate is shown qualitatively by conductivity experiments and quantitatively by elutriation experiments.

In elutriation of flooring plaster by aqueous solutions which had been previously saturated with anhydrous calcium sulphate, there was always a loss through solution of an amount approximately equal to that calculated from the water content of the original plaster. When the original percentage was high, it was impossible to obtain satisfactory results on account of the large proportion dissolving.

Two direct tests for the formation of hemihydrate were carried out. In the first, some pure dihydrate was ignited at 700° C. for 5 hours, ground to pass through a sieve 25,600 meshes per sq. inch, and intimately mixed with an equal quantity of pure dihydrate dried in a current of warm air. The mixture was kept in a sealed specimen tube for six months. The electrical conductivity was then determined, 25 c.c. of liquid being used and 0·1 g. of solid being added at a time. The temperature was constant at 25°±0·08° C.

TABLE D.

Time. Min.	Resistance. Ohms	Time Min.	Resistance. Ohms.
0	75·40 (sat. $CaSO_4,2H_2O$ sol.)		0·1 g. added.
0·1 g. added		45	60·6
5	66·0	50	60·6
10	66·5	55	61·25
25	67·0	60	62·7
30	67·7	70	63·7
40	67·7	80	63·95

There is thus conclusive evidence of the presence of a much more soluble constituent. These figures differ from other conductivity figures in that with each addition, the first decrease in resistance was followed by a small increase. This increase is obviously due to the deposition of dihydrate, and is due to the large amount of dihydrate present acting as crystalline nuclei, and perhaps also the β-modification of the dihydrate being formed by dehydration, the dihydrate initially crystallising as β salt except under special conditions.

In the second experiment, mineral anhydrite was finely ground, and placed in a covered dish over water for six months. At the end of that period, the powder was found to contain 15·05% of combined water. Here, of course, the first phase, the formation of hemihydrate, had been completed, and the second phase commenced.

Elutriation.

In the apparatus used for elutriation a constant head was obtained by an overflow apparatus, and two nozzles were employed, giving velocities of 0·223 and 0·42 mm. per second respectively, when the elutriating medium was saturated with anhydrous calcium sulphate; 5 g. of the cement was mixed with a bone spatula with some of the elutriating liquid, and the suspension washed into the elutriating vessel. The elutriation was then commenced, and the elutriated particles continuously

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filtered off, the filtrate being transferred to a reservoir. After six hours the operation was virtually complete, and the experiment stopped. Perfect elutriation was impossible owing to the formation of more finely divided particles, gradual solution, and also to slight setting when copper sulphate solutions were used for elutriation purposes. When the elutriating medium was 5% copper sulphate solution, the head was adjusted to give the same velocity, subsequent corrections for density and viscosity being made. The amounts of elutriated solid and residue etc., were ascertained by filtering, washing with saturated calcium sulphate solution, and igniting. The figures are shown in Table E.

TABLE E.

Elutriating liquid	Speed of liquid. Mm. per sec.	$CaSO_4$ elutriated. g.	$CaSO_4$ residue. g.	Loss. g.
Water saturated with $CaSO_4$, $2H_2O$	0·223	1·11	3·27	
		1·04	3·75	
		Mean, 1·07	3·51	0·44
	0·42	2·17	2·29	
		2·37	2·25	
		Mean, 2·27	2·27	0·46
6% Copper sulphate saturated with $CaSO_4$ $2H_2O$	0·223	1·22	3·31	
		1·37	3·29	
		Mean, 1·30	3·30	0·40

Good duplicates were not obtained. The plaster contained 0·40% of water, corresponding to an anticipated loss of about 0·5 g. if no setting occurred.

The relative densities of water saturated with calcium sulphate, and of 5% copper sulphate solution similarly saturated are 1·01 and 1·04, and the absolute viscosities 0·01235 and 0·01360.

Stokes' well-known law states that $v = \frac{2}{9} \times \frac{gr^2}{\eta}(a-\beta)$

v being the constant velocity acquired by a particle of radius r in a liquid of viscosity η, and $(a-\beta)$ the difference in specific gravity of the liquid and the solid.

The specific gravity of anhydrous calcium sulphate is 2·9. A velocity of 0·223 mm. per second yields 21·4% elutriated, and of 0·42 mm. per second, 45·4% in calcium sulphate solution. A velocity of 0·223 mm. per second in copper sulphate solution is equivalent to a velocity of 0·249 mm. per second in water, which would be expected to elutriate about 25%. The actual amount elutriated was 26%. As the experimental error is several per cent., there is obviously no appreciable peptisation, which should occur if acceleration is to be explained thereby.

Agglomeration of particles.

The effect of intensity and duration of heating on the size of particles was also investigated. To avoid any loss, dry paraffin was used as the elutriating medium.

The constants for the paraffin were—velocity of flow 0·233 mm. per second, specific gravity 0·817, and viscosity 0·02962 dyne.

The following results were obtained:—Original dihydrate, d 2·30, 55·8% elutriated. Dihydrate heated to 200° C. for 12 hours, 59·0%; heated to 440° C. for 12 hours, 24·8%; and heated to 440° C. for 60 hours, 8·9%. Thus, despite the greater amount of dihydrate elutriated on account of its lower density (equivalent to 39% of anhydrous salt) it will be seen that dehydration decreases the size of particles, and agglomeration of particles is caused both by increasing the temperature and duration of heating.

It is generally stated in text-books that the aggregation of particles when precipitates are boiled is due to the finer particles re-dissolving, and precipitating on the coarse particles. That this is not the case with calcium sulphate is shown by the data given below.

The solubility of flooring plaster was determined at higher temperatures under conditions similar to those in the solubility experiments previously described. The temperatures varied from 50° to 65° C. in different experiments. Between these temperatures the solubility of dihydrate varies from 2·01 to 1·93 g. per litre, and the solubility of anhydrous flooring plaster must be higher, as these temperatures are below the inversion point of the dihydrate. The figures obtained varied from 1·39 to 1·90 g. per litre in different experiments. The higher figures were due to the fact that in some experiments the solvent was partially saturated with dihydrate at the beginning of the experiments. There was obvious coalescence of particles, and no hydration.

The solution was never saturated with respect to anhydrous calcium sulphate, yet coalescence of these particles occurred. The phenomenon must be due to the same cause as the agglomeration of particles on heating, the particles colliding and adhering. In the case of the solid alone, the movement of the particles is obviously due to Brownian movement, the amplitude at ordinary temperatures being sufficient to bring small particles in suitable contact with other particles, and at high temperatures the larger particles also acquire sufficient amplitude or velocity.

The colloidal theory of the setting of flooring plaster.

It has already been stated that the setting speed prevents very high supersaturation, and hence the deposition of colloidal precipitates. The supersaturation with plaster rarely rises above 2 g. per litre.

Weissenberger[3] considered that he had established the existence in metals of colloidal phenomena. His experimental method consisted in determining the depth to which a Vicat needle penetrated into a mixture of finely powdered anhydrite and solution. The depth was plotted against time and an ∽-shaped curve obtained in each case. He argued that an initial set took place at the steep part of the curve, and the final hardening later. The first stage of setting he regarded as colloidal—the absorption of water to form a gel—and he associated hardening with the deposition of crystals of dihydrate. He also found that the maximum strength was obtained with 16% of water, as against a theoretical value of 26·7% for perfect hydration. It is obvious from other figures that only part of the anhydrite had hydrated, and thus the optimum percentage of water is a function of voids between the particles and rate of evaporation, and has nothing to do with the amount necessary for hydration or with colloidal phenomena.

To the authors it appeared that the penetration of a Vicat needle would fall into three periods :—(1) In the early stages the needle would penetrate practically to the bottom, just as if allowed to fall into wet powder. (2) The plaster is becoming sufficiently strong to bear the weight of the needle; this is the steep part of the curve. (3) The plaster is strong enough to bear the weight of the needle, but the momentum of the needle carried it a small distance into the plaster—the final gentle slope.

To prove that this was the correct explanation, the "dash-board" of the needle was filled with oil, the plunger lifted, and allowed to fall under the weight of the needle. This insured a constant velocity of penetration. The weight of the needle was altered by placing different weights on the pan. The depth of the pat was 40 mm. The figures in Table F were obtained, and are plotted in Fig. 1.

FIG. 1.

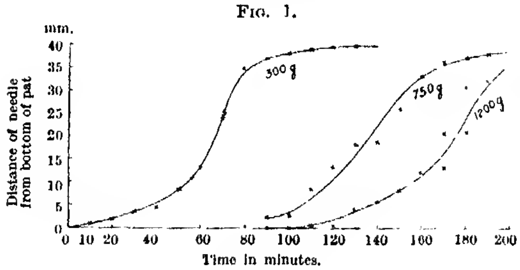

TABLE F.

Time. Min.	Height in millimetres. Pan wt. : 300 g.	750 g	1200 g.
0	0	0	0
10	1, 0·5	-	—
20	1·5, 2·0	—	—
30	3·5, 3·5	—	—
40	5·0, 4·0	—	—
50	7·5, 9·5	-	—
60	12, 20, 8	-	—
70	27, 17, 29	—	—
80	35, 34	—	—
90	37, 37, 37	2·5	0
100	38, 38	3	0
110	39, 39	8, 9	0·5, 0·5
120	39, 39·5	16, 10	0, 1
130	39·75, 39·75	38, 13, 14	2, 6, 4
140	39·75	30, 15, 11	2, 8, 7
150	—	35, 11, 32	9, 7
160	-	32, 34, 35	8, 19, 8
170	—	35, 37, 36	9, 10, 20
180	—	38, 37, 37	20, 12, 32
190	—	38, 38, 38	32, 29, 34
200	—	39, 38, 39	36, 36

The erratic figures on the steep part of the curve afford additional evidence that the strength then is just sufficient to bear the weight of the needle, and is not connected in any way with colloidal phenomena.

Modifications of dihydrate.

In order to confirm that monoclinic $CaSO_4,2H_2O$ can act as crystalline nuclei as well as the normally formed orthorhombic variety, some mechanical experiments were carried out. The results are shown in Table G :—

TABLE G.

Proportions of mixtures. Flooring plaster. g.	Monoclinic crystals. g.	Mean figures of two briquettes. Tensile strength in lb. per sq. in. After 6 hours.	After 24 hours.
350	Nil.	66	260
340	10	70	280
330	20	107	360
320	30	105	350
300	50	120	280

The acceleration of setting shows that the dihydrate has acted as crystalline nuclei. A patent by Linck in 1908 covers this method of accelerating setting, but it is unsatisfactory from the practical point of view.

The great differences in setting speeds caused by varying conditions are shown in Table H. Two pats of flooring plaster and distilled water were made under similar conditions. Specimen A was covered immediately with a little distilled water, and B exposed to air in the ordinary way. Samples of each specimen were dried, and the percentage of combined water was determined.

TABLE H.

Time.	Percentage of combined water. A %	B. %
After 2 days	0·5	0·70
,, 5 ,,	0·5	3·86
,, 9 ,,	0·63	0·83
,, 11 ,,	0·80	12·75
,, 14 ,,	1·05	14·60
,, 17 ,,	2·22	—

These figures illustrate difficulties in gauging setting speeds by determination of the percentage hydration.

Intercrystalline cement.

The well-known theory of Rosenhain[12] of the existence of a powerful intercrystalline cement, amorphous in nature, has not been universally accepted, and F. C. Thompson[13] has put forward an alternative surface tension theory. Metallographic methods do not afford conclusive proof of either theory.

Experiments were carried out to examine the adhesion of set plaster. It was considered that if an amorphous intercrystalline cement existed, it must be much more soluble than crystalline gypsum, and its existence confirmed by electrical conductivity methods. The following experiments were made :—

(1) A flooring plaster (distilled water paste) was rammed into a tube, and a piece of copper wire inserted into each end of the paste. The paste was kept moist for one month, when it thus became fully hydrated. It was then again saturated with water, and allowed to dry, the resistance and weight being determined daily. The specimen was finally dried in a desiccator. The experiment was stopped when the resistance reached 10 million ohms, the initial figure being 5000 ohms. The conductivity per gram of uncombined water was plotted against the water content, but no sudden increase of conductivity was found when the water content became very small.

(2) Briquettes were made, care being taken that the hydration was complete, and saturated with distilled water. The resistance was determined, and the briquette repeatedly strained in the hope of producing more amorphous material. It was found that the elongation of the briquette decreased the resistance by 30%, the original resistance being restored by slight compression. This method was useless for the purpose intended.

It was thus found necessary to revert to mechanical tests. In a previous paper it was shown that the strength of dry briquettes was reduced by 50% on

soaking in water or saturated gypsum solutions. Mineral oils did not decrease the strength at all, nor did absolute alcohol, though mixtures of alcohol and water affected the strength, according to the percentage of alcohol.

The effect of saturated calcium chloride (in which calcium sulphate is only very sparingly soluble) and of glycerin (in which it is more soluble than in water) was studied. The calcium chloride solution was found to reduce the strength in the same degree as water. The results are shown in Table J.

TABLE J.

	No. of briquettes tested.	Tensile strength (lb. per sq. in.).
Dry briquette ..	2	680, 510
Soaked in water	2	410, 425
Soaked in saturated $CaCl_2$ solution	3	400, 460, 140
Soaked in glycerin	2	470, 560

The glycerin took several days to permeate to the centre of the briquette, and even then, on breaking, certain parts of the fractured surface were not visibly permeated.

It is thus obvious that substances in which amorphous calcium sulphate would be anticipated to dissolve decrease the strength of briquettes, and other liquids do not.

It might be objected that though calcium sulphate is more soluble in certain mixtures of alcohol and water than in saturated calcium chloride solution, yet saturated chloride solutions decrease the strength more than alcohol solutions. The cause of this is probably due to surface tension. For this reason the composition of a solution alters as it soaks up into blotting paper, and the same must happen in a briquette. Thus the composition of the solution in the centre of a briquette is probably very different to the composition at the surface.

The evidence obtained supports Rosenhain's theory against Thompson's theory of the cause of intercrystalline strength.

CONCLUSIONS.

The following conclusions may be drawn from the above work:—

(1) Only one modification of anhydrous calcium sulphate exists: its solubility at 33° C. is 2·29 g. per litre and in 5% copper sulphate solution 2·08 g. per litre, against the corresponding solubilities of gypsum of 2·09 and 1·88 g. of $CaSO_4$ respectively.

(2) Rohland's theory of the catalytic action on setting of other salts is shown to be incorrect. Calcium sulphate dissolves and precipitates more readily in the presence of copper sulphate.

(3) Flooring plaster consists essentially of anhydrous calcium sulphate and hemihydrate.

(4) Anhydrous calcium sulphate absorbs moisture from the air to form hemihydrate, the speed depending on the particle size.

(5) Agglomeration of particles is increased by intensity and duration of heating.

(6) Growth of particles in precipitates is due to the particles adhering and not to the finer particles dissolving and reprecipitating.

(7) The different setting rates of different plasters are due to the particle size and percentage of hemihydrate. The importance of external conditions is also shown.

(8) The setting is caused by the interlocking of the needles of precipitated dihydrate and by crystal adhesion.

(9) Crystal adhesion is due to amorphous cement which dissolves in certain solvents, with corresponding loss of mechanical strength.

Finally, we wish to express our thanks to the Chairman and Directors of Messrs. Swan, Hunter and Wigham Richardson, Ltd., in whose laboratory this work was done; to the Department of Scientific and Industrial Research for a grant to one of us from the Building Research Board; and to Messrs. Earle's, Ltd., for supplying a sample of very pure flooring plaster made under works conditions.

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THE PRESERVATION OF FOOD BY STERILISATION.

BY CLARICE M. DUGDALE.*

The method of preserving food for an indefinite period which is used in all its essentials to-day, was first introduced in 1810, in Paris, by Nicolas Appert, who published his discovery in a communication to the Consulting Bureau of Arts and Manufactures.

This communication has recently been translated in America, and the gist of it cannot be expressed more adequately than in Appert's own words:—"Before entering into the details of the execution of my process, I ought to say that it consists principally:—

(1) To enclose in the bottle or jar the substances that one wishes to preserve.

(2) To cork these vessels with the greatest care because success depends chiefly on the closing.

(3) To submit these substances thus enclosed to the action of boiling water in a water-bath for more or less time according to their nature, and in the manner that I shall indicate for each kind of food."

At that time the current theory of putrefaction was that of spontaneous generation, and Appert explained the success of his method as follows:—"The subject of heat has the essential quality in itself, not only of changing the combination of the constituent parts of animal and vegetable products, but also, if not of destroying, at least of arresting for many years the natural tendency of these same products to decomposition."

The growth of the science of bacteriology in the latter part of the last century gave the clue to the true explanation of the practical success of this process; it was shown that the decomposition of organic materials was due to the action of small extraneous organisms which could be killed by heat. Thus foods heated in carefully sealed containers were freed from these destructive organisms and were protected from the attack of others as long as the seal was perfect.

The problems of food preservation were thus clearly defined as follows:—

(1) To choose a suitable container.

(2) To seal it perfectly.

(3) To heat the whole package so as to destroy the organisms present.

The different types of container and the several methods of sealing them will be considered later in their bearing on the sterilising process required in each case.

The outline of the methods used for sterilisation and the principles involved will first be considered.

The heating of the sealed packages of foodstuffs is usually effected in large metal retorts by steam under pressure; this steam may be supplied from a boiler serving several retorts, or by water contained in the retort itself. Careful comparative experiments made by the staff of the Research Laboratory of the National Canners' Association in America have shown that the same heat process as regards time and temperature has equal sterilisation value whichever type of retort is used.

The problem to be solved is the amount of heat to be supplied to secure the destruction of all the organisms present. The two most important factors in determining this are:—(*a*) The specific resistance to heat of these organisms; (*b*) the rate at which heat is conducted through the mass of the food.

The resistance of bacteria to heat.

Bacteria are divisible into two large groups—those which form spores and those which do not. Non-sporing (*i.e.*, vegetative) forms are usually readily killed at a temperature of about 60° C. The spores of most pathogenic bacteria are killed by boiling for a few minutes. Until recent years little more than this was known about the resisting power of bacteria.

In 1910 Miss Chick[1] published the results of certain investigations of the rate of destruction of bacteria in the vegetative form by heat and disinfectants. One of the facts which emerged from her work was that the resisting power of cultures of the same age, from the same strain of bacteria, produced on standardised media under apparently identical conditions, varies very considerably. The cause of this variation is not known. Miss Chick concluded from her work that the destruction of bacteria by hot water takes place in accordance with the logarithmic law of a chemical reaction, in which the individual bacteria behave like the molecules in such reaction, and each has the same resisting power.

Other workers have, however, shown that her figures could be explained on the assumption that the resistance of individuals of a culture varies amongst those individuals in the normal way in which biological characteristics are distributed

* Read at a meeting of the Newcastle Section on Dec. 12, 192[illegible]

[1] J. Hygiene, 1910.

amongst a group, *i.e.*, a large number have a resistance near some mean value, with fewer and fewer of gradually increasing or decreasing resistance. These figures showed also that the mean resistance varies from culture to culture.

The distinct analogy between the destruction of organisms by heat and the coagulation of their proteins has led to the conclusion that this destruction is a chemical reaction, involving changes in the chemical constituents of the proteins present and having a very high temperature coefficient, so that at some temperature it appears to take place instantaneously. (This, of course, is a very different thing from assuming that the bacteria themselves behave like uniform molecules.)

A comprehensive study has recently been made in America by Meyer and his co-workers,[2] on the heat-resisting properties of *B. botulinus*. The method used was to seal up a spore suspension in a hard glass tube and immerse this tube in an oil-bath, electrically controlled at the desired temperature. At a given time the tube was withdrawn, cooled and opened, and sub-cultures were made on suitable media. These were incubated and examined from time to time for evidence of germination

All results gained in this way are strictly comparable, but, as was pointed out by one worker, considerable radiation of heat takes place from the glass walls of the tube, and a definite time elapses before the spore suspension itself reaches the temperature of the bath. At 120° C. this time was stated to be 30 min. The actual heat-resistance of the spores is therefore rather less than would appear from these experiments.

The results of this work may be summarised as follows :—

(1) The maximum heat-resistance of spores of different strains of *Bacillus botulinus* may, under exactly similar conditions, exhibit enormous variations; *e.g.*, 78 strains of type (*a*) were examined and the resistance at 105° C. was found to vary from 3 min. to 80 min.

(2) Spores of the same strain showed marked variation in their powers of resistance. This made comparative determinations of the resistance under different conditions impossible, as the effect of the changed conditions could not be distinguished from the normal variations. It was, however, found that the drying of the spores under carefully standardised conditions left them with constant though slightly reduced resistance. The study of the effect of certain reagents could then be carried out on dried spores. In this way it was found that :—

(3) The resistance is greater in a neutral medium. With increase or decrease of the hydrogen-ion concentration the resistance falls off.

(4) For a given spore suspension, the resistance varies with the concentration.

(5) In a medium containing amino-acids but no other soluble nitrogen compounds, the spores exhibited relatively low resistance.

(6) The resistance in the juices of certain canned foods remained almost constant despite a very considerable difference in hydrogen-ion concentration of the juices.

In addition Meyer found that young moist spores are the most resistant; they can be kept for a few days at 0° C. without losing their resisting power, but cannot be so kept at 20° or 37° C. Dried spores retain their resistance when kept at 0°, 20°, or 37° C.

The germination of spores may be delayed for a long time without the spore necessarily being killed; *e.g.*, *B. botulinus* has been known to germinate after a year's incubation at 37° C.

The media and conditions most favourable to the production of resistant spores were studied, and then the resistance of a large number of suspensions was determined under the conditions most favourable to resistance.

The maximum survival times of *B. botulinus* and two other anaerobes as found by Meyer are as follows :—

Temperature, ° C.	Time (minutes) *B. botulinus.*	*B. sporogene*	*B. tetani.*
120	4	—	—
115	10	—	—
110	33	12	—
105	100	45	25
100	330	150	90

These show that *B. botulinus* in its most resistant forms is markedly more resistant than the other common anaerobes.

The sterilising process used for any food must be based principally on the maximum heat-resistance of the organisms which may be present.

Bacterial contamination.—Owing to the widesprea distribution in nature of bacteria of different kinds, it is impossible to prevent some organisms from gaining access to foods, particularly in transit, however careful and adequate may be the covering of the foods. Moreover, fruits and vegetables have been found in perfectly fresh condition to carry on their surfaces soil organisms, which are not removed by washing. The number of bacteria present in food before the sterilising process may, however, be minimised by attention to strictly sanitary conditions in transit and preparation, and to the reduction, as far as practicable, of the length of the preliminary steps in manufacturing or packing. It is particularly desirable that cooling processes, where necessary at all, should be carried out as quickly as possible.

It has been found, however, that a few very highly resistant spores may be produced in very young cultures of certain organisms, and the strictest regard to sanitation cannot entirely preclude the occasional access to food of various types of spoilage-producing bacteria.

The following study of the conditions affecting the sterilisation of preserved foods was undertaken with a view to determine the steps necessary to eliminate trouble from such accidental sources.

Much more needs to be known about the distribution in nature and the resistance to heat of non-pathogenic organisms, which are mainly the cause of spoilage in preserved foods. In this connexion the following experiments made by the author on the resistance of certain sporing aerobes may be described.

[2] J. Infect. Diseases, [illegible]

In empirical tests on the sterilisation of food mixtures it was noticed that a group of sporing, aerobic organisms frequently survived what seemed a very severe heating, and it appeared to be desirable to determine their distribution, the degree of resistance to heat normally exhibited, and what would be their action if allowed to develop in the foods.

They were, therefore, carefully isolated and their cultural characteristics examined. A bacteriological study of various foodstuffs was also made. This showed the organisms to be widely distributed in foods, particularly cereals, as normally offered for sale.

The chief characteristics of the group are as follows:—

Type.	α	β	γ	δ	η	θ
Shape	Bacillus	Bacillus	Bacillus	Bacillus (usually in long massive chains)	Bacillus	Bacillus
Gram	Negative	Negative	Negative	Negative	Negative	Negative
Spores	Central and oval	Central and flat	Central and oval	Central and oval; very large	Central	Terminal and round
Broth culture	Cloudy—soft pellicle formed	Thick tenacious ridged pellicle	No pellicle—liquid cloudy and sediment formed	Cloudy—heavy sediment	Soft film	Cloudy—no film
Agar slope	Soft white film—slight ridges—non-tenacious	Much ridged, very tenacious. Yellowish film. Removed from agar with great difficulty	Soft smooth white glistening film	Thick white growth. Soft and non-tenacious	Yellowish film, in appearance like β but non-adhesive	Soft, brownish-white growth
Potato	White, soft, much-ridged — non-tenacious film	Pinkish ridged film — closely adherent to surface of potato	Soft smooth moist white growth	Thick white soft film	Yellowish white moist film. In a few days potato becomes vacuolated and alcoholic smell is noticed	
Milk	Alkaline and peptonised	Alkaline and peptonised	Alkaline and peptonised	Alkaline and peptonised	Acid and clot	Alkaline and peptonised
Gelatin stab	Rapid liquefaction	Rapid liquefaction	Rapid liquefaction	Rapid liquefaction	—	Rapid liquefaction
Egg-meat broth	Egg white rapidly digested. No odour	Egg white rapidly digested. No odour	Egg white slowly digested. No odour	Egg white fairly rapidly digested. No odour	—	Egg white digested. Slight putrid odour
Sugar-media: Glucose	Acid but no gas	Acid but no gas	Acid but no gas	Acid but no gas	No acid or gas	No acid or gas
Lactose	No acid or gas	No acid or gas	No acid or gas	No acid or gas	Acid and slight gas	No acid or gas
Sucrose	Faint acid, no gas	Marked acid, no gas	No acid or gas	Acid but no gas	—	No acid or gas
Mannitol	No acid or gas	Faint acid, no gas	No acid or gas	No acid or gas	—	No acid or gas

The most important of these characteristics are the almost complete absence of fermentation on carbohydrate media and the definite though varying proteolytic action of all the members of the group. The last one is noticeably different from the others; it was isolated only from a mixture of foodstuffs and was never definitely traced to its origin. It has terminal spores, and produces a slight putrefactive odour on milk and egg-meat broth. It was thought that it might really be an anaerobe with unusual stability in the presence of oxygen, but it was not successfully grown under anaerobic conditions. On the other hand, two of the aerobes, α and β, could be readily grown under the degree of anaerobiosis normally produced in a Buchner tube.

The different organisms were inoculated on to jars of meat which were then sealed as usual, incubated, and examined after some weeks. In each case the organism was recovered, and changes in the meat had definitely taken place, though the nature of these changes was not investigated. There was no objectionable odour or taste to be noticed, but the meat had entirely lost its characteristic meat flavour, and had deteriorated markedly. No marked change in the reaction of the meat was noticeable.

It may be mentioned here that one of the most satisfactory methods of closure for glass jars is the "Phœnix cap" method, in which the cap is clamped tightly on to the jar by a mechanical device, the seal being made air-tight by a rubber ring between the lid and the jar. This leaves a layer of air on the top of the jar which is evidently sufficient to permit of the development of these aerobic organisms. It is necessary, therefore, to use a sterilising process adequate to destroy these, if spoilage is to be prevented.

Some knowledge of the resisting power of the organisms was therefore desirable. From preliminary tests on their resistance in foodstuffs it was concluded that three of them, α, β, and γ, were more resistant than the others, and about as resistant as each other.

The tests were made on ordinary nutrient broth cultures for convenience in detecting growth and also because it seemed that such broth was fairly similar in essentials to the foodstuffs under consideration. The heating of the cultures at 100° C. was effected in the steamer; at higher temperatures, the experiments were made in the autoclave, the time taken after closing the autoclave before reaching the desired temperature, and the time taken to "blow off" the pressure before opening up, being in each case carefully noted and controlled.

The tests were mainly made on one type of organism (β) and fall into three groups:—

(1) Tests made on 16-hr. old cultures to determine the approximate resistance of young cultures, as under normal conditions of preparation of food for preservation by heat, the time in which development of the organism is possible would be limited to a few hours.

(2) Tests on 24-hr. old cultures in which a pellicle had formed definitely, and a large number of spores were present.

(3) Tests on 10—14-day old cultures in which no vegetative forms were found.

Tests at 100° *C.*—A large number of experiments may be summarised as follows:—The maximum heat-resistance found for a 16-hr. old culture at 100° C. was 55 min. It was noticeable that in this

particular series, apparently identical cultures showed no growth in three weeks after heating for 5, 10, 15, and 20 min. respectively, and yet cultures heated for 55 min. grew out in two days. This showed the production of a few fairly resistant spores in quite young cultures; these resistant spores happened to be located in the tubes heated for 55 min.

In the examination of about 70 cultures of 1 day's growth, the maximum heating at 100° C. after which growth occurred was 1½ hr., with growth delayed for at least 3 weeks.

When older cultures (10–14 days old) were studied, a considerable number survived heating for 3 hr.; several survived 4 hr. and one survived 6 hr. The last grew out in less than a week; some of the others only grew out in from two to three months. These older cultures therefore showed a definitely higher resistance than the younger ones, probably because the increased spore-formation increased the chance of the production of some highly resistant spores.

At higher temperatures the following resistances have been noted: –5 min. at 115°; 20 min. at 108°; 35 min. at 107°; 45 min. at 105° C. Many more tests would be necessary to determine the actual maximum resistance of these spores at these temperatures.

The time required to raise the autoclave to the desired temperature was usually 4 min., and the time to drop to 100° C. was 3 min. A broth culture immersed in boiling water was found to attain a temperature of 100° C. in about 4 min. The above processes probably, therefore, represent very nearly the actual temperatures which the cultures themselves reached. The autoclave method has, however, many obvious disadvantages and could not be used where standardised conditions were desired for comparative studies. It suffices, however, to give much information for practical purposes.

In the case of the heating of the culture which survived 115° for 5 min., the "getting-up" time of the autoclave was accidentally increased to 10 min.; this, therefore, indicates a very high resistance, particularly as the culture grew out in about eight days.

No attempt has been made to identify these organisms, but they are very similar to some of the sporing organisms which Savage[3] and his co-workers in their investigations of the bacteria of canned meats found fairly commonly occurring in these foods. They show still more marked resemblance to the bacilli found widely distributed in cereals, in the course of an investigation of rope in bread.[4] One of the latter bacilli in broth culture also resisted heating at 100° C. for 6 hr.

Amongst the few facts about the resistance of bacteria to heat that really seem to be established, the variation in this property stands out as most important. In the present state of our ignorance of the causes affecting this, it is necessary to take the maximum resistance that the organism has ever shown as the factor to determine the heating to be given wherever it is desired to destroy the organism with certainty.

As these commonly occurring sporing aerobes described appear to have a maximum resistance of quite the same order as *B. botulinus*, it would seem to be possible to determine from their death or survival after given sterilisation processes the adequacy of that process to destroy all food-poisoning organisms, if the tests are made on a sufficient number of samples.

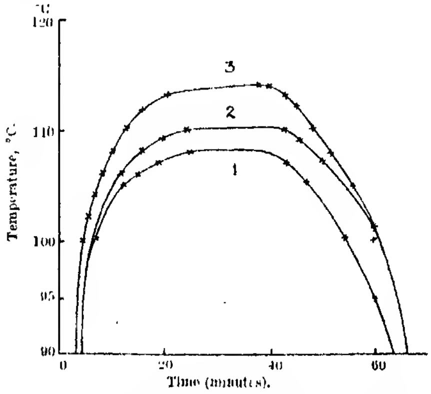
Rate of heat penetration.

The second factor of primary importance in the sterilisation of foodstuffs is the rate at which the heat penetrates to the centre of the food.

This is influenced by the following conditions:—

(1) The size and shape of the container.
(2) The consistency and viscosity of the food.
(3) The specific conductivity of the food.
(4) The temperature at which the retort is maintained.
(5) The initial temperature of the food when the retort process is begun.

The actual temperature of the centre of a package has been studied by a simple device originally designed in slightly different forms by various American workers. These studies have shown that where (as is usually the case) the consistency and viscosity of the food is such as to minimise convection currents, the rate of heat penetration into the centre of the can is very slow. This rate must be determined for each type of package and kind of food.



Curves showing temperature at centre of a given food package when held at (1) 108° C. for 40 mins., (2) 110° C. for 40 mins., (3) 111° C. for 40 mins., and then cooled in air.

The consistency of the food has slight effects, as curves for the same type of food under the same temperature conditions are rarely absolutely identical.

The initial temperature of the food has a marked influence on the time required for the centre of the package to reach its maximum temperature, and this is of the first importance in dealing with certain products, as will be shown later: *e.g.*, it has been found that for a given food-package processed at 110° C., increasing the initial temperature from 20°

[3] "The Bacteriology of Canned Meat and Fish," Savage, Hunwicke, and Calder, 1922.
[4] Jordan, Lloyd, Clark and McCrea, J. Hygiene, 1920-21.

to 40° C. causes the centre of the food to reach 110° C. from 7 to 10 min. earlier. This may increase the efficiency of the whole processing by 20%.

Since it is essential for the sterilisation of food sealed in a container that every portion of the food should receive a given minimum heating, it is necessary in calculating the desired retort process to take the temperature of the centre of the pot as the basis of calculation.

Calculation of the process required to sterilise the food, from the resistance of the organisms and the rate of heat penetration. The rate of destruction of an organism at a given temperature varies with the temperature.

Let this rate of destruction $= f(\tau)$.

(If τ is the temperature at the centre of the food it also varies in a way which is known, with the time t calculated from the beginning of the sterilisation process.)

The destruction at temperature τ in time $dt = f(\tau)dt$, and the total destruction in the whole process $= \int_{t=0}^{t=p} f(\tau)dt$ where p is the total time of the process and the cooling.

Since the equation representing the relationship between the temperature τ and the rate of destruction at that temperature is not known, the value for $\int f(\tau)dt$ cannot be calculated, but it is clearly the area bounded by the curve relating the time to the corresponding rate of destruction.

This curve can be plotted from the resistance curve of the organisms and the heat-penetration curve for the food, if the rate of destruction at any temperature is assumed to be approximately inversely proportional to the length of time required to kill the organism at that temperature. The area of the curve can then be determined mechanically, and this gives the proportion of destruction effected. For complete sterilisation this must at least equal unity.

Owing to the great variation in the resistance of organisms under different conditions, it is always necessary to try out calculated processes with the organisms present in the actual food and to note their adequacy under actual practical conditions. In this way something very closely approaching complete sterility can be readily achieved, but as foods must have other qualities besides sterility to recommend them, the problems in practice are considerably less simple.

The practicability of calculated processes.—Too prolonged heating destroys the characteristic taste and appearance of many foods, and the crucial problem in food preservation is to devise that process of heating which will eliminate troubles of bacterial origin, without impairing the appearance and flavour of the food.

It has been shown that in the case of highly resistant spores the rate of destruction increases very rapidly with the temperature after a given minimum, *e.g.*, for *B. botulinus*, heating for 6 min. at 115° C. may be as effective as for 60 min. at 105° C.

It is found in practice that the taste and appearance of foodstuffs are less affected by a short cooking at a higher temperature than by a slow cooking at a lower temperature. This suggests the adoption of processes at a high temperature for a short time, *e.g.*, under certain conditions a process of 115° C. at 20 min. has the same sterilising value relative to the sporing aerobes described as a process of 107° C. for 65 min.

The treatment of food previous to the sterilisation process is also a matter of importance here, and the methods employed in packing foods may be briefly considered.

The container materials used are tin-plate and glass. Containers made of tin-plate may be sealed by either the solder or the double seam method; in either case the can is first exhausted of air by heating, so that there will be a low internal pressure in the sealed, cooled can. This step is largely necessitated by the much increased chemical action which takes place between the food and the tin-plate in the presence of oxygen. Glass containers may be sealed by the Phœnix cap, as already described, which leaves a layer of air above the food, or by one of two methods which remove the air, so that ultimately the cap is kept in place by the external atmospheric pressure.

In one of these methods—that of the automatic cap—the jars are heated slowly with the cap held in place by steel bands. This drives out the air and produces the desired low internal pressure. Here sterilisation must be carried out in an open water-bath.

A new method has recently been introduced in which the air is removed from the jar mechanically with the lids held in place. External pressure again keeps on the caps after the vacuum is released in the exhausting machine. This type of container is sterilised in a special retort into which compressed air can be introduced. The heating is effected by steam under pressure, but the pressure outside the jars is maintained at a higher level than that inside, by admitting compressed air into the retort.

Thus in three of the methods in common use the food is inevitably slightly cooked before the actual sterilising process begins. Some types of food must also be heated to facilitate the mixing of ingredients or to allow the foods to be packed in certain shapes of containers. It has been found that where the initial temperature of the food is increased the sterilising process may be decreased by varying amounts depending on the type of food and container, and on the temperature of the process.

It is therefore necessary in some cases where this preliminary heating takes place to arrange that the sterilising process shall follow before considerable cooling can take place. This assists in effecting adequate sterilisation without over-cooking.

The effect of this heating on the vitamins of the food cannot be overlooked, but recent work has shown that much of the destruction originally attributed by workers in this field of research to heat is really due to oxidation. This points to the desirability of developing those methods of packing and sterilising preserved foods in which no considerable heat is applied until the partial pressure

of oxygen in the container has been reduced. Tests on some canned vegetables heated only in this way have shown that they have retained much more of their vitamins than the same vegetables cooked in the usual way for domestic consumption.

The most important factor in determining whether a food can be given a perfectly safe processing is undoubtedly the size of the container. The outer layers of a food package must always receive a much greater cooking than the inner. There is therefore clearly a practical limit to the size of the container which can be used. The shape of the container has, however, a considerable hearing here. Values for the time required for the centre of the food to reach a given temperature have been calculated on the assumption that convection currents were entirely eliminated, and these have shown that the ratio of the length of the container to the diameter is an important factor in determining this time.

Actual experiments have shown that, with certain foods, if the nett volume of a container be doubled with the height approximately constant, the process time necessary for sterilisation must be more than doubled, whilst for a container of the same volume but different shape (a reduced ratio of length to diameter) the time is only increased by about 50%.

In America the size and shape of containers are legally standardised: if such a course were ever contemplated in England the bearing of these on the sterilisation of the foods would appear to be a matter for consideration.

Discussions have taken place recently as to the relative merits of tin-plate and glass as containers, with special reference to the heating necessary for sterilisation, and various public health experts have expressed preference for tin-plate. In actual practice, however, there are many factors operative to make glass ultimately the more satisfactory.

(1) A good grade of glass is necessary even for the partial sterilisation essential for the production of those "keeping qualities" which are the *sine qua non* of any type of preserved food.

(2) When the heating has been carefully planned to give the best effects not only for sterility but also for taste, the glass normally used for containers presents no difficulties in the way of sterilisation.

(3) Chemical reaction between the glass and the food is negligible, whilst such reaction in the case of tin-plate always occurs to a greater or less extent.

(4) All faulty glass packages are weeded out in the heating, so that spoilage on the market due to leaking glass packages is almost unknown, whilst it has been shown that a very large proportion of the spoilage of canned goods is due to small leaks which either admit the organisms responsible for the spoilage, or admit air which enables organisms already there to develop.

The size and shape rather than the material of the container would, therefore, seem to be the factors of fundamental importance in devising satisfactory sterilising processes.

Retort control.—This having been done, it remains to ensure that these processes shall be actually carried out under factory conditions. A temperature recorder for each retort gives a written record of the internal temperatures. By a very simple method any considerable variation in this temperature in different parts of the retort may be noted and considerable information as to the actual heating of the foodstuffs may be gained. It has been seen that heating to a high temperature for a short time can have the same sterilising value as heating at a lower temperature for a much longer time, with much less danger of over-cooking. It thus frequently happens that the process used is one in which the centre of the pot only just reaches the temperature of the retort or never reaches it at all. If, therefore, a small maximum thermometer is placed with its bulb in the centre of a pot which is processed, it will register the temperature there at the end of the process, because the maximum is only reached at the end. If this temperature is that deduced from heat penetration studies under the given conditions, then the food must have been heated at least as efficiently as is desired.

Tests of this kind have been made on a large number of samples placed in different parts of different retorts and have shown a very high degree of agreement with each other and with the temperature theoretically expected. There seems, therefore, no reason to suppose that the temperature in any part of the retort differs from that registered by the thermographs.

It has been seen that in preserving food there exist many variable factors influencing the sterilising value of given retort processes, some of them peculiar to the bacteria themselves, others dependent on external conditions such as the rate of carrying through certain operations.

It might appear, therefore, that very consistent results could not be obtained, as it might always be possible that an organism slightly more resistant than those examined might be found.

Safety factors in practical application.—There are, however, certain safety factors which allow for a considerable margin of variation in practice. The resistances of bacteria, as has been pointed out, are frequently expressed in terms of the temperature of the oil-bath and not of the organisms themselves. If the bacteria could actually be raised instantaneously to that temperature this resistance would clearly seem less. But the temperature of the centre of the pot used for the calculation of the process time refers to the actual temperature of the food, and therefore of the organisms. In the case of the higher temperatures this factor may be of very great importance.

Secondly, all organisms not placed exactly in the centre of the jar receive more, and in some cases very much more, than the minimum heating required to kill resistant forms.

As a result of their investigations of the bacterial condition of canned meat and fish, Savage[3] and his co-workers came to the conclusion that the successful exclusion of air from the contents of cans was of greater importance than the sterilising processes usually given, because of the incompleteness of those processes.

In his book on botulism, Leighton§ points out, however, that for safety an efficient final sterilising process is absolutely essential, but questions whether this is practicable for all foods. This is not a question to which a conclusive answer can yet be given, but it would seem probable that by suitable choice of shape and size of container and careful adjustment of all preliminary heating operations an adequate sterilising process may be given to any type of food, while preserving the essential characteristics of the food.

[illegible] I desire to thank Messrs. Angus [illegible] subject, for permission to include some of the [illegible] to require [illegible].

THE PREPARATION OF ETHYL ETHER BY WILLIAMSON'S METHOD.

BY W. B. S. BISHOP, B.SC.

The preparation of ethyl ether by Williamson's method from ethyl iodide and sodium ethoxide was originally undertaken with the object of testing whether pure ether made by this method possesses anæsthetic properties. At the time when the work was started, ethyl ether prepared synthetically had not been tested as an anæsthetic, but in 1922 experiments were published by Stehle and Bourne* in which ether prepared from ethyl iodide and sodium ethoxide was used, the results showing that ether so made was as good an anæsthetic as the ordinary anæsthetic ether. Stehle and Bourne give no details of their method of preparation, but state that their ether contained a little ethyl iodide.

That pure ether is an anæsthetic has been definitely proved by the experiments of Dale, Hadfield, and King.† The ether used in their experiments was made from alcohol and sulphuric acid.

The literature contains practically no details of the preparation of ether by the synthetic method, the only reference being to Williamson's original paper.‡ Preliminary experiments showed that ethyl chloride was somewhat troublesome to use, and did not give good results. Ethyl bromide was found unsuitable, as it was impossible to free the ether from the last traces of bromide.

Ethyl iodide was therefore adopted as the most suitable halide. Preliminary experiments showed that it was somewhat difficult to separate the ethyl iodide from the ether itself. Excess of sodium oxide was therefore used in order to react with as much of the ethyl iodide as possible.

Ethyl iodide.—The older methods of preparation nearly all involve the use of yellow phosphorus, the main advantage of this over red phosphorus being that the reaction proceeds faster, and may be made automatic by the use of special apparatus.§ This method appears to be most convenient for large quantities of ethyl iodide (about 4–6 kg.) and gives very good yields. In the present work however, relatively small quantities of ethyl iodide were required, and the method adopted was that of E. Hunt.* The only departure from that method was that the amounts of the reacting substances were doubled, the resulting yield being slightly greater (by 2%) than that given by Hunt.

Experimental.

Iodine (1221 g.) was mixed with 80% ethyl alcohol (450 g.) in a 3-litre flask, the mixture was cooled, and 90 g. of red phosphorus (an excess) added during twenty minutes. The reaction was so controlled that no iodine vapour escaped. The mixture was heated under a reflux condenser for three hours on a boiling water bath and then distilled, the fraction from 63° to 83° C. being collected. The distillate was colourless, whereas that from a former preparation using yellow phosphorus was discoloured with iodine. The distillate was washed with a dilute solution of sodium carbonate containing a trace of sodium thiosulphate, dried over calcium chloride, and distilled, the fraction of b.p. 72·3°–72·4° being collected. This fraction was free from alcohol. The yield of pure ethyl iodide was 1425 g. (95% theory on the iodine used; Hunt obtained 92%). From the quantity of phosphorus recovered (28 g.) it appears that the reaction proceeds according to the equation given by Beilstein and Rieth† and noted by Hunt (*loc. cit.*), *viz.*:—

$$P+5I+5C_2H_5OH=5C_2H_5I+H_3PO_4+H_2O$$

and not according to that usually given in textbooks, *viz.*:—

$$P+3I+3C_2H_5OH=3C_2H_5I+H_3PO_3.$$

For converting the ethyl iodide into ether a solution of sodium oxide in absolute alcohol was used. In the subsequent experiments a large excess of ethyl alcohol was used to prevent the separation of ethoxide from solution. To remove the last traces of the petroleum from the sodium, each piece, after drying on filter paper, was dipped in absolute alcohol, and then used in the preparation of the ethoxide.

To 2 litres of absolute alcohol in a 3-litre flask, cooled by running water, 187 g. of clean metallic sodium was added in small pieces at a time. The solution showed no signs of darkening, as is observed in the solid substance, but remained quite clear. This solution represents 552 g. of sodium oxide in 1215 g. of absolute ethyl alcohol.

Ethyl ether.—The ethyl iodide (1265 g.) was added gradually to the solution of sodium ethoxide (552 g.) in a 4-litre flask, fitted with a 12-bulb pear still-head and thermometer, attached to a bulb condenser (Allihn's) through which ice-cold water was circulating. The ether was collected in a Dewar flask, whereby the loss due to evaporation was reduced to 3%. An excess of sodium ethoxide was used to prevent any of the ethyl iodide being subsequently distilled unchanged. The iodide was added at the

§ "Botulism," by Gerald Leighton, 1920.
* J. Amer. Med. Assoc., 1922, 72, 375.
† Lancet, March 10, 1923.
‡ J. Chem. Soc., 1850–51, 4, 229.
§ Voorhees, J. Amer. Chem. Soc., 1919, 41, 789.

* Chem. Soc. Trans., 1920, 117, 1592.
† Annalen 1863, 126, 250.

same rate as the ether distilled, by means of a dropping funnel reaching to the bottom of the flask. The reaction did not commence until 100 g. of the ethyl iodide had been added, and then it proceeded violently unless checked by cooling. If, however, the sodium ethoxide was warmed to 60°–70° C. and the iodide then added, the reaction began at once. After most of the iodide had been added and the ether bubbles were no longer visible in the mixture, it was found necessary to heat the mixture to drive off the ether, but the thermometer in the still-head did not rise above 45° C. This fraction was collected separately and was found to contain a trace of ethyl iodide, which was removed by twice distilling with solid sodium ethoxide. The yield of crude ether containing alcohol was 540 g.

The crude ether distillate (30°–45°) was dried over solid potassium hydroxide for one week, and then allowed to stand over a mixture of solid potassium hydroxide and potassium permanganate (2 g. of each per 100 c.c. of ether) for two weeks, being shaken occasionally, and then distilled. The fraction 34°–35° C. was allowed to stand over metallic sodium for one week, decanted, and distilled through a 12-bulb pear still-head, the fraction 34·45°–34·5° at 760 mm. being collected. The b.p. agrees exactly with that given by Wade and Finnemore.* The yield of pure dry ether (b.p. 34·45°–34·5°, $d^{15.5}$ 0·7199(8), n_D^{15} = 1·35543) was 480 g., or 80% of theory on the ethyl iodide used. The ether gave negative tests for water, aldehydes, alcohol, halogens, and acids.

The products recovered were:—alcohol 1360 c.c. ($d^{15.5}$ 0·819), *i.e.*, approximately 90% of the excess alcohol used for the solution of the sodium oxide; phosphorus 28 g. (93% of that used in excess of theory); sodium iodide 105·6 g. (88% of theory).

For the preparation of 1 kg. of ether by the method given in this paper, with a yield of 80%, the following quantities are required:—Metallic sodium, 390 g.; iodine, 2·4 kg.; red phosphorus, 140 g., absolute ethyl alcohol, 3 litres; ethyl alcohol 80%, 1·02 litres.

* Chem. Soc. Trans., 1909, **95**, 1842.

Detection of halogens.—A method commonly employed as a test for halogens in organic substances is to dip a piece of well-oxidised copper gauze into the liquid, and then place the gauze in a Bunsen flame, which becomes green if a halogen be present. This test was found to be more delicate than Lassaign's test (dropping into sodium vapour, adding excess of nitric acid and then silver nitrate) even if benzaldehyde were used as a solvent. Burning the ether in a lamp as recommended by Rübke,* using benzaldehyde as a solvent, failed to detect less than 0·05% of the halogen u[illegible] of th[illegible]c. of ether. With the copper gauze it therefore, a[illegible] detect 0·05% of ethyl iodide in [illegible]ced with its [illegible] of iodine. The gauze used absorbed [illegible]ccessed, it [illegible] the ether at one dip, so that the amount of i[illegible] actually detected is 0·00004 g. It was also f[illegible] possible to detect 0·01% of bromine in the e[illegible] The delicacy of the test for chlorine was [illegible] determined.

Summary.

(1) Pure ether can readily be produced [illegible] Williamson's synthesis, using ethyl iodide [illegible] sodium ethoxide, with a yield of 80% of [illegible] theoretical amount, calculated on the ethyl iodid[illegible]

(2) The copper oxide test for halogen compo[illegible] in ether will readily detect 0·00004 g. of io[illegible] present as ethyl iodide.

In conclusion, I have to express my thank[illegible] Professor J. A. Schofield, for suggesting the w[illegible] and for his help in the preparation of this pape[illegible]

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ERRATUM.

Acceleration of Vulcanisation by Xanthates. By D. F. Twiss and F. Thomas (J., 1923, 499-505 T).

Fig. 1 (p. 500 T) should be Fig. 4 and Fig. 4 (p. 501 T) should be Fig. 1.

* Z. angew. Chem., 1923, **36**, 156.

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FURTHER NOTES ON THE CONSISTENCY OF ROAD TARS.

BY D. C. BROOME.

In a previous communication by the author on ve subject,* several facts were noted which d to require further investigation, and the paper is an account of some experiments ve been carried out in order to throw further n three of these problems, namely the effect consistency of a prepared tar of :—

he addition of powdered fillers.

he addition of bitumens.

The maintenance of tar at an elevated temerature for long periods.

The addition of fillers.

as previously stated that experiments have that granite-dust, limestone-dust, and cement e an identical effect on the consistency of tar. , however, been found that if limestone-dust d as a filler in granite tar-macadam the actual s obtained are better than if granite-dust e only filler. The two facts are difficult to cile with each other, and further investigation undertaken to discover an explanation for uperiority of limestone-dust shown in practice. ne "affinity" of limestone for tar is a property hich, so far as the author is aware, has not been ıvestigated to any great extent; but many roadıakers contend that there is something in the ature of limestone that renders it exceptionally ıitable for use in tar-macadam. Some suggest ıat the reason is the ease with which limestone is ushed under the roller, the road being thus more adily consolidated; but all limestones do not ush to an appreciable extent. For example, the mestone of Emborough, Somerset, is harder than any other road stones that do not give such tisfactory results. The only suggestion put forward explain this is that limestone possesses some operty that is not altogether understood, but which s been termed "affinity."

The author has found that the apparent similarity ove mentioned between limestone and graniteıst is only temporary. In other words, if a mixture tar and limestone-dust is prepared and tested mediately the consistency of the mixture is found be normal, *i.e.*, agreeing with the equation $V_F = V^x$ ere V is the consistency of the original tar and V_F at of the mixture of tar and limestone-dust at e same temperature. If tested again later, the sistency is found to have increased, and it inues to increase until at last a maximum is ained in a time varying considerably according to the conditions of experiment; from this point the consistency remains constant. This increase in consistency is such that the final consistency (V_L) is given approximately by the equation $V_L = V^{x^2}$. The reinforcing effect taking place after mixing is, therefore, $V^{x^2} - V^x$. In the case of the other fillers, no increase in consistency apart from the initial increase could be detected.

The following table gives some consistency figures obtained with various mixtures of tar and limestone-dust and clearly shows the gradual reinforcing effect referred to.

TABLE I.

Original tar.		Hours after mixing. Nil.	3.	6.	24.	48		V^{x^2}
11	..	13	14	14	15	15	..	14
36	..	44	47	48	50	50	..	49
40	..	48	50	51	54	54	..	55
45	..	52	54	56	60	60	..	62
48	..	55	60	63	69	69	..	67
50	..	60	64	66	68	68	..	70
57	..	66	71	74	81	81	..	80
60	..	69	75	79	85	85	..	85
65	..	72	80	85	93	93	..	93
90	..	105	110	115	125	125	..	132
100	..	120	130	135	160	160	..	148
195	..	245	290	310	340	340	..	306

This gradual reinforcing effect has obviously some connexion with the superiority of limestone-dust shown in practice and is doubtless due to the "affinity" of limestone for tar, but it is difficult to find a satisfactory scientific explanation of this. The following have been suggested as possible explanations :—

(*a*) Chemical reaction between the limestone and some constituent or constituents of the tar.

(*b*) Absorption—the less viscous constituents of the tar being soaked up by the stone, the effect being as though they were removed altogether from the mixture.

(*c*) Adsorption — a molecular surface reaction between the limestone and certain constituents of the tar.

Of these suggestions the first may be rejected as unlikely (though not definitely impossible) as no evidence of any such reactions can be found. Similarly, the second suggestion is without foundation; and further, the author's experiments are evidence against the validity of this suggestion, for it is noted above that the percentage increase in consistency is higher with tars of high consistency than with those of low consistency, whereas the presence of a higher percentage of light oils in the latter would give greater facilities for absorption if this took place. The author therefore puts forward the third of the above suggestions as the one which best fits in with the facts. It should, however, be noted that this is only a suggestion, as the present state of the experimental evidence is not sufficient to allow a definite conclusion to be drawn.

J., 1923, 192 T.

The addition of bitumens.

It was recently suggested to the author that, in considering the addition of bitumen to tars for road-making purposes, it is safe to assume that the lower the penetration of the bitumen used, the greater would be the increase in consistency of the tar due to the addition of the bitumen. On investigation, however, it was found that the nature of the bitumen must be taken into account, as well as its penetration.. The various grades of "Texaco bitumen," a petroleum residual manufactured by the Texas Oil Co., Ltd., give particularly striking examples of this influence of the nature of the bitumen, the increase in consistency of a tar due to the introduction of one of these products being much higher than would be expected from a consideration of its penetration alone. This is shown in Table II., which contains representative results obtained with mixtures of 95% of prepared tar with 5% of bitumen.

TABLE II.

Consistency of tar	Bitumen.	Penetration.	Consistency of mixture. Obs	Calc.
36	Texaco No. 9	60	60	46
	Mexphalte	45	48	50
	Trinidad	7	125	125
50	Texaco No. 9	60	80	66
	Mexphalte	45	70	69
	Trinidad	7	140	140
60	Texaco No. 9	60	82	70
	Mexphalte	45	72	73
	Trinidad	7	145	145
68	Texaco No. 9	60	96	78
	Mexphalte	45	80	82
	Trinidad	7	152	152
90	Texaco No. 9	60	145	100
	Mexphalte	45	118	104
	Trinidad	7	175	175

The last column is calculated on the assumption that the increase in consistency varies inversely as the penetration of the bitumen added, the increase due to the addition of Trinidad bitumen being taken as standard.

Hence it follows that if a certain percentage of bitumen is being used in the manufacture of tar-macadam and it is desired to increase the proportion of bitumen without rendering the material more difficult to handle. the use of a softer bitumen will not necessarily solve the difficulty. In every such case it is essential that the actual effect of the bitumen proposed to be used must be determined in the laboratory prior to any definite decision being made.

The effect of heat.

It was suggested in the author's previous paper (*loc. cit.*) that the increase in consistency of a tar when heated might in part be due to the breaking-up of complex compounds with increase in free carbon. On further investigation, however, no evidence of such a change occurring to any appreciable extent could be found; but on analysis of the tar, before and after heating, an unexpected decrease in the percentage of tar acids was noted. This is of interest in view of the recent discussion on the occurrence of phenols in tars produced by the carbonisation of coal at various temperatures. In general this supports the results obtained by Schütz,* Gollmer,† Morgan and Soule,* Hoffmann,† and Currey,‡ showing that the percentage of phenols in tar decreases with increasing temperature of carbonisation.

The method of conducting the experiments to investigate the effect of heat was as follows:—About a gallon of prepared tar was taken for each experiment and after thorough mixing this was divided into two portions. A complete analysis of one portion was carried out in accordance with the Road Board Specification,§ and the other portion was transferred to an ordinary half-gallon can and a reflux condenser connected to the tubulure. The can was surrounded by a water-bath which was slowly heated to boiling, and this temperature maintained over varying periods of time. In this way the tar could be maintained at approximately 100° C. for long periods without the slightest risk of any appreciable loss by evaporation.

The time of heating varied from 8 to 24 hours and the consequent rate of increase in consistency varied from 0·33 to 2·96 secs. per hour, increasing with increase in the consistency of the original tar. The rate of decrease of the tar-acid content does not appear to be related to the original tar consistency, but varied from 0·01 to 0·12% per hour. The results are shown in Table III.

TABLE III.

Expt.	T.	V_1.	V_2.	V_2-V_1.	dV/dT.	A_1.	A_2.	A_1-A_2.	dA/dT.
1	12	94	98	4	0·33	2·7	2·2	0·5	0·04
2	24	94	103	9	0·37	2·7	1·3	1·4	0·12
3	8	96	110	14	1·75	—	—	—	—
4	16	96	115	19	1·18	—	—	—	—
5	10	128	140	12	1·20	3·4	3·3	0·1	0·01
6	12	220	230	10	0·92	2·4	2·4	0·0	0·00
7	24	220	290	70	2·96	2·4	2·1	0·3	0·02

T = time in hours at 100° C.
V_1 = original consistency. A_1 = original % tar acids.
V_2 = final ,, A_2 = final % ,,

In view of this decrease in the percentage of tar acids present, it was thought advisable to investigate the effect of maintaining tar acids alone at an elevated temperature for a number of hours. This was done, using about 250 c.c. of the crude acids, as extracted from carbolic oil, contained in an ordinary glass flask. No sign of change, however, could be detected in either the physical or chemical properties of the material even after heating to boiling point for 24 hours. In one case a slight decrease in viscosity was noted, but on further investigation it was found that this sample was contaminated with a small percentage of creosote oils. It would thus appear that the change going on in a heated tar is dependent upon the action on the phenols of some other constituents of the tar. This view is supported by the results obtained by heating carbolic oil for some hours at approximately 100° C., when the percentage of phenols as determined by Church's method is decreased by an amount varying with the quantity of phenols originally present. A decrease of as much as 1% in three hours has been noted in the case of an exceptionally rich oil prepared in the laboratory and containing 45% of phenols. It has long ago

* Ber., 19[illegible], 56, 109, 162. Brennstoff-Chem., 1923, 4, 85.
† Brennstoff-Chem., 1923, 4, 1, 19.

* Chem. and Met. Eng., 1922, 928, 977, 1025. Ind. Eng. Chem., 1923, 15, 587. Chem. and Ind., 1923, 1178.
† Brennstoff-Chem., 1923, 4, 209.
‡ J., 1923, 179T.
§ "General Directions and Specifications relating to the Tar Treatment of Roads," H.M. Stationery Office, 1923.

been suggested* that in the presence of homologues containing the methyl group, phenol itself may be oxidised, with the formation of a triphenylmethane derivative. If this is true, the addition of some oxidising substance to heated tar should bring about an increased change. The passing of hot dry air, free from carbon dioxide, or a mixture of oxygen and air, through tar during distillation has been found to thicken the residue into a "resinified tar."† Although this investigation deals only with temperatures below the temperature of distillation, it seemed possible that even at these lower temperatures the passage of air or oxygen through the tar would lead to an increase in the thickening or "resinification" of the tar if the theory of oxidation is valid; and experimental results obtained by the author have supported this. Table IV. shows the enormous increase in consistency brought about by this passage of air through the tar.

TABLE IV.

T.	V_1.	V^t Without air.	V^t With air.	Δ.
8	50	65	75	20
12	94	98	160	62
12	220	230	360	130
24	94	103	200	97

It has been suggested by Schrader‡ that the phenols present in the low-temperature tar first formed in the distillation of coal, as far as they are not cracked with deposition of carbon, react with the hydrogen present in the distillation gases, being partly reduced, with formation of benzene and its homologues, and partly condensed to high-molecular compounds. It is interesting to note that at the low temperatures employed in the course of the author's experiments there is no evidence of reduction, but rather of oxidation, as already stated. The second reaction supposed by Schrader to take place during carbonisation, however, has been found to occur in the case of tars heated to 100° C., as is shown in the analyses above referred to, by an increase in the percentage of pitch. The results of distillation tests are shown in Table V.

TABLE V.

Expt.	Hours heated.	Water.	Light oil.	Middle oil.	Heavy oil.	Pitch.
1	Nil	Nil	Nil	15·9	5·4	78·6
	10	Nil	Nil	14·3	6·5	79·1
2	Nil	Nil	0·4	13·3	5·5	80·8
	12	Nil	0·4	13·7	6·1	79·8
	24	Nil	0·3	13·6	5·2	80·9
	12*	Nil	Nil	12·5	6·0	81·5
3	Nil	0·6	0·5	11·7	7·3	79·9
	12	0·8	0·5	11·6	4·8	82·3
	24	0·6	0·6	10·9	5·3	82·6
	12*	0·5	0·2	10·8	6·6	81·9
	24*	0·2	0·2	11·1	6·6	81·9

* Air current passed through.

This is also in accordance with what would be expected from a comparison of the constituents of low- and high-temperature tars.

In conclusion, there is yet a third action which probably takes place, but which the author has not yet been able to prove, namely, the formation of pyrocresols, as shown by Bott* to take place on the distillation of crude phenols.

* Tschelnitz, Wiener Akad. Ber., 23, 169. Smith, Chem. Gaz., 1858, No. 20. Yvon, Pharm. J. Trans., 1881, 1051.

† E.P. 16,182 of 1905 (Soc. Anon. des Combustibles Industriels); E.P. 26,689 of 1906.

‡ Chem. Zentr., 1922, 1042.

The tar used throughout the course of this investigation was prepared from horizontal-retort tar obtained from the gasworks at Rhyl, Denbighshire.

Summary.

(1) An earlier statement that granite-dust, limestone-dust, and cement all have an identical effect on the consistency of tars is modified as a result of further investigation, and the final consistency of mixtures containing fillers of the granite-dust type is given by $V_F = V^x$, while the use of limestone-dust leads to a final consistency $V_L = V^{x^4}$

(2) It is suggested that adsorption is the cause of this greater increase in the case of limestone-dust.

(3) The increase in consistency of a tar due to the addition of a bitumen is dependent upon the nature of the bitumen, and not merely upon its penetration. Soft bitumens sometimes produce a greater increase in consistency than do harder bitumens.

(4) If prepared tar is maintained at an elevated temperature over long periods of time, several reactions take place, viz., oxidation of phenols, condensation of phenols to high-molecular compounds, and formation of pyrocresols. These reactions lead to a considerable increase in the consistency of the tar.

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Penmaenmawr and Trinidad Lake Asphalt Co.,
Penmaenmawr, N. Wales.

* J., 1887, 646.

NOTE ON THE ACTION OF POTASSIUM CARBONATE ON LEAD GLASS.

BY E. A. COAD-PRYOR, B.A.

H. Droop Richmond, has recently (Analyst, 1923, 48, 200) described some interesting experiments showing the absorption of appreciable quantities of lead and arsenic by potassium carbonate which had been stored in lead glass bottles. The facts which he records serve again to bring into prominence the need for a simple standard test for the suitability of a glass for any particular purpose.

It is well known that glasses vary very considerably in their durability and their resistance to attack by chemical reagents, and it is also well known that though one glass may be more resistant to an acid solution than another, yet it may be less resistant towards alkaline reagents.

Any simple test must, therefore, of necessity give only approximate results if it is to be regarded as a criterion of the general stability of a glass which is used as a container for a variety of different solutions. Fortunately there are a number of tests which will distinguish a really bad bottle, and the choice of a specified test for this purpose is generally determined by the simplicity of the operation and the rapidity with which it can be carried out.

A sample of glass with which Mr. Richmond carried out his experiments was analysed in the present author's laboratory with the following result: SiO_2 67·30%, PbO 13·25%, CaO 2·30%, Al_2O_3 trace, alkalis 17·00%, As_2O_3 0·34%. It was certainly a most unsuitable glass in which to store potassium carbonate. There is no objection, of course, to the use of lead in these bottles—in fact some lead glasses are equal in durability to some of the best chemical resistance glasses.*

For instance, some experiments were carried out with the object of comparing the durability towards chemical reagents of a heavy lead glass of composition:—SiO_2 47·0%, PbO 40·0%, K_2O 7·8%, Na_2O, B_2O_3, Al_2O_3, and CaO traces, with that of the well-known Jena chemical resistance glass.

Losses in mg. per sq. dm.

	Lead-potash	Jena
Boiling water	0·5	0·6
Autoclave, at 183°	10·0	23·0
Hydrochloric acid	3·0	9·6
2*N* Sodium carbonate	57·0	31·5
2*N* Caustic soda	102·0	112·0

It will be seen that as regards any of the tests, with the exception of that with sodium carbonate, the lead glass is the better of the two.

It is necessary, however, to keep the alkali content low—below say, 16%. Where glasses contain lead or arsenic in large quantities, obviously the danger through lack of durability is increased.

With a view of obtaining a comparison between the glass received from Mr. Richmond and a common bottle made from a soda-lime glass, samples of the two glasses were painted with a sludge of damp potassium carbonate and stored for 12 days. Thus the surfaces of the glasses were exposed to a saturated solution of potassium carbonate. At the end of that time the potassium carbonate was washed off the surface and the arsenic in the washings determined. The following results were obtained, calculated as milligrams of arsenic per 100 sq. cm. of glass surface exposed to attack:—Glass from Mr. Richmond 0·0240, soda-lime glass 0·0018, showing a ratio of about 13 to 1 in favour of the soda-lime glass. The latter glass was a bottle glass of medium quality, having an approximate composition of:—SiO_2 75·5%, CaO 8·0%, Al_2O_3 0·7%, Na_2O 15·8%, As_2O_3 0·2%.

Making allowance for the arsenic contents of the two glasses, the soda-lime glass is the better as regards total solubility in the ratio of about 8 to 1. It must not be inferred from these remarks that a soda-lime glass will be superior in durability to any lead glass, but merely to the particular glass in question. There are many medical bottles of "white flint" considerably superior to the bottle (soda-lime) selected for test. The durability increases rapidly with rise in the lime content of the glass, a glass containing 9% of lime being markedly superior to a glass containing 8% of lime, and 10% better still, substituting the lime for the alkali.

Unfortunately the low-lime, high-alkali glasses are very easy to melt and it is the practice of some firms to make a glass containing anything up to 20% of soda and from 5 to 7% of lime. These low-lime glasses have also the advantage, from the manufacturing point of view, that it is easy to obtain a good colour, since one of the principal sources of iron, from which the green colour is derived, is the limestone. The introduction of automatic machinery has made the position still more critical since, on many machines, the high-lime glasses are difficult to work, and it requires great attention to detail and rigorous supervision.

It is therefore desirable that some sort of specification for durability should be established. Even the most discriminating buyer of glassware has no safeguard at the present time that enables him to obtain with any certainty a glass of first-class quality, and manufacturers who go to the trouble and expense of maintaining strict supervision and analytical control, which are necessary for the production of "white flint" glass of a high lime content, are penalised by those manufacturers who, by giving scant attention to the matter, bring disrepute on the glass industry as a whole and particularly on machine-made bottles which, as regards uniformity and accuracy to specified capacity, are far in advance of any bottles which can be made by hand.

A standard test should be simple in operation. Many workers advocate the use of an autoclave test, but, while this test gives valuable results up to a certain point, it entails the use of an expensive apparatus. A promising test appears to be that described by H. S. Blackmore, V. Dimbleby, and W. E. S. Turner,† which consists of exposing the glass to the action of a solution of narcotine hydrochloride for a period not exceeding an hour at 100° C. The durability of the bottle can be estimated by the time which elapses before the solution becomes cloudy and the extent of the cloudiness. With the test carried out as described by the authors, bottles showing no cloudiness until 45 minutes have elapsed might be considered first-class. Bottles which show a faint cloudiness at the end of 20 minutes, but no further increase in the cloudiness at the end of an hour, could be regarded as second grade quality, to be used where no great demand for durability is made.

If this test is proved to be satisfactory from a practical standpoint, it should meet an urgent requirement, and it is to be hoped that users of bottles required for containing chemicals will take the matter up seriously with a view to the establishment of a rational specification. Such a procedure might also be followed with advantage in the case of glass vessels required to contain food.

* J. D. Cauwood, W. [illegible]ner, and D. Webb, J. Soc. Glass Tech., 1918, 2, 32.

† J. Soc. Glass Tech., 1923, 7, 122.

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NOTE ON THE LIDSTONE VISCOSIMETER.

BY GUY BARR, B.A., D.SC.

The "mercurial viscosimeter" described by Lidstone (J., 1917, 270; 1918, 148T) appears likely to find considerable application, not only for the examination of small quantities of material, but also for the determination of the viscosity of dark-coloured liquids, which give a meniscus which cannot readily be observed in an instrument of the Ostwald type. Under these circumstances, it may be well to draw attention to some points connected with the design of the viscosimeter and with the interpretation of the results obtained with it.

The formula obtained by Lidstone in his second paper for the calculation of viscosity from the times of flow observed is derived by making some tacit assumptions which may not be justified in all cases: the full formula is deduced below, and from this it will be possible to find in what cases it may be simplified.

Let V be the volume of the bulb between the fiducial marks used in timing the flow, and let l_a, l_b, and r_a, r_b be respectively the lengths and effective mean radii of the capillary above the bulb through which the liquid is drawn and of the tubing (including stop-cock and jet) below the bulb through which the mercury escapes.

Further, for abbreviation, put

$$\frac{8Vl_a}{\pi r_a^4} = a \qquad \frac{8Vl_b}{\pi r_b^4} = b$$

$$\frac{mV^2}{\pi^2 r_a^4} = p \qquad \frac{mV^2}{\pi^2 r_b^4} = q$$

where m is the coefficient of the kinetic energy term in the amended Poiseuille equation for viscosity.

Now if η_m be the viscosity and d_m the density of mercury at a given temperature, the mean difference of pressure necessary to cause the volume, V, of mercury to flow through the lower tube in a time t will be equal to

$$b\eta_m/t + qd_m/t^2$$

Similarly, for the flow of the liquid through the upper capillary the mean difference of pressure necessary is

$$a\eta_1/t_1 + pd_1/t_1^2$$

where η_1 and d_1 are the viscosity and density of the liquid and t_1 is the observed time for the mercury-liquid meniscus to pass from one fiducial mark to the other in the determination.

A blank run is also made in which the mercury is allowed to run out freely, with no liquid above it. If the height of the mercury column is small compared with the external pressure, we may, to a first approximation, neglect the error due to compressibility of air and write,

$$\text{pressure difference} = a\eta_0/t_0 + pd_0/t_0^2$$

where η_0 and d_0 are the viscosity and density of the air (or air plus vapour in Lidstone's second arrangement).

If H is the mean height of the mercury column and h that of the liquid column during a run, the total pressure difference in the case of the blank run is $P_0 = H(d_m - d_0)g$ and in the case of a run with liquid it is $P_0 + P_1 = H(d_m - d_0)g + h(d_1 - d_0)g$, where g is the acceleration due to gravity.

Hence

$$P_0 = a\eta_0/t_0 + pd_0/t_0^2 + b\eta_m/t_0 + qd_m/t_0^2 \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$P_0 + P_1 = a\eta_1/t_1 + pd_1/t_1^2 + b\eta_m/t_1 + qd_m/t_1^2 \quad \ldots\ldots \quad (2)$$

Substituting for q in equation (2) from (1) we get

$$P_0 + P_1 = a\eta_1/t_1 + pd_1/t_1^2 + b\eta_m/t_1 + t_0^2/t_1^2(P_0 - a\eta_0/t_0 - pd_0/t_0^2 - b\eta_m/t_0)$$

whence

$$\eta_1 = \frac{P_0 t_1}{a}\left\{1 + \frac{P_1}{P_0} - \frac{t_0^2}{t_1^2}\left(1 - \frac{a\eta_0}{P_0 t_0}\right) - \frac{b\eta_m}{P_0 t_1}\left(1 - \frac{t_0}{t_1}\right) - \frac{p}{P_0 t_1^2}(d_1 - d_0)\right\} \quad \ldots\ldots\ldots\ldots \quad (3)$$

This equation will obviously be much simplified if the terms in the large bracket which involve a, b, and p are so small that they may be neglected. If an accuracy of 0·5% is considered ample for the determination of viscosities by this method and η_1 is the viscosity and d_1 the density of the least viscous liquid to be used in the instrument, it will be seen from equation (3) that the term $p(d_1 - d_0)/P_0 t_1^2$ may be omitted provided $pd_1/P_0 t_1^2 < 0.005\ (1 + P_1/P_0)$ or, substituting for t_1 the approximate value $t_1 = a\eta_0/(P_0 + P_1)$ and replacing a and p by their defined values, provided

$$r_a^4 < 0.005\ \frac{64\eta_1^2 l_a^2}{m(P_0 + P_1)d_1} \quad \ldots\ldots\ldots\ldots \quad (4)$$

where m may be taken as unity.

The air friction term $\frac{a_0\eta_0 t}{P_0 t_1^2}$ may be seen to be negligible compared with $1 + P_1/P_0$, since on substituting the approximate value $a = (P_0 + P_1)t_1/\eta_1$, it becomes $\eta_0 t_0/\eta_1 t_1$, where η_0/η_1 is less than 0·1% (taking $\eta_1 = 0{\cdot}2$ poise) and t_0 is less than t_1. If the attempt be made to design an instrument such that it may be used for liquids of fluidity approaching that of water, the term may not be negligible, and it becomes necessary to evaluate a approximately either by direct measurement of the quantities involved in its definition, or, as will usually be easier in a completed viscosimeter, by the following method: Let the instrument be inverted and the capillary and bulb filled with water, the wider tube at the other end of the capillary and the tube through

which the mercury is normally discharged being empty. The temperature being known roughly, let the time, T, required for the water to run out of the bulb be determined. Then writing η_w and d_w for the viscosity and density of the water, we have from Poiseuille's law,

$$\frac{\eta_w}{d_w} = \frac{hg\mathrm{T}}{a} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

so that the term $\frac{a\eta_0}{\mathrm{P}_0 t_0}$ is approximately equal to $\frac{hd_w\eta_0\mathrm{T}}{\mathrm{H}d_m\eta_w t_0}$. If the accuracy required is 0·5%, this may be neglected so long as

$$\frac{t_0\mathrm{T}}{t_1^2}\cdot\frac{h}{\mathrm{H}}\cdot\frac{d_w}{d_m}\cdot\frac{\eta_0}{\eta_w} < 0{\cdot}005 \quad \ldots\ldots\ldots \quad (5\mathrm{A})$$

For the term involving b to be negligible we require

$$\frac{8\mathrm{V}l_b}{\pi r_b^4}\cdot\frac{\eta_m}{\mathrm{H}d_m g t_1} < 0{\cdot}005$$

or

$$r_b^4 > \frac{1600\mathrm{V}l_b\eta_m}{\pi\mathrm{H}d_m g t_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

If we are designing a viscosimeter to give a certain time of flow t_1 with a liquid of viscosity η_1, we can fix V after deciding on the value of r_a according to (4) by assuming certain values for l_a, h, and H. The lower tube will then be selected so as to have an effective mean radius not less than that specified by equation (6). This tube includes a stopcock and jet: the latter cannot be made unduly large or trouble may be experienced in keeping it full of mercury: consequently it will be best to select a tube and stopcock having a bore considerably greater than the equation demands, and to make the jet taper fairly rapidly. A formula for the resistance offered by a tapering tube to the flow of liquid through it is given by Bond (Proc. Phys. Soc., 1922, 34, 187) from which the effective mean radius of the tube so constructed may be calculated approximately. A direct determination of r_b in a finished viscosimeter offers considerable difficulty, but the value may be deduced with ample accuracy for the present purpose by timing the flow of a liquid of known viscosity, η_s, and density, d_s, through the lower tube: this liquid would naturally be that selected for the calibration of the viscosimeter. The apparatus having been filled by sucking the standard liquid through the jet to the upper fiducial mark, the time, T_1, for the discharge of the volume, V, through the lower tube should be noted. Then, neglecting air friction, we have in addition to

$$\mathrm{H}d_m g = b\eta_m/t_0 + qd_m/t_0^2$$

the similar relation

$$\mathrm{H}d_s g = b\eta_s/\mathrm{T}_1 + qd_s/\mathrm{T}_1^2$$

By eliminating q we find

$$b = \frac{\mathrm{H}d_s g\mathrm{T}_1}{\eta_s}\cdot\frac{1 - t_0^2/\mathrm{T}_1^2}{1 - \frac{t_0\eta_m d_s}{\mathrm{T}_1\eta_s d_m}}$$

Since t_0 will be much smaller than T_1 and $\eta_m d_s$ much smaller than $\eta_s d_m$, tais becomes

$$b = \mathrm{H}d_s g\mathrm{T}_1/\eta_s \quad (7)$$

and the term involving b in equation (3) may be omitted provided

$$\frac{\mathrm{T}_1\eta_m d_s}{t_1\eta_s d_m} < 0{\cdot}005 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

The criteria (5) and (8) for the negligibility of the air friction and mercury friction terms are of such a form that they may be readily applied to a finished viscosimeter. The viscosity of the least viscous liquid for which the simplified form of equation (3), viz.,

$$\eta_1 = \frac{\mathrm{P}_0 t_1}{a}\left\{1 + \frac{\mathrm{P}_1}{\mathrm{P}_0} - \frac{t_0^2}{t_1^2}\right\}$$

may be used without error due to the omission of the kinetic energy term, is given by substituting in (4) the value of a given by equation (5); thus

$$0{\cdot}005\,\eta_1^2 > \frac{(\mathrm{P}_0 + \mathrm{P}_1)\mathrm{V}\eta_w d_1}{8\pi l_a\mathrm{T}hd_w g}$$

or

$$\eta_1 > \sqrt{\left\{\frac{(\mathrm{H}d_m + hd_1)\mathrm{V}\eta_w d_1}{0{\cdot}04\,\pi l_a\mathrm{T}hd_w}\right\}} \quad \ldots\ldots\ldots \quad (9)$$

The mean heads H and h are measured, for the purpose of this calculation, from the middle of the bulb to the ends of the respective tubes: the discrepancy between these means and the true time averages of the heads is less than 4% for a cylindrical bulb* of length twice that of the efflux tube (*cf.* Bingham, Schlesinger, and Coleman, J. Amer. Chem. Soc., 1916, 38, 27) and just over 2% for a spherical bulb* of diameter twice the length of the tube. A more definite limiting value for η_1 will, of course, be found by calibrating the viscometer with a series of standard liquids, but the above approximation will be useful in limiting the number of standard liquids which are required.

If the viscosimeter is calibrated with a liquid of viscosity η_s and density d_s and its design is such that the simplest formula applies, we have, if t_s be the observed time of flow—

$$\eta_s = \frac{\mathrm{P}_0 t_s}{a}\left\{1 + \frac{hd_s}{\mathrm{H}d_m} - \frac{t_0^2}{t_s^2}\right\}$$

Hence, writing k for P_0/a and n for $h/\mathrm{H}d_m$

$$k = \frac{\eta_s}{t_s}\cdot\frac{1}{1 + nd_s - t_0^2/t_s^2}$$

and the viscosity η of any liquid for which the time of flow is t may be found from the equation

$$\eta = kt(1 + nd - t_0^2/t_1^2).$$

The values of the constants n and t_0 require to be measured, the former by the use of a centimetre scale, the latter by timing the flow of the mercury in a blank run. The equation differs but slightly from that given by Lidstone (1918): it is, however, only applicable if the conditions 5a, 8, and 9 are satisfied.

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* The formula for the time average, P_s, of the head when the discharge is from a spherical bulb of radius R the centre of which is at a height H above the exit from the capillary is

$$\mathrm{P}_s = \frac{4\mathrm{R}/3}{2c - (c^2 - 1)\log_e\frac{c+1}{c-1}} \quad \text{where } c = \mathrm{H}/\mathrm{R}$$

which may be compared with the corresponding formula for a cylinder of length l_v,

$$\mathrm{P}_s = \frac{l_v}{\log_e\frac{\mathrm{H} + \frac{1}{2}l_v}{\mathrm{H} - \frac{1}{2}l_v}}.$$

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THE DETERMINATION OF THE ACTIVITY OF AN ACCELERATOR OF VULCANISATION.*

BY G. MARTIN, B.SC., A.I.C., AND W. S. DAVEY, B.SC., A.I.C.

The chief difficulty encountered in comparing the activity of different accelerators is that they are used for a variety of purposes and in a still larger number of mixes. It does not follow that if accelerators are arranged in order of effectiveness in one mix they will have the same relative order of effectiveness in another mix. Although at the present stage of our knowledge this is an almost insuperable difficulty, classification on broad lines is possible. On questions of detail there is no doubt that individual accelerators require individual experiments.

In addition to the thousands of mixes in which accelerators may have to function, they may also be used under a variety of curing conditions. The simplest and the most generally applicable mix is one containing rubber, sulphur, zinc oxide, and accelerator, and the most generally applicable conditions are vulcanisation in steel moulds under hydraulic pressure in steam. The factors affecting the activity of the accelerator in this mix and in these conditions are:—

1. The purity, concentration, and specific surface of the substances used.
2. The temperature of vulcanisation.

It is proposed to consider these factors in detail.

Purity.

The ingredients of the mix other than rubber are substances of definite chemical composition, the purity of which can and should be checked before using. On the other hand, raw rubber contains small and varying quantities of valuable natural products, some of which affect the activity of the accelerator.

The authors[1] have shown that in the presence of zinc oxide and an accelerator, some of the acetone-soluble substances present in raw rubber have a remarkable effect on the physical properties of the vulcanised rubber. Thus in the mix 90 rubber, 10 sulphur, 5 zinc oxide, 1 thiocarbanilide, it was found that good physical properties were obtained when 0·9% of sulphur had combined with the rubber, whereas in the case of another rubber over 5·0% of combined sulphur was necessary to produce a similar physical effect, as judged by the elongation at the standard load; and it was found that the rubbers which required a relatively small quantity of combined sulphur were the rubbers which gave strong vulcanised products, while those requiring the most combined sulphur gave weak products even at the maximum tensile strength cure.

In a recent paper Sebrell and Vogt[2] stated that a deficiency of resin acids in raw rubber gives stocks of poor physical properties. Experiments at the Imperial Institute indicate that the addition of certain long-chain fatty acids to a hexamethylenetetramine mix containing 5% sulphur and 5% zinc oxide results in a considerable acceleration of vulcanisation when the natural acids are absent (acetone-extracted rubber), but has little effect on vulcanisation in the presence of normal amounts of the natural acids. In the presence of an equal quantity by weight of rubber and zinc oxide, vulcanisation proceeds normally whether the resin acids are present or absent. The explanation of these phenomena may be connected with the chemical action of the so-called heveic acid[3] on the zinc oxide forming a soap solution in the rubber.[4] Similar zinc salts have been shown by Bedford and Gray[5] to be capable of replacing zinc oxide. The effect of resin acids appears therefore to be tantamount to increasing the zinc surface available for the formation and stabilisation of the catalyst and for the production of the physical effects associated with an increased amount of zinc oxide. In the presence of large quantities of zinc oxide the space between the particles is reduced by an amount which may be considerably more than the percentage increase in concentration, so that eventually diffusion and surface effects and therefore vulcanisation proceed unaffected by moderate variations in the available surface of zinc oxide.

The differences developed in the physical properties of the vulcanisate with different rubbers seem to be independent of the nature and amount of the accelerator.[6] Although increasing the amount of zinc oxide renders the results much more uniform, there is still a certain amount of variation, which is not connected with the acetone-soluble substances present in raw rubber. Thus in the mix 90 rubber, 90 zinc oxide, 5 sulphur, 1 hexamethylenetetramine, the time required to bring 2% of sulphur into combination with rubber at 148° C. is about 25 minutes for a rubber containing all the latex by-products, and 30 to 50 minutes for different samples of plantation rubber.

In determining the activity of an accelerator, it is evident that, irrespective of the amount of zinc oxide present, the results will be affected by the chemical composition of the raw rubber. In the presence of a large amount of zinc oxide, however, this variation is reduced considerably, especially when comparisons are based on physical standards of cure.

For this reason and also for the purpose of bringing out the full activity of an accelerator, a mix contain-

* Read at a joint meeting of the Manchester Section and the Manchester Section of the Institution of Rubber Industry on Dec. 7, 1923.

[1] Martin and Davey, J., 1923, 98T.

[2] India Rubber World, 1923, 69, 23.

[3] Whitby and Cambron, J., 1923, 333T.

[4] Cf. Bedford and Winkelmann, India Rubber World, 1923, 68, 497.

[5] Ind. Eng. Chem., 1923, 15, 720.

[6] Martin and Davey, *loc. cit.*

ing equal proportions by weight of rubber and zinc oxide is more satisfactory for the comparison of accelerators than one containing only small amounts of zinc oxide.

Concentration.

(*a*) *Accelerator.*—If the concentration of the accelerator is doubled, it is generally realised that the rate of combination of rubber and sulphur is not doubled. The acceleration factor for aldehyde-ammonia in the rubber : sulphur mix (90 : 10) has been shown by Twiss and Brazier[7] to be increased by 76%, 66%, and 50% respectively on repeatedly doubling the concentration of the accelerator. The authors mention that the vaporisation of the aldehyde-ammonia during mixing probably had an influence on the results. In the following table, compiled from work done at the Imperial Institute, is shown the percentage increase in the rate of combination of rubber and sulphur obtained by doubling the concentration of the accelerator in a mix containing equal quantities by weight of rubber and zinc oxide.

TABLE I.

Mix: 90 rubber, 90 zinc oxide. Temperature 141° C.

	10 Sulphur.	7½ Sulphur.	5 Sulphur.
Aldehyde-ammonia	33	25	25
Hexamethylenetetramine	30, 29	31, 25	-
"Supatac"	25	31	32
p-Phenylenediamine	--	31	30
"Accelerene"	-	38	--

The vulcanisation coefficient of each sample was determined at a value approximately 2·0, and a correction made for any deviation from this value. A small error in mixing or curing causing an error amounting to 1% of the total amount of combined sulphur will raise or lower the figures shown in the table by three units.

The results indicate that the increase in activity of the above accelerators on doubling their concentration is fairly uniform. Confirmation of this conclusion was obtained in the presence of still smaller quantities of sulphur. It follows that if a given quantity of accelerator A is found to enable sulphur to combine with rubber 30% more quickly than the same quantity of accelerator B under the conditions observed above, then half the quantity of accelerator A has the same activity as accelerator B. The results suggest that it may be possible to obtain an accelerator constant which is independent of the accelerator concentration.

(*b*) *Zinc oxide.*—The diminished activity of unit quantity of accelerator on increasing its concentration may be connected with surface phenomena. It is to be expected that in those cases where the accelerator functions through the formation of a zinc salt stabilised by the presence of zinc oxide, diminishing or increasing the concentration of the zinc oxide will have some effect on the rate of combination of rubber and sulphur.

It is interesting to note therefore that in the case of piperidinium pentamethylenedithiocarbamate Twiss and his collaborators[8] found that 1% of zinc oxide greatly increased the potency of the accelerator. The addition of a further 4% of zinc oxide increased its potency by approximately 50%, and a still further addition of 15%, making 20% altogether, gave a still further increase in activity of nearly 10%. It is evident that the effect of increasing the concentration of zinc oxide in the case of this accelerator is to increase the rate of combination of rubber and sulphur at a rapidly decreasing rate. It may be expected therefore that when the concentration of the zinc oxide exceeds a certain amount, further addition of zinc oxide will have little effect on the rate of combination of rubber and sulphur. The mix selected for the majority of the experiments described in this paper contains a large amount of zinc oxide, so that small variations in the amount present are not likely to affect the results.

(*c*) *Sulphur.*—The rate of combination of rubber and sulphur is markedly affected by the concentration of the sulphur. According to Fol and van Heurn[9] in a rubber-sulphur mix the rate is nearly proportional to the amount of sulphur present. The following table shows the variation in rate of combination of rubber and sulphur in a mix containing equal quantities by weight of rubber and zinc oxide, a fixed amount of accelerator, and varying amounts of sulphur. It will be seen that the rate of combination of rubber and sulphur increases with the concentration of the sulphur, but is not directly proportional except in the case of *p*-phenylenediamine.

TABLE II.

Accelerator.	Accelerator concentration %	Sulphur concentration %	Rate of combination of rubber and sulphur per minute. %	Rate of combination of rubber and sulphur per unit of sulphur present. %
Hexamethylenetetramine	1·11	11·11	0·0925	0·0083
		8·33	0·0738	0·0089
		5·56	0·0427	0·0077
		3·33	0·0256	0·0077
Aldehyde-ammonia	1·11	11·11	0·0805	0·0083
		8·33	0·0805	0·0097
		5·56	0·0595	0·0107
		3·33	0·0222	0·0067
p-Phenylenediamine	1·11	8·33	0·0590	0·0071
		5·56	0·0400	0·0072
		3·33	0·0228	0·0069
Thiocarbanilide	4·44	8·33	0·0840	0·0102
		5·56	0·0706	0·0127
		3·33	0·0260	0·0078

It may be mentioned that in carrying out these tests, no attempt was made to use the same raw rubber for the different accelerators, as the object in view at the time of the experiments was not the comparison of accelerator activities.

Specific surface.

The effect on vulcanisation of the state of dispersion of the zinc oxide is said to be considerable in the absence of an added accelerator. Very little work on this subject has been published.

Temperature.

In connexion with the effect of temperature on the rate of vulcanisation, Twiss and his collaborators[10] state: "The fact that the temperature coefficient

[7] J., 1920, 129T.
[8] J., 1922, 81T.

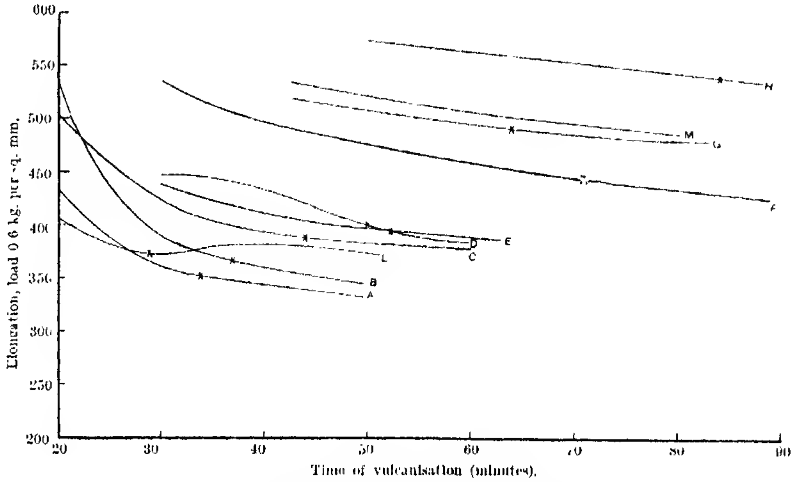
[9] Delft Communications, 6, 189.
[10] *Loc. cit.*

possesses comparable values for mixings with and without an artificial catalyst appears . . . to be a general one for all catalysts." In the case of a mix containing piperidinium pentamethylenedithiocarbamate the same authors state: "These figures indicate that for a mixture containing sufficient zinc oxide a fall of 10° C. in the temperature necessitates a period of vulcanisation 2-2½ times as long; the value is comparable with that found for the temperature coefficient of vulcanisation of simple mixtures containing simple accelerators. . ."

There are, of course, upper limits of temperature, fixed by circumstances of stability, beyond which accelerators will not follow the above law. At lower temperatures the insolubility of sulphur and accelerator are complicating factors.

The conclusions of Twiss and his collaborators in the case of zinc oxide mixings are based on physical measurements of the rate of cure. Chemical measurements of the rate of cure of zinc oxide mixings are insufficient to draw general conclusions. containing large quantities of zinc oxide the variation is greatly reduced, and in the case of the accelerators for which results are given in the accompanying figure, a relation can be traced between the rate of change in physical properties per unit of combined sulphur and the rate of combination of rubber and sulphur.

The quicker the rate of combination of rubber and sulphur, the less sulphur is required to bring about the physical changes associated with vulcanisation. Hence ultra-accelerators require very little sulphur. There is no independent evidence to show that this is connected with the reduced heat treatment required. When accelerators are present in equivalent amounts the elongation-cure curves appear to be approximately the same. Shepard and Krall[11] found differences in the vulcanisation coefficients when accelerators were present in amounts sufficient to give the same stress-strain curve in the same time. It follows therefore that different accelerators have specific effects on the physical properties of



The mark **x** shows the point in the curve corresponding with a vulcanisation coefficient of 2·0.

90 rubber, 90 zinc oxide, 7½ sulphur

A. 1% *p*-Phenylenediamine
C. ½% ,,
B. 1% Hexamethylenetetramine.
D. ½% ,,
E. 1% "Accelerene."
F. ½% "Accelerene."
G. ½% "Supurac."
H. ¼% ,,
L. 1% Thiocarbanilide.
M. 1% ,,

Comparison of results of chemical and physical tests.

It should be emphasised that there is a difficulty in correlating the results of physical tests with those of chemical tests. It is now well established that in mixes of the type under discussion the physical changes associated with vulcanisation are brought about with a lower percentage of combined sulphur than in the case of rubber sulphur mixes, and that the physical change corresponding with a given vulcanisation coefficient is dependent upon the accelerator used. The authors have recently shown that in the case of mixings containing only small quantities of zinc oxide the physical changes per unit of combined sulphur vary considerably with the raw rubber used. In the case of mixings vulcanised rubber. This receives some support in the results obtained above with thiocarbanilide. The nature of the accelerator does not, however, appear to be as important a factor as the rate of combination of rubber and sulphur.

The quicker the rate of combination of rubber and sulphur, still more quickly are produced the physical effects associated with vulcanisation, so that the results of physical tests give a greater value for accelerator activity than the results of combined sulphur determinations.

From the curves shown it may be inferred that there is a relation which will allow the two sets of results to be correlated.

[11] J. Ind. Eng. Chem., 1922, 14, 951

Acceleration factor.

Some investigators[12] have made use of an acceleration factor as follows: $k = S_a/S_r$, where k is the acceleration factor, S_a is the rate of vulcanisation in the presence of the accelerator, and S_r is the rate of vulcanisation in the same mixing in the absence of the accelerator.

In this paper, to avoid the complications connected with the difference between physical and chemical measurements of rate of cure, S_a and S_r are regarded as referring to the rate of combination of rubber and sulphur and not to the physical effects produced.

Such an acceleration factor is useful if its limitations and approximations are understood. It is dependent upon the ratio of two values both of which are affected by the raw rubber used and not always in the same direction. The greater the acceleration factor the less seriously is its value affected. Moreover, the variation can be distinctly reduced if thin crêpe rubber, which requires a long time of cure in the rubber-sulphur mix, is always employed when making determinations. The value of the acceleration factor is also affected, but not to a large extent, by the concentration of the sulphur and possibly by the temperature of vulcanisation. The most uniform results are obtained in the presence of large quantities of zinc oxide.

The value found for the acceleration factor is, of course, affected considerably by the concentration of the accelerator. In view of the indications obtained of the connexion between the concentration of the accelerator and the rate of combination of rubber and sulphur in the zinc oxide mixing described it is suggested that the term "potency" should be reserved to describe the acceleration factor found for a 1% concentration of the accelerator in the rubber. By suitable adjustments of temperature this can be actually determined, or it can be calculated from the formula $K = k/A^{1/n}$ where K is the potency of the accelerator, k the acceleration factor, and A the percentage concentration of the accelerator in the rubber; n has a value of about 2·6 (calculated from the results in Table 1).

The potency of an accelerator is not strictly constant under varying conditions. It should, however, be useful for the purpose of commercial descriptions.

Imperial Institute,
London, S.W. 7.

[12] Twiss and Brazier, *loc. cit.*

THE ESSENTIAL OIL OF MANUKA (*LEPTOSPERMUM SCOPARIUM*).

BY ROY GARDNER, M.SC.

The shrub known as "manuka" (*Leptospermum scoparium*, Forst.) is the dominant plant on heathlands in New Zealand and covers thousands of acres of land, much of which is of little use for agricultural purposes. The oil-glands in the leaves are apparent to the naked eye. Distillation on a commercial scale would not be difficult if the oil should prove to be of sufficient value; an investigation of it has therefore been made.

The only previous investigation of which any record can be found was made by Atkinson (Pharm. J., 4, 15, 369), who gives saponification and bromination values for several fractions, but apparently came to no conclusion as to the composition of the oil.

The samples referred to in this paper were obtained from plants growing practically at sea-level, on basaltic soil at Dunedin, and were collected between March and August. No attempt has been made to investigate the influence of situation, season, or varietal differences in the plants on the yield or nature of the oil.

The leaves and branchlets were treated with superheated steam at about 120°—150° C. and the oil floated off the condensed water, the average yield being 0·45%. The largest sample of oil used in this investigation was about 170 grams.

The oil is pale greenish-yellow in colour; it has $n_D = 1{\cdot}50$; d^{15} 0·921; the approximate boiling-range at atmospheric pressure is 160°—270°. The oil was shaken out with sodium hydroxide solution; the aqueous layer on acidification gave a liquid phenol (fraction 0, below) and the unabsorbed oil was fractionally distilled *in vacuo*. The appended table gives the result after three distillations.

Fraction.	% by wt.	B.p. 15 mm.	Colour.	n_D approx.	$d^{15/15}$	$[\alpha]_D^{22}$	Gram-equivs. of ester per 1000 g.
0.	2·8	140°-170°	Brown	1·505	1·059	0	—
I.	2·8	65°-98°	Colourless	1·485	0·830	+ 4·7°	—
II.	6·7	98°-135°	Colourless	1·510	0·926	+ 5·3°	2·9
III.	29·9	135°-145°	Pale yellow	1·517	0·933	+ 9·9°	1·4
IV.	42·2	145°-150°	Pale yellow-green	1·517	0·930	+ 14·5°	0·4
V.	8·4	150°-160°	Green	1·550	0·934	—	1·6
VI.	7·7	above 160°	Dark (semi-solid)	—	—	—	—

The saponification values were determined by boiling on the water-bath with standard alcoholic potash for half-an-hour. Saponification for two hours in the cold gave much lower values. The above figures were not altered by acetylation, showing the absence of free alcohol.

A long series of fractional distillations at atmospheric pressure failed to give any more definite separations.

The following substances were identified:—

Phenolic constituent. The phenolic substance (Fraction 0) gave a red colour with ferric chloride and a deep blue with copper sulphate. The quantity was too small for purification, but the major constituent is undoubtedly leptospermol, a phenol isolated by Penfold from the oil of *Leptospermum flavescens* (Proc. Roy. Soc. N.S.W., 1921, 49). The characters of the present fraction are here given, those given by Penfold for leptospermol being added in brackets: b.p. (10 mm.) 140°—170° (145°—146°); colour with ferric chloride, orange-red (orange-red); colour with copper sulphate deep blue (deep blue); d 1·059 (1·073); $[\alpha]_D = 0°$ (0°); $n_D = 1{\cdot}50$ (1·5000); molecular weight by freezing-point method 261 ($C_{14}H_{20}O_4 = 252$).

Terpene. Fraction I. consisted almost certainly of terpenes, the odour suggesting pinene. The

largest sample obtained—less than 4 g.—was allowed to stand in a corked flask for some months, before examination; this fraction was then found to have absorbed oxygen and formed a viscous material resembling old turpentine.

Cinnamic esters. These are present principally in Fraction III., and to a less extent in Fractions II. and IV. On warming with alcoholic potash, potassium cinnamate separates. The acid was obtained and identified by determination of equivalent, by oxidation to benzaldehyde, and by mixed-melting-point tests. It is presumably present as its ethyl or methyl ester, but as little saponification takes place even on long boiling with aqueous alkali this point was not decided. The quantity of acid obtained corresponded with the presence of 4·8% of ethyl cinnamate in the oil.

Other esters. The esters present, particularly in Fractions II. and III., gave on saponification an alcohol having a fine rose-like odour, and acetic acid mixed with other acids, probably including butyric acid, was recovered from the potassium salts. Attempts to separate the alcohol from the sesquiterpene with which it is mixed have not yet been successful. Prolonged boiling of the material with phthalic anhydride gave no result, nor did treatment with anhydrous calcium chloride in a freezing mixture for the extraction of geraniol. When the material was shaken with 50% resorcinol solution (which absorbs several terpene alcohols and other oxygenated compounds), and the aqueous layer steam-distilled, a few drops of rose-scented liquid were obtained, but the quantity was too small for identification.

Sesquiterpene. The greater part of the oil consists of sesquiterpene. A fairly pure specimen was obtained by allowing the oil (after saponification, and separation of acids and phenols) to stand over sodium for several days, heating with sodium for an hour, separating the liquid as completely as possible from the sodium and from the semi-solid substances which had formed, and distilling *in vacuo.* This material gave C 87·8%, H 11·7%, molecular weight 203; $C_{15}H_{24}$ requires C 88·16%, H 11·84%, mol. wt. 204.

This sesquiterpene gives the beautiful colour-reactions characteristic of aromadendrene, the characteristic sesquiterpene of the Eucalypts and also found in several of the Leptosperms, which belong to the same sub-order of the *Myrtaceæ* as do the Eucalypts *cf.* Baker and Smith, "Eucalypts and their Essential Oils," Sydney, 1920). The physical constants are appended, with those (in brackets) given by Penfold (Proc. Roy. Soc. N.S.W., 1920, **54**, 197) for aromadendrene:—B.p. 122°—128° at 11 mm. (123°—125° at 10 mm.); d^{20} 0·913 (d^{15} 0·910); n_D=1·50 (1·4967); $[\alpha]_D$=−12·8°. Aromadendrene from a Eucalypt gave $[\alpha]_D$=+4·7° (Smith, *op. cit.*) and from *Leptospermum flavescens* —6·2° (Penfold, *loc. cit.*).

It has been found, however, that the sesquiterpene of the present oil on treatment in ethereal solution with hydrochloric acid gas gives a definite liquid monohydrochloride, b.p. about 160° at 10 mm. (found Cl=14·4%, $C_{15}H_{24}$.HCl requires 14·8%). As no such derivative appears to have been prepared from aromadendrene (of which, indeed, no definite derivatives are known), it would seem either that the sesquiterpene here described is similar to, but not identical with, aromadendrene, or that this hydrochloride is the first derivative of aromadendrene to be prepared. This point must be left open at present, but is being further investigated.

Semi-solid, non-volatile material. No definite substance was obtained from this (Fraction VI.). Combustion gave C 73·9%, H 10·5%, and the average molecular weight is about 360. No conclusion has been arrived at as to the nature of the substances present.

Summary.

The following is the approximate composition of the oil:—

	%
Phenols (leptospermol)	2·8
Terpenes	2·8
Esters of cinnamic acid, calculated as ethyl cinnamate	4·8
Other esters (acetic etc. esters of alcohol, unidentified, of rose odour) calculated as $CH_3COOC_{10}H_{15}$	12·9
Semi-solid, non-volatile matter	7·7
Sesquiterpene (by difference)	69·0
	100·0

The sesquiterpene agrees in character with aromadendrene and gives the colour reactions characteristic of that substance, but yields a definite liquid monohydrochloride.

In conclusion I desire to record my indebtedness to Professor Worley, of Auckland University College, for an arrangement which prevented overlapping, and to express my sincere thanks to Professor Inglis, of this University, for his helpful interest in the work.

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THE DETERMINATION OF PENTOSANS IN WOOD CELLULOSE.

BY WALTER JAMES POWELL AND HENRY WHITTAKER.

The method which is at present in general use for the determination of pentosans in wood cellulose consists in distilling a known weight of the sample with 12% hydrochloric acid until no more furfural is evolved, as indicated by the absence of a pink coloration with aniline acetate. The furfural in the distillate is then determined by precipitation of its compound with phloroglucinol. After warming and standing overnight, the phloroglucide is collected on a Gooch crucible, washed free from acid, dried, and weighed. The composition of this compound is not definitely known, and a factor is used

to calculate the weight of furfural, whilst a correction must also be made for the solubility of the phloroglucide in the mother liquor. Accurate results are obtained, but the method is tedious, as much as three days being necessary to complete a determination. The volumetric method now described is based on a definite reaction between furfural and bromine. By its means consistent results in close agreement with those given by the gravimetric method are obtained, and the analysis can be completed in a single day.

At first an attempt was made to modify the existing method in the following way. To the distillate a known excess of a standard solution of phloroglucinol in 12% hydrochloric acid was added, and after standing for one hour a known amount of $N/10$ sodium bromide-bromate solution was added to an aliquot portion. The excess of bromine was then determined by means of potassium iodide and $N/10$ sodium thiosulphate. It was hoped in this way to determine the uncombined phloroglucinol, the assumption being made that the latter would react quantitatively with bromine. The preliminary experiments showed, however, that furfural and phloroglucinol only react very slowly at the ordinary temperature and, further, that furfural itself reacts quantitatively with bromine in dilute acid solution. It has now been found that it can be readily determined by this reaction, in which one molecule of furfural combines with four atoms of bromine.

Since the completion of this work, our attention has been drawn to a paper by Pervier and Gortner (Ind Eng. Chem., 1923, 15, 1167, 1255) in which a method based on a similar reaction is described. These authors determine furfural in the distillate by adjusting the acidity of the latter to 4%, and adding $N/10$ bromide-bromate slowly from a burette until a trace of free bromine is present. The end point is determined electrometrically. Under these conditions they found that one molecule of furfural reacts with two atoms of bromine, from which a simple conversion factor for c.c. of bromide-bromate to grams of furfural is calculated.

These authors state (*loc. cit.*, 1256, footnote) that they were unable to secure satisfactory results in the determination of furfural by any method involving the addition of an excess of bromine. The experience of the present authors, however, indicates that an accurate and simple determination of furfural can be made by adding an excess of bromine. In these circumstances the limit of the reaction is expressed by one molecule of furfural using four atoms of bromine. In 10% hydrochloric acid this limit is soon reached, and consistent results have been obtained when the reacting solution has been allowed to stand for periods varying from one to twenty-four hours. The fact that one molecule of furfural reacts with four atoms of bromine when the latter is present in excess explains why Pervier and Gortner (*loc. cit.*) experienced difficulty in obtaining a satisfactory end point in their titration, unless the rate of addition of the bromide-bromate was very carefully adjusted.

Details of method.—0·5–0·8 g. of material is distilled with 12% hydrochloric acid until the distillate gives no further coloration with aniline acetate. The distillate is then made up to 500 c.c. with 12% hydrochloric acid. It may be noted that the presence of cork or rubber in the distillation apparatus leads to inaccuracies, and all connexions should be of glass. Into each of four well-stoppered bottles are pipetted 25 c.c. of the standard, approximately $N/10$ sodium bromide-bromate solution. To two of these bottles there are now added 200 c.c. of the distillate and to the other bottles 200 c.c. of 12% hydrochloric acid. The bottles are allowed to stand in the dark for one hour, and after the addition of 10 c.c. of 10% potassium iodide solution, the liberated iodine is determined by titration with $N/10$ sodium thiosulphate. The number of c.c. required by the sample is subtracted from the number of c.c. required by the blank, the difference being a measure of the furfural present. The method was standardised against a solution of pure redistilled furfural in 12% hydrochloric acid (1 c.c. of solution contained 0·00206 g. of furfural). It was found that 10 c.c. of this solution required 8·6 c.c. of $N/10$ sodium thiosulphate, *i e.*, 1 g.-mol.of furfural reacts with 4·05 g.-atoms of bromine.

In calculating the following results it has been assumed, therefore, that 1 mol. of furfural reacts with 4 atoms of bromine, *i.e.*, 1 c.c. of $N/10$ sodium thiosulphate is equivalent to 0·0024 g. of furfural.

Comparative determinations of furfural in the same sample have been carried out by the gravimetric and volumetric methods, and the results obtained are shown in the following table:—

Material.	Furfural, %. Gravimetric method.	Furfural, %. Volumetric method.
1. Easy bleaching sulphite cellulose	2·95	2·70
2. Klered bleached sulphite cellulose	1·75	1·76
3. Bleached sulphate cellulose	3·20	3·40
4. Bleached poplar soda cellulose	7·47	7·38
5. Unbleached poplar soda cellulose	6·00	6·20
6. Purified ash sawdust	9·40	9·62
7. Purified ash sawdust (different sample)	8·30	8·00
8. Easy bleaching soda cellulose	5·00	5·09
9. Sulphate cellulose	6·03 6·04 6·10	6.06 5·99
10. Unbleached spruce soda cellulose	1·80	1·85

This investigation was carried out in the Research Department, Royal Arsenal, Woolwich. The results are published by permission of the Director of Artillery, to whom our thanks are due.

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THE DESULPHURISATION OF IRON PYRITES.

BY F. C. THOMPSON, D.MET., B.SC., AND NORMAN TILLING, M.SC.

The present ore reserves of ferrous materials have been estimated to be equivalent to about 500 years' supply at the present rate of consumption. If, however, the rate of increase during the past few decades holds, the supply would be sufficient for much less time. It is, perhaps, less the total supply which is of interest in many quarters than the amount available of the low-sulphur ore suitable for the production of steel. It appeared, therefore, that it would be of some interest to investigate the problem of the desulphurisation of iron ores from a laboratory point of view, and to this end the present paper—the first, it is hoped, of a series bearing on the same problem—deals with the removal of sulphur from iron pyrites. If an adequate removal could be effected by an economically useful method the iron ore reserves suitable for the production of a pig iron available for the production of acid steel, would be considerably increased.

Present methods of desulphurisation of iron ores. Treatment of ores before charging into the blast furnace.

(*a*) *Magnetic concentration.*—This treatment not only removes a considerable proportion of the gangue, but it has the additional advantage of eliminating a large proportion of the phosphorus, and, in some cases also, the sulphur that is present in the original ore. It is stated that when sulphur is present in the form of pyrites it is more readily removed by magnetic concentration than by calcination. This method is used in the treatment of Lake Superior ores, and of the magnetites of Sweden, where apatite and pyrites exist in the form of separate particles. It does not, however, yield such good results with British ores, since the phosphate, silica, and sulphide are in a state of fine division, and are intimately associated with the ore.

(*b*) *Weathering.*—The process has a twofold object: (1) removal of shale; (2) removal of sulphur. Weathering is uncommon, but is carried on in Sweden, where ores containing sulphur in the form of pyrites are left exposed to the atmosphere. The sulphide is oxidised to ferrous sulphate, which is soluble, and is carried away by the rain.

Materials containing both lime and sulphur should not be weathered, since the ferrous sulphate formed would interact with the lime yielding calcium sulphate, which is insoluble, and would not be washed away.

(*c*) *Calcination.*—One of the objects of this treatment is to eliminate sulphur. The ore is roasted in an oxidising atmosphere, so that at any rate some of the sulphide present is oxidised and the sulphur expelled.

S. G. Valentine[1] carried out a series of experiments on the calcination of iron ores containing pyrites. Such ores can be satisfactorily desulphurised if there is free access of air during roasting; in the absence of air only one-half of the sulphur in the pyrites, at the most, is eliminated. Sulphates of iron are decomposed equally well, whether air is present or absent, so that, if the ore be sufficiently oxidised in the preliminary stages of calcination, desulphurisation may be completed in a neutral atmosphere.

The magnetic ore of Cornwall Banks in Pennsylvania contains about 2·5–3·25% of sulphur. On calcination the sulphur is reduced to about one-twentieth of that in the native ore. It is thus possible by efficient calcination very considerably to diminish the percentage of sulphur in many iron ores.

Desulphurisation in the blast furnace.

Usually not more than one-twentieth of the sulphur present in the charge passes into the iron. Turner[2] has considered the conditions affecting the absorption of sulphur, and has arrived at the following conclusions: (*a*) A high temperature prevents the absorption of sulphur by iron. (*b*) A basic slag readily combines with the sulphur. (*c*) The amount of sulphur actually retained in the iron on cooling is influenced by the proportions of silicon, manganese, and possibly other elements present in the metal, these elements tending to exclude sulphur.

For every proportion of silicon there is a certain proportion of sulphur, which cannot be exceeded in cast iron under normal conditions. Hilgenstock[3] confirmed these observations, the desulphurising effect of manganese being more marked than that of silicon.

As the materials pass down the furnace, sulphur from the coke is absorbed by ferric oxide the action being quite evident at about 250° C. From 800° C. upwards the action is reversed, and lime becomes the chief absorbent of sulphur, the affinity of lime for sulphur increasing as the temperature rises.

Desulphurisation of pyrites in the manufacture of sulphuric acid.[4]

Insufficient air causes sulphur to distil. The burning of pyrites in this process reduces the sulphur in the cinders with good work to 3 or 4%, or even less with very good ores.

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[1] J. Iron and Steel Inst., 1889, ii., 333.
[2] J. Iron and Steel Inst., 1888, i., 28.
[3] J., 1894, 1064.
[4] "Sulphuric Acid and Alkali"—Lunge.

Dissociation pressure of iron pyrites.

E. T. Allen and R. H. Lombard[5] have determined experimentally the dissociation pressure of FeS_2 by a method which depends on balancing the dissociation pressure of the sulphide against the vapour pressure of sulphur at known temperatures. They found that the dissociation pressure of pyrites over a range of pressure of 1 mm. to 500 mm., increased from 0·75 mm. at 575° C. to 518 mm. at 680°. The dissociation may be represented by the equation :—

$$FeS_2 = FeS + S.$$

Vapour pressures of sulphur dioxide, sulphur trioxide, and oxygen over heated iron sulphates ; and the equilibrium $2SO_3 \rightleftarrows 2SO_2 + O_2$.

M. Bodenstein and W. Pohl[6] investigated the equilibrium $2SO_3 \rightleftarrows 2SO_2 + O_2$, and obtained values for the equilibrium constant $K = (C^2_{SO_2} \times C_{O_2})/C^2_{SO_3}$ for temperatures ranging from 528° to 897° C. By plotting log K values against temperature the values of K may be obtained for intermediate temperatures.

G. Keppeler and J. D'Ans[7] investigated the vapour pressure of sulphur dioxide, sulphur trioxide, and oxygen overheated ferric sulphate, the basic sulphate, $Fe_2O_3,2SO_3$, and ferrous sulphate. A current of air or nitrogen was passed through a tube containing anhydrous sulphate heated to a definite temperature, and the proportions of SO_2 and SO_3 in the issuing gas were determined. From their results the equilibrium between $Fe_2(SO_4)_3$ and SO_3 is best represented by :—

$$Fe_2(SO_4)_3 \rightleftarrows Fe_2O_3 + 3SO_3.$$

In the gaseous phase the equilibrium $2SO_3 \rightleftarrows 2SO_2 + O_2$ is established, and the equilibrium constants are in agreement with the values given by Bodenstein and Pohl.

The pressure of SO_3 over basic ferric sulphate, $Fe_2O_3,2SO_3$, is greater than over normal ferric sulphate at the same temperature, and the former is regarded as a labile compound. In the gaseous phase at lower temperatures the expected equilibrium was not reached ; too much SO_2 was found in all cases.

The behaviour of ferrous sulphate is best represented by the equation $2FeSO_4 \rightleftarrows Fe_2O_3,SO_3 + SO_2$. In the gaseous phase above $FeSO_4$ at high temperatures there is a constant ratio between the partial pressures of SO_2 and SO_3. The graphs obtained by plotting vapour pressures against temperature are shown in Figs. 12 and 13.

L. Wöhler, W. Plüddemann, and P. Wöhler[8] used a static method in the determination of the vapour pressures of the sulphates. The total pressure of the system at a known temperature was determined, and the partial pressures of SO_3 and SO_2 were calculated from Bodenstein and Pohl's measurements.

To ascertain whether $Fe_2(SO_4)_3$ was decomposed directly into Fe_2O_3 and SO_3, the basic sulphate Fe_2O_3,SO_3 was heated, and the vapour pressures found at three different temperatures agreed with those found for $Fe_2(SO_4)_3$, thus showing that a basic sulphate is not formed, and that there is no evidence for the formation of a solid solution of oxide and sulphate.

M. Bodenstein and T. Suzuki[9] repeated the experiments of Keppeler and D'Ans, and of Wöhler, Plüddemann, and Wöhler, and obtained results in agreement with the original measurements in both cases. The measurements by the static method of the partial pressure of SO_3 in equilibrium with $Fe_2(SO_4)_3$ give values three or more times as large as those obtained by the dynamic method of Keppeler and D'Ans. In Wöhler's method it is shown that the gases are really in equilibrium, and, therefore, the calculation of the partial pressures of SO_3 and SO_2 is justifiable. In Keppeler's method the ratio between the oxides of sulphur and oxygen is not in agreement with Bodenstein and Pohl's measurements of the dissociation of SO_3 ; there is always too little SO_3. The deviation diminishes as the temperature rises, and it appears, therefore, that the low results obtained by Keppeler are due to equilibrium not being established. If $Fe_2(SO_4)_3$ dissociates directly to Fe_2O_3 and SO_3, an excess of SO_3 would be anticipated, instead of a deficit, and hence the mechanism of the reaction is probably more complicated.

L. Wöhler and M. Grünzweig[10] improved the apparatus previously used by Wöhler, Plüddemann, and Wöhler. The measurements with $Fe_2(SO_4)_3$ gave results in agreement with those obtained by Bodenstein and Pohl.

Action of steam on ferrous sulphide.

At an incipient red-heat steam decomposes ferrous sulphide with the formation of a black magnetic mass containing Fe_3O_4, and the evolution of hydrogen and hydrogen sulphide :—

$$3FeS + 4H_2O = Fe_3O_4 + 3H_2S + H_2.$$

At higher temperatures sulphur dioxide and sulphur are also products of the reaction.[11]

EXPERIMENTAL.

The first portion of the research consisted in determining the effect of various common gases and gas mixtures upon the desulphurisation of pyrites at different temperatures. The gases experimented with were air, air saturated with steam, steam, hydrogen, carbon monoxide, carbon dioxide, and coal gas.

Preparation of sample of pyrites.

A dozen or more lumps of pyrites, weighing approximately one pound, were pulverised and intimately mixed. This was used in the determination of the total sulphur in the pyrites, the result being 52·54%.

Measurement of temperature.

The temperature of the furnace in all experiments was determined by means of a platinum, platinum iridium thermo-couple, and a millivoltmeter.

[5] Amer. J. Sci., 1916 (IV.), 43, 175.
[6] Z. Elektrochem., 1905, 11, 373.
[7] Z. physik. Chem., 1908, 62, 89.
[8] Ber., 1908, 41, 703.
[9] Z. Elektrochem., 1910, 16, 912.
[10] Ber., 1913, 46, 1587.
[11] Comptes rend., 1906, 142, 1489.

Furnaces.

Two furnaces were employed, viz., for temperatures above 700° C. a gas-fired furnace designed for the determination of carbon in steels by the combustion method, and for lower temperatures an electric furnace. When both furnaces were heated the silica tubes passing through them were explored by means of the thermo-couple, and it was found that in the hottest zone of each furnace there was a length of 5–6 in. where there was no appreciable variation in temperature.

The apparatus.

A constant volume of the gas to be experimented with was passed over a known weight of pyrites heated to a determined temperature, and the percentage of residual sulphur in the mineral determined after treatment. The apparatus consisted of a gas holder, from which the gas was forced through a wash-bottle containing concentrated sulphuric acid to dry it, and then through the silica tube, which was contained in the furnace. Into the end of the tube near the sulphuric acid wash-bottle was inserted the thermo-couple, protected by a fireclay sheath, the end of which reached the hottest zone of the furnace. A fireclay boat, containing 5 g. of pyrites, was pushed in at the other end, until it touched the end of the thermo-junction. The combustion products passed finally through a wash-bottle containing sodium hydroxide solution to absorb SO_2, SO_3, and sulphur. The volume of air used was 17 litres for 5 g. of pyrites, when there was 0·85 litre of oxygen in excess of the amount theoretically required. The time taken for the whole 17 litres to pass through the furnace was two hours, and in all experiments this same rate of flow was attained.

In all experiments the pyrites was allowed to cool inside the furnace, so that it was not subject to the oxidising influences of the atmosphere.

Air.—After passing 17 litres of air over 5 g. of

Air and air saturated with steam.

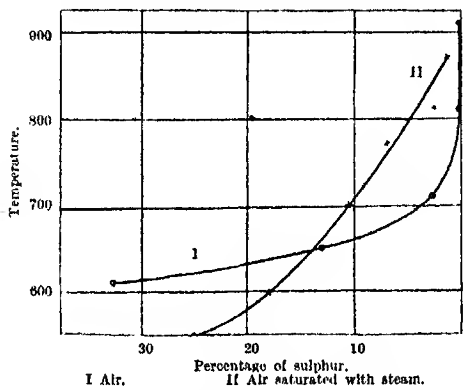

FIG. 1.

in pyrites, the sulphur content of the residual substance rapidly decreased from 32·99% at 610° C., to 13% at 810°, whilst at 910° the residual sulphur was only 0·092%. On plotting the results on a graph (Fig. 1) a perfectly smooth curve, not exhibiting any break, was obtained. The graph demonstrates that pyrites can be desulphurised almost completely under the conditions of the experiment, when heated to a temperature between 800° and 900° C.

Air saturated with steam.—The next set of experiments was carried out with air which before being passed over the pyrites was bubbled through boiling water. In order that all the experiments should be comparable the rate of ebullition was kept as nearly as possible constant. The results obtained are also plotted on Fig. 1. The curve shows that at temperatures below 650° C., air saturated with steam is more efficient as a desulphurising agent than dry air, whilst at temperatures above 650° the reverse is the case.

Steam.—In order to obtain a series of determinations showing the effect of steam as a desulphurising agent, the flask containing water was connected to a steam bath. Thus, by turning the tap of the steam bath, steam bubbled through the water in the flask, and then entered the silica tube. The wash-bottle containing sodium hydroxide solution was not used. Before the experiment was commenced the furnace was heated to the required constant temperature, while steam was passing through the silica tube,

Steam.

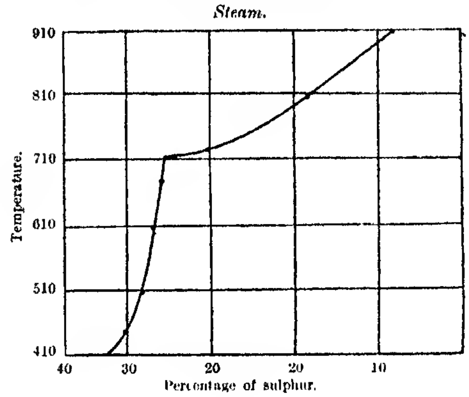

FIG. 2.

and then the fireclay boat containing the mineral was introduced. In order that approximately the same amount of steam should pass over each sample of pyrites, each experiment was of one hour's duration, and the rate of flow of steam through the apparatus was regulated by the height of the water in the tube open to the atmosphere, and dipping under the water in the flask. In every experiment the pyrites was allowed to cool inside the silica tube in an atmosphere of steam. It was then removed, and dried in a steam oven.

Although the results obtained in this manner are not strictly comparable with those obtained with other gases, they are useful when explaining the varying desulphurising action of air and air saturated with steam.

The graph obtained (Fig. 2) by plotting temperature against the percentage of residual sulphur indicates that desulphurisation commences at a temperature

in the region of 380° C., and increases rapidly as the temperature is raised to 500°. From 500° to 680° the amount of sulphur removed increases more gradually with rise in temperature, until at the latter temperature the sulphur content of the residue is 35·69%. Since the calculated percentage of sulphur in ferrous sulphide is 36·36, it is only reasonable to suppose that the action of steam on pyrites between 380° and 680° C. tends to produce ferrous sulphide:—

$$3FeS_2+2H_2O=3FeS+2H_2S+SO_2.$$

Water vapour is present in the system so that the hydrogen sulphide will reduce the sulphur dioxide with the separation of sulphur, thus:—

$$2H_2S+SO_2=2H_2O+3S.$$

The sulphur vapour is then swept away by more steam. The net result of the two reactions is the removal of one atom of sulphur from iron disulphide to form ferrous sulphide, while the quantity of steam at the end of the reactions is the same as that in the initial stages. Thus the steam appears to act as a catalyst of the dissociation of iron disulphide into ferrous sulphide and sulphur, which commences under ordinary conditions, according to E. T. Allen and R. H. Lombard, only at 575° C., and is complete in the vicinity of 700°.

About 700° the curve exhibits a marked break, and desulphurisation again rapidly increases with rise of temperature. At this temperature the iron disulphide will dissociate into ferrous sulphide and sulphur, the sulphur being carried away by the stream of steam. The steam will then react with the ferrous sulphide, according to the reaction advanced by Gautier:—

$$3FeS+4H_2O=Fe_3O_4+3H_2S+H_2,$$

which is stated to commence at incipient red heat; from the results obtained in these experiments this reaction begins at a temperature of 680° C.

Carbon dioxide.

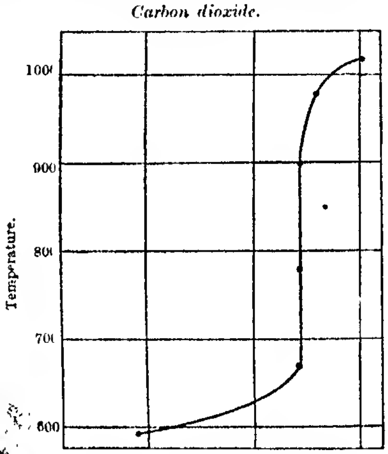

FIG. 3.

These reactions may be applied to the case of air and air saturated with steam, in order to explain the nature of the curves obtained in the experiments with these gas mixtures. Below 650° air saturated with steam removes more sulphur from pyrites than dry air.

Carbon dioxide.—Before the commencement of each experiment carbon dioxide was passed through the whole apparatus to remove all traces of air, and at the end of each experiment the boat containing the pyrites was allowed to cool in an atmosphere of the gas. The curve obtained by plotting the results (Fig. 3) shows that desulphurisation commences about 580°–590° C. As the temperature is raised to 670° the quantity of sulphur removed rapidly increases, until at this temperature the percentage of sulphur in the residue is 35·67, corresponding approximately to the formula of ferrous sulphide. Between 670° and 900° the residual sulphur content remains constant at 35·6%. Above 900° desulphurisation again increases, and at 1020° the residual sulphur is 29·88%.

Carbon monoxide.

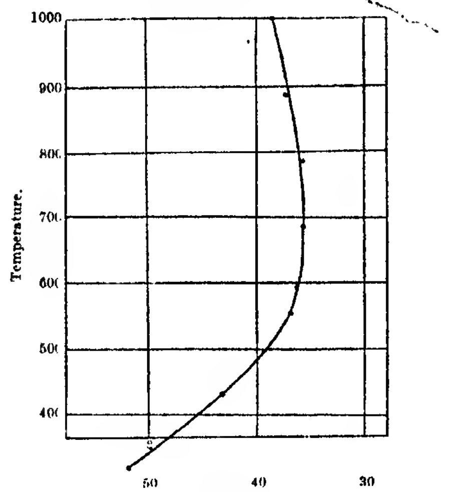

FIG. 4.

From these results it would appear that at temperatures below 900° C., carbon dioxide exerts no oxidising influence on the iron disulphide, but that this merely dissociates into ferrous sulphide and sulphur.

The action of carbon dioxide at temperatures above 900° C. may be explained as follows. At high temperatures carbon dioxide tends to dissociate; at 900° normally this reaction is unimportant. Raising the temperature, however, increases the decomposition, and if some oxidisable substance be present the whole of the carbon dioxide may, in time, be converted into carbon monoxide.

In the experiments performed an oxidisable substance in the form of ferrous sulphide is present. The carbon dioxide will then be decomposed into carbon monoxide and oxygen, the latter oxidising the ferrous sulphide.

Carbon monoxide.—The carbon monoxide used was prepared by passing carbon dioxide from the cylinder over heated charcoal. The gas was led through three wash-bottles, containing a concentrated

solution of caustic soda to remove any carbon dioxide, and collected in the gas holder. More carbon monoxide was collected in another gas holder, and this gas was used in expelling all air from the experimental apparatus before the commencement of each determination. The carbon monoxide was passed over 5 g. of iron pyrites in the same manner as before, and the residue in the fireclay boat was allowed to cool in the gas.

The graph (Fig. 4) obtained by plotting the percentage of sulphur against temperature shows that at 350° C. desulphurisation commences, and increases up to a temperature of 590°, where the composition of the residue corresponds to the formula of ferrous sulphide. Between 590° and 800° no further desulphurisation occurs, and above 800° the percentage of sulphur remaining gradually increases with rise in temperature from 35·56% to 38·25%.

At low temperatures carbon monoxide is very efficient in the removal of sulphur. Below 575° the iron disulphide does not dissociate, and the efficiency of the carbon monoxide is probably due to the combination of the gas with one atom of the sulphur in pyrites to form carbon oxysulphide :—

$$FeS_2+CO=FeS+COS,$$

since this gas is formed when a mixture of sulphur vapour and carbon monoxide is passed through a moderately-heated tube.

There is an increase in the amount of residual sulphur at temperatures above 800° C. At these temperatures a partial fusion of the sulphide on the surface may occur, which hinders the removal of more sulphur. This partial fusion of the sulphide is well known in the manufacture of sulphuric acid by the chamber process, and is always noticed in the pyrites burners, when they become overheated. The cinders after such treatment always contain more sulphur than cinders which have been properly burnt. This explanation of the increase in residual sulphur after treatment with carbon monoxide at high temperatures seems therefore to be correct.

Hydrogen.—The hydrogen used was obtained from cylinder of the gas, and the details of the experimental work did not differ in any respect from those using air.

The curve (Fig. 5) obtained indicates that hydrogen commences to remove sulphur from pyrites at a temperature of 440° C., and at 530° the iron disulphide totally converted into ferrous sulphide. The sulphur content of the residue then remains constant to 900° C., but between this temperature and 1000° there is a slight decrease in the percentage sulphur.

Between 440° and 575° the hydrogen reacts with the iron disulphide producing ferrous sulphide and hydrogen sulphide, according to the equation :—

$$FeS_2+H_2=FeS+H_2S.$$

At higher temperatures, since hydrogen sulphide begins to dissociate into its elements, the main factor which causes the removal of sulphur will be the dissociation of the iron disulphide. Above 900° C. the only reaction which will account for the decrease in the sulphur is the conversion of ferrous sulphide into metallic iron with the formation of hydrogen sulphide thus :—

$$FeS+H_2=Fe+H_2S.$$

Coal gas.—The experiments with coal gas were carried out in the same way as with the other gases.

Hydrogen and coal gas.

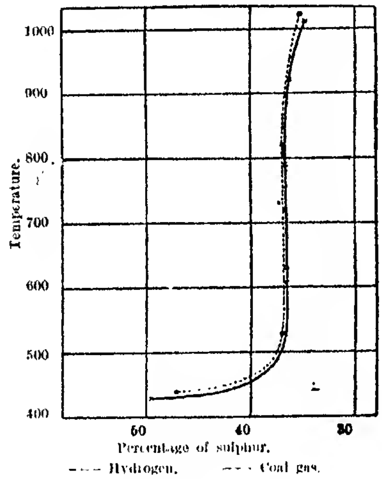

FIG. 5.

The curve (Fig. 5) obtained was practically the same as that of hydrogen.

Soluble sulphur determinations.

The weathering of ores containing sulphur, carried on in Sweden, converts some sulphide into sulphate, and the latter, being soluble in water, is washed away by the rain. It was, therefore, considered of interest to determine the amount of soluble sulphur in the pyrites after treatment with the various gases. The remaining portion of each sample of pyrites after the previous experiment was used.

The amount of soluble sulphur in the samples after treatment with air decreases with increasing temperature from 0·155% at 650° C. to 0·044% at 910°, while the sulphur determinations in the residue after treatment with air saturated with steam show a maximum of 0·227% at 600°. The soluble sulphur content of the samples treated with dry air was less than that of those treated in air saturated with steam for corresponding temperatures.

A series of experiments was then carried out with air at temperatures between 350° and 545°. Five grams of pyrites were placed in the furnace heated to a constant temperature, and air was passed over the sulphide without being dried. Each experiment was of three and a half hours' duration, the quantity of air passing through the furnace being approximately 30 litres per hour. The total sulphur and soluble sulphur were determined in the burnt pyrites, and these percentages were plotted against temperature.

No oxidation occurs below 330° C.; at 350° the soluble sulphur content is 2·72%, and this increases to a maximum of 4·05% at 430°, while a further

increase in temperature causes the percentage of soluble sulphur to decrease rapidly (Fig. 6).

The total sulphur curve (Fig. 7) shows a break at 430° C., corresponding to the maximum on the

Air.

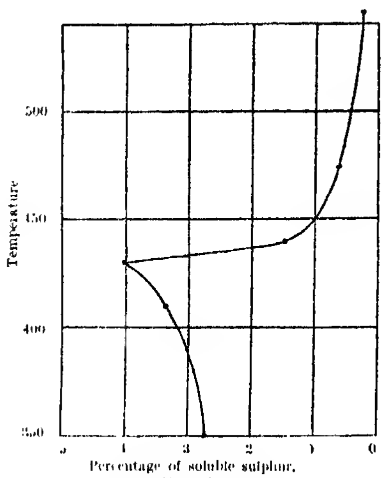

FIG. 6.

soluble sulphur curve. The first portion of these curves up to 430° corresponds to the formation of some soluble salt of iron containing sulphur, and the second portion to the decomposition of this salt.

The graph (Fig. 8) resulting from the soluble sulphur determination in the pyrites after treatment with steam, also reaches a maximum at 430° C., and

Air.

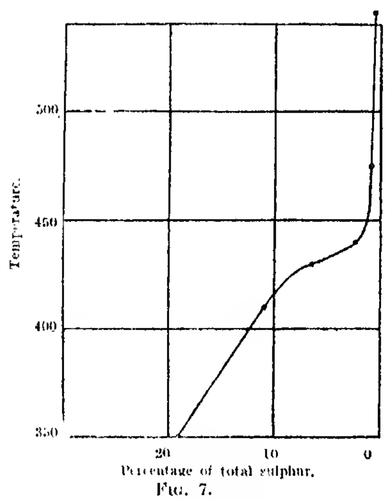

FIG. 7.

exhibits a break at 680° analogous to the break in the total sulphur curve.

The carbon monoxide and hydrogen soluble sulphur curves (Fig. 9) show maxima in the region of 530°–550° C., but the carbon dioxide and coal gas results present no striking feature. Since all the sulphides of iron are insoluble in water, it is difficult to explain the occurrence of a soluble iron-sulphur compound in the case of hydrogen and carbon monoxide, but its appearance is probably due to traces of moisture

Steam.

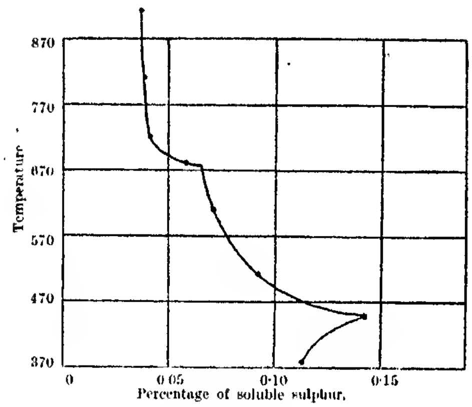

FIG. 8.

in the apparatus. This compound must be ferrous sulphate, since this salt begins to decompose at 530° C., and also the reducing conditions imposed by the gases will inhibit the formation of a ferric salt. The amount of soluble sulphur remaining after the action of hydrogen and those gases which convert the iron disulphide into ferrous sulphide, is greater than the amount obtained after the action of air and air saturated with steam. This is due to the conversion of part of the ferrous sulphide into ferrous sulphate and sulphuric acid during the digestion of the mass with water.

Carbon monoxide and hydrogen.

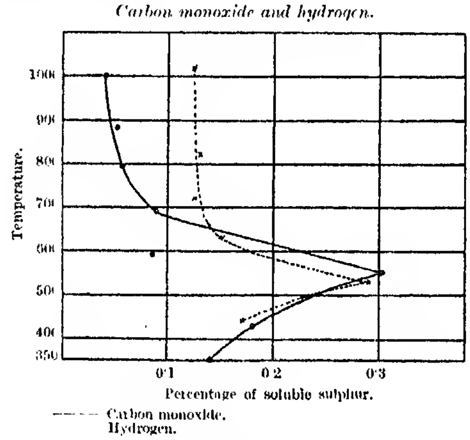

FIG. 9.

From these results it would appear that a soluble sulphur compound of iron may be an intermediate product in the oxidation of iron pyrites to iron oxide.

Up to this point a sulphate had been supposed to be the soluble iron salt. In order to ascertain the proportion of ferrous and ferric iron in the solutions,

obtained when the burnt pyrites was treated with water, the following determinations were made.

A sample of pyrites, after being heated for three-and-a-half hours at a constant temperature in the range of 400°–480° C., was weighed, and lixiviated with hot distilled water, and the solution obtained, after cooling, was made up to 250 c.c. in a graduated flask, and the amounts of ferrous and ferric iron and soluble sulphur were determined.

The results for the percentage of soluble sulphur, obtained indirectly from the weight of iron present in the solution, are not in agreement with those determined by the direct method of precipitation with barium chloride. In all cases where the pyrites was treated below 430° C., the sulphur derived from the iron determinations is always less than that obtained by the direct method, and in the great majority of those samples heated above 430° this is also true.

The cause of the discrepancy between the sulphur determined directly and that obtained indirectly, appears to go to the root of the removal of sulphur again. Further, the difference in the soluble sulphur as sulphates, and that present as a persulphate, is also at its maximum at 430° C., indicating that up to that temperature the persulphate is being formed, while as the temperature is raised still further it again breaks up.

Temperature, °C.	Ratio ferrous ferric.	Soluble S, %	Difference.*
370°	2 67	2 03	0 23
430°	1 41	3·39	1 11
480°	1 22	0 67	0·30

* Being % S determined directly *minus* that calculated from amounts of ferrous and ferric iron.

Determination of the vapour pressures of sulphur dioxide, sulphur trioxide, and oxygen during the oxidation of iron pyrites.

These determinations had a two-fold object: (1) to ascertain in what condition the sulphur was removed, (2) to ascertain whether the vapour pressures observed offer any data for the solution of the problem of the soluble sulphur.

The dynamic method was used, since it offers less experimental difficulties than the static method.

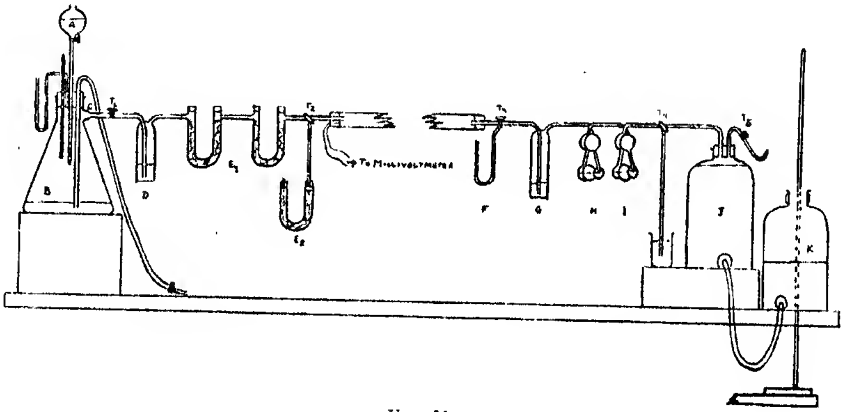

FIG. 10.

om a calcined ore by a process of weathering. In l probability there is formed some soluble sulphur mpound of iron which contains more sulphur than e sulphates, and exists along with the latter. On reful examination it was shown that the following sses of soluble iron compounds containing sulphur re absent: Acid sulphates, thiosulphates, sulphites, posulphites, and thionates, and that there was very ong reason to believe that a persulphate was sent. The existence of such a compound was er shown from the vapour pressure measurements, that it may be said with a tolerable degree of tainty, that a persulphate is the cause of the sence in the partly oxidised pyrites of a greater iount of soluble sulphur than is accounted for by e sulphates there. This persulphate is not improbably an intermediate product in the formation of the ferrous sulphate.

It will be seen from the figures below that as the temperature rises the ratio of the ferrous to the ferric iron decreases, that the amount of soluble sulphur increases to about 430° C., and then falls off

The apparatus was similar in construction to that used by Keppeler and D'Ans[9] in their determinations of the vapour pressures of sulphur dioxide and sulphur trioxide over dry sulphates of iron. A known volume of air was led over iron pyrites heated at a known temperature, and the amount of sulphur dioxide and sulphur trioxide determined by absorption, and the amount of oxygen by the analysis of the residual gas.

Fig. 10 represents the form of the apparatus finally employed. The Buchner flask, B, was fitted with a four-holed rubber stopper, provided with a dropping funnel, A, a thermometer, a pressure gauge containing xylene, and a glass tube reaching to the bottom of the flask. A long piece of rubber tubing, closed at the end by means of a screw clip, was fitted to this glass tube, so that water could be siphoned out of the flask when necessary. The side outlet tube, C, was connected through a tap, T_1, to a small wash bottle, D, containing concentrated sulphuric acid, and then to the U-tubes, E_1, containing calcium chloride, in order to dry the air used in the apparatus

ments. The last calcium chloride tube was connected to one end of the three-way tap, T_2, the second end of which fitted into the rubber stopper closing the end of the porcelain tube contained in the furnace, while to the third end a calcium chloride tube, E_2, was attached. At this end of the porcelain tube the thermo-couple was introduced, and its hot junction reached the hottest zone of the furnace. Inside the tube a fireclay boat containing about 5 g. of pyrites was placed, so that the end of the boat touched the end of the thermo-couple. The space at the opposite end of the tube was occupied by two fireclay boats containing pieces of broken fireclay. The end of the tube was closed by means of a one-holed rubber stopper, into which fitted one end of the three-way tap, T_3. The second end of the tap was connected to a pressure gauge, F, and the remaining end to the first absorption vessel, G, containing 40—50 c.c. of $N/20$ iodine solution. Then came two bulb tubes, H and I, the former containing more $N/20$ iodine solution, and the second 15 c.c. of $N/20$ sodium thiosulphate solution. The latter was attached to the three-way tap, T_4, to one end of which was connected a piece of glass tubing dipping under the surface of caustic soda solution contained in a beaker. The remaining end was connected to a bent glass tube, fitted into a two-holed rubber stopper, closing the open end of a glass bottle, J, so that it did not protrude beyond the end of the stopper into the bottle. Into the other boring of the stopper was fitted a bent capillary tube having a tap, T_5, and drawn out to a fine upturned point at the open end. The bottle had an outlet at the bottom which was connected by a long piece of pressure tubing to a similar outlet in the bottle, K. The latter could be raised or lowered when required. Both bottles contained a concentrated solution of caustic soda. All connexions were made with pressure tubing, and were rendered gas-tight by the use of collodion.

Experimental method.

On raising the bottles, K and J, the outlet tube up to T_4 and the whole of the capillary tube filled with the caustic soda solution. The pressure gauge, F, was then detached, and T_3 turned so that the absorption vessels were open to the air, while the porcelain tube was shut off from contact with the atmosphere. The absorption bulbs were connected to the beaker containing caustic soda solution, and carbon dioxide was passed through the absorption vessels to expel all traces of air, entering at T_3 and escaping through the liquid in the beaker under T_4. The passage of carbon dioxide was continued for a period of time, never less than half-an-hour, until, when the stream of gas was stopped, the caustic soda solution rapidly rose up the outlet tube from T_4. It was then assumed that all air had been expelled from the absorption apparatus, and the pressure gauge was replaced.

Meanwhile the furnace was being heated to the required constant temperature, the porcelain tube being connected to E_2, but not with E_1. T_1 was turned in order to shut off the flask from the drying train. A small quantity of water was placed in B, so that the siphon tube dipped below the surface of the liquid. A small quantity of water was then allowed to drop from the funnel into the flask, until the difference in the level of the xylene in the two limbs of the pressure gauge was about 7 cm. This was the pressure found to be necessary before air could be forced through the sulphuric acid drying bulb. The tap of the funnel was turned, and all water removed from the bulb by means of a pipette. 100 or 150 c.c. of distilled water were then placed in the funnel.

When the temperature of the furnace was steady at the required temperature, T_1 was opened, and the drying train connected with the porcelain tube, but not with E_2. Finally, the height of K was so adjusted that, on turning T_4 to connect the absorption vessels with the caustic soda bottles only, no caustic soda passed into the sodium thiosulphate bulb. Then the tap of the dropping funnel was turned, and water dripped slowly into the flask, forcing air into the apparatus. By raising or lowering the second caustic soda bottle it was so arranged that the height of the liquid in the two limbs of the pressure gauge, F, was the same throughout the experiment, and therefore the pressure inside the porcelain tube was atmospheric. When the water in the funnel had fallen to the tap it was turned off. T_1, T_2, and T_3 were then turned to their initial positions while T_4 remained unaltered. F was detached, and carbon dioxide again passed through the apparatus to drive all nitrogen and oxygen in the absorption bulbs into J. The carbon dioxide was readily absorbed by the caustic soda, and the passage of carbon dioxide was continued for half-an-hour or more. T_4 was then turned to allow the carbon dioxide to pass into the beaker containing caustic soda solution, and the stream of carbon dioxide was stopped.

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Keppeler and D'Ans determined the sulphur trioxide by titration of the residual solution with standard barium hydroxide solution. This method is, however, impracticable in the present case, since the solution is saturated with carbon dioxide. Hence the following method was adopted. Hydrochloric acid was added, and the solution boiled to decompose the sodium tetrathionate formed by the interaction of the iodine with sodium thiosulphate. Carbon dioxide was bubbled through the solution to facilitate the removal of sulphur dioxide, and after boiling for some time the sulphur was filtered off. The sulphate in solution was precipitated in the usual manner by the addition of barium chloride solution. Allowances were made for the sulphuric acid formed by the oxidation of sulphur dioxide by the iodine solution and the sodium sulphate formed by the decomposition of the sodium tetrathionate, and the weight and

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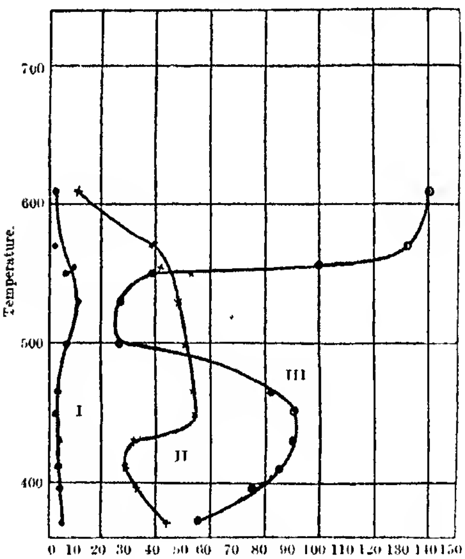
The amount of oxygen present was determined by absorption with alkaline pyrogallol. From the data thus obtained the volume of residual gas containing the amount of nitrogen in the original air could be calculated, and hence the volume of oxygen in the residue was known.

Sulphur [illegible]xide, sulphur trioxide, and oxygen pressures over heated iron pyrites during oxidation with air



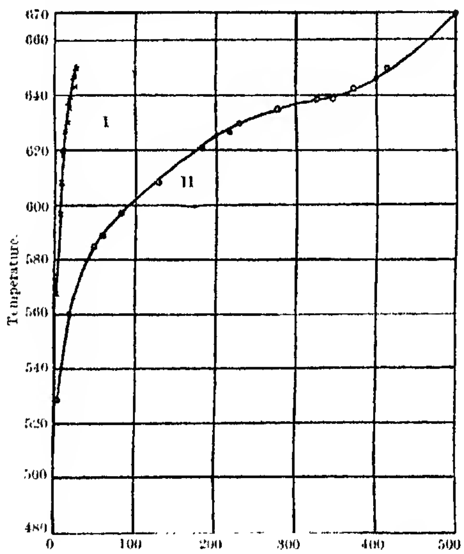
I Oxygen. II SO_3. III SO_2.

FIG. 11.

In order to test the accuracy of the apparatus the vapour pressures of sulphur dioxide and sulphur trioxide over dry ferric sulphate heated to a temperature of 670° C. were determined. The partial pressures of the two gases were then found to be $P_{SO_3} = 24·08$ mm. and $P_{SO_2} = 31·16$ mm. By reference to the graph of the vapour pressures of sulphur dioxide and sulphur trioxide over heated ferric sulphate obtained by Keppeler and D'Ans, the pressures of the two gases were observed to be 22 mm. and 33·5 mm., respectively. This agreement was sufficiently good for the determinations with iron pyrites, which were only performed in order to form an idea of the conditions in the gaseous phase during the oxidation of the sulphide. The ferric sulphate was then replaced by iron pyrites, and the ends of the porcelain tube were closed up. The same pyrites was used in all the determinations, and when it was removed from the furnace at the end of the series of experiments there was a comparatively large quantity of unchanged sulphide. The passage of air over the heated sulphide in each determination occupied between 70 and 80 minutes for 150 c.c. of air, and about 50 minutes for 100 c.c. The determined pressures of the three gases were plotted against temperature on a graph (Fig. 11).

The curves obtained by plotting the pressures against temperature were of a most extraordinary character. At 370° C. the vapour pressures of sulphur trioxide and sulphur dioxide are practically the same, but, as the temperature is raised, the partial pressure of the sulphur dioxide increases to 90 mm., while that of sulphur trioxide decreases to 28 mm. Between 430° and 450° there is a sudden increase in the amount of sulphur trioxide, while the sulphur dioxide remains constant. This increase is due to the decomposition of the soluble sulphur salt of iron. With further increase in temperature the sulphur trioxide gradually falls from 55 mm. at 450° to 39 mm. at 570° C. Meanwhile the sulphur dioxide pressure decreases rapidly to 25 mm. at 520°, and then again increases, until at 570° it is 130 mm. This increase corresponds to the decomposition of ferrous sulphate, since sulphur dioxide is the main constituent of the gaseous phase over the heated salt, and the dissociation of FeS_2, the sulphur vapour being oxidised to SO_2. At 610° C., the highest temperature at which a determination was made, the partial pressure of sulphur dioxide is 140 mm., while that of sulphur trioxide is 11 mm.

Sulphur dioxide and sulphur trioxide pressures over heated ferrous sulphate (Keppeler and D'Ans).



I Sulphur trioxide. II Sulphur dioxide.

FIG. 12.

The sulphur dioxide curve is perfectly continuous, although the vapour pressures are of such a varied nature, and all the points obtained find a position on it. The sulphur trioxide curve is flattened between 450° and 570° C., and the pressure obtained at 550° is too great to find a place on the smooth curve. It

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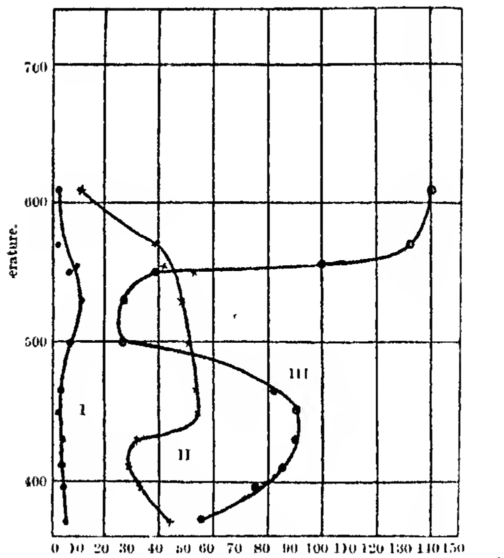

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Sulphur dioxide and sulphur trioxide pressures over heated ferrous sulphate (Keppeler and D'Ans).

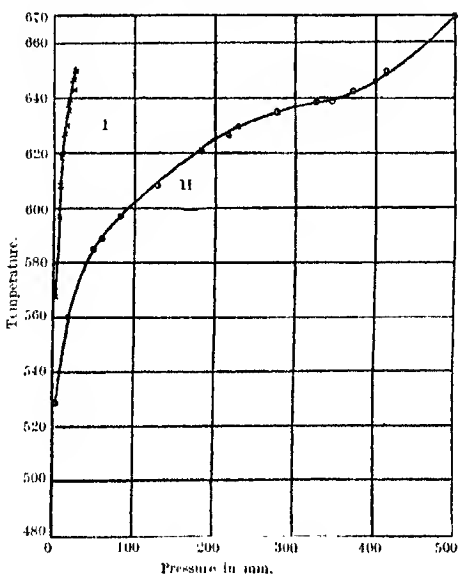


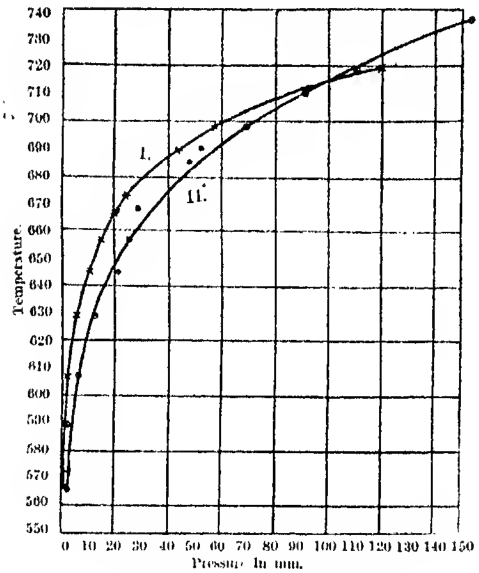
FIG. 12.

The sulphur dioxide curve is perfectly continuous, although the vapour pressures are of such a varied nature, and all the points obtained find a position on it. The sulphur trioxide curve is flattened between 450° and 570° C., and the pressure obtained at 550° is too great to find a place on the smooth curve. It

is noticeable that where this flattening occurs the sum of the pressure of the dioxide and trioxide is less than that at 370° C.

The following explanation appears to fit in well with the results. Even at 370° C. the low value for the oxygen pressure shows that the oxidation of the pyrites has already become appreciable, giving considerable vapour pressure for both the SO_3 and SO_2. As the temperature rises, the pressure of the former decreases. This would not be expected, but it fits in well with the idea of the formation of a persulphate from the ferric oxide already produced, and some of the SO_3. The increase of the pressure of the SO_2 would normally be expected. This formation of the persulphate continues to about 400° or just over, during which period there is a continuous decrease in the pressure of the SO_3. At that temperature the persulphate commences to decompose, as has already been shown from the soluble sulphate determinations. This decomposition of the persulphate generates sulphur trioxide, which rapidly increases in the gaseous phase.

Sulphur dioxide and sulphur trioxide pressures over heated ferric sulphate (Keppeler and D'Ans).



I. Sulphur dioxide. II. Sulphur trioxide.

FIG. 13.

At about 430° C. the fall in the vapour pressure of the SO_2 is the result of the formation of ferrous sulphate according to the equation :—

$$Fe_2O_3+SO_2+SO_3=2FeSO_4.$$

The simultaneous absorption of SO_3 flattens the curve for the vapour pressure of the latter, which would otherwise increase to a maximum at about 520° C.

At about 525° the ferrous sulphate commences to decompose; SO_2 and SO_3 are liberated, but in amounts which are widely different. Reference to Fig. 12 will show that the gaseous phase is almost entirely SO_2, the SO_3 having presumably decomposed according to the equation :—

$$2SO_3 \rightleftarrows 2SO_2+O_2.$$

The pressure of the SO_2 increases rapidly, while that of the SO_3 decreases. The oxygen produced will fail to increase the pressure of that element, as at these temperatures the pyrites is dissociating rapidly, and any oxygen generated will react with the sulphur vapour, producing more SO_2.

The only point of interest in the oxygen curve is the slight increase around 520° C., due to the decomposition of the persulphate, according to some such equation as :—

$$2FeS_2O_8 \rightleftarrows Fe_2O_3+SO_2+3SO_3+O_2.$$

Temperature, ° C.	Partial pressures. SO_2 mm.	SO_3 mm.	O_2 mm.
370°	55·9	44·1	5·332
395°	75·3	32·32	5·293
410°	84·29	27·89	4·71
430°	90·03	31·2	4·63
450°	90·69	54·05	2·604
465°	81·93	52·71	3·434
500°	26·76	50·1	7·171
530°	26·83	47·74	11·02
550°	38·61	52·22	6·725
555°	99·36	41·07	9·43
570°	131·0	38·66	2·477
610°	149·6	11·35	2·981

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TRANSACTIONS

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THE TENSILE STRENGTH OF RUBBER.

BY O. DE VRIES.

In the testing of crude rubber the determination of tensile strength has always taken a prominent place; many investigators determine only tensile strength and rate of cure, and nothing else; several manufacturers base their private valuation of the rubber mainly on the figures for tensile strength.

Now, rate of cure is a factor of chemical composition and not of quality in the strict sense of the word. Probably chemical analysis will never be able to eplace vulcanisation tests in the determination of the omplex of accelerators and retarding catalysts present n the rubber, and the vulcanising test will retain ts place as the surest and quickest means of deternining the amount of these catalysts. But this loes not promote the determination of rate of cure o the rank of a test of quality, and the fact remains hat at present in many cases, probably the majority, he quality of the crude rubber is only determined y means of one property, viz., tensile strength.

The breaking load of rubber is not actually so mportant a property as might appear from the ttention paid to it in testing work; rubber in ractice is seldom stretched to near the break. Even the tearability of rubber, for instance in tyrecovers, is not directly related to tensile strength determined by a regular, slow stretching process, nd is certainly more dependent upon the composiion of the mix than upon the properties of the crude ubber. There seems to be no other reason why nsile strength has been given so much attention an that other more suitable properties have not een formulated or have not yet been worked out fficiently.

It should further not be forgotten that breaking ures are always more or less accidental, and a tively large number of test pieces is necessary obtain a reliable average. The accurate deteration of tensile strength is a tedious process; ny of the published and unpublished figures have y little value, as the number of test pieces was too small and the error of determination far too ge to allow of any reliable conclusion being drawn. ere is little doubt that many consignments of ber have been condemned or accepted on insufient and unreliable figures by manufacturers who e their valuation on tensile strength determinations.

ur regular testing work led us to the conclusion at the tensile strength of first-grade plantation ıbber is practically always good and that, when ouble is experienced in manufacture, the reason is be sought amongst the other properties (rate of re, plasticity, etc.). For this reason, also, there is little inducement to determine this property. True, it is not always easy for manufacturers to know whether a certain lot of rubber is what producers call "first grade"; on certain markets the estate names are often replaced by dealer's marks, and a lot of native and Chinese smoked sheet is mixed under what is called "standard." In such cases the quality of the rubber must be carefully tested; but determinations of "slope" and viscosity are easier and give as good a verdict in such cases as tensile strength figures. In "off" grades and lower grades the figures for tensile strength are sometimes inferior; but in these grades pieces of dirt may play a rôle, and the quality of the rubber is much better gauged by properties such as slope and viscosity than by the (in such cases) doubly uncertain breaking figures.

There is, in our opinion, little doubt that in the future other testing methods will be developed, and that tensile strength determinations will be relegated to the fourth or fifth place or used only in special cases, for instance, in the study of new or deviating types of rubber with an uncommon content of serum substances, etc. Nowadays tensile figures are often used to determine "broadness of peak," the range of cures over which tensile strength is a maximum. This is certainly an important property for manufacturing purposes, but it is mainly influenced by the type of compound and not by the crude rubber, and it need not be expected to play a rôle in the routine testing of the ordinary forms of plantation rubber, though again its determination may be of value in the study of special types.

Relation between tensile strength and time of cure.

Whilst it will be generally acknowledged that tensile strength figures determined on separate samples are mostly unreliable (unless an excessive number of test pieces is used) and therefore should be accepted only with a certain reserve, there are pitfalls even when drawing conclusions from averages of a very large number of determinations, which have not received general attention. Many examples have been given, for instance, of the fact that quick-curing matured rubber (slab rubber etc.) gives rather high figures for tensile strength, and that smoked sheet gives higher figures than first quality crêpe; in this paper it is hoped to show that it would be unjustifiable to draw the conclusion that matured rubber is the best in quality, or that the quality of smoked sheet (as far as tensile properties are concerned) is better than that of crêpe.

1. *Estate samples.*—The largest number of figures is available when comparing data obtained in the regular testing of estate samples in the course of

years. For thin pale crêpe (" first latex ") our figures are summarised in Table I. :—

TABLE I.

Thin pale crêpe from estates.

Year.	Number of samples.	Tensile strength.	Standard time of cure	Slope.	Viscosity.
1917	265	1·385	119 ± 8·7	$35{\cdot}0^{5}$	34·5
1918	131	1·472	118 ± 6·0	35·5	31·0
1919	241	1·345	110 ± 8·4	36·0	27·2
1920	227	1·409	106 ± 7·0	34·7	30·5
1921	354	1·417	109·2 ± 7·3	34·6	35·5
1922	450	1·443	106·0 ± 6·8	35·2	32·7
	1668	1·403	110·5	$35{\cdot}2^{5}$	32·3

The figures for tensile strength variations which, at least to a great extent, must be ascribed to experimental errors, mostly fall under the head, " errors of the testing machine " (the smoothness of running decreases as the axles and ball bearings become slightly worn etc.). These errors make it difficult to compare figures over a long range of years, but are without importance for the purpose of this discussion, as the difference between crêpe and smoked sheet in each year, and the average of these differences over a period of six years, are independent of these errors.

Incidentally it may be pointed out that the figures for standard time of cure show a gradual decrease from about 119 to about 107 minutes. This is principally caused by the fact that estates have gradually abandoned the old practice of diluting the latex to 15% rubber content for crêpe preparation and have changed over to a standard dilution of of 20 or 25%.

The figures for slope and viscosity are added for the sake of completeness, but are not of interest for the present purpose and will not be discussed here.

In the same way the average figures for smoked sheet were :—

TABLE II.

Smoked sheet from estates.

Year	Number of samples.	Tensile strength.	Standard time of cure	Slope	Viscosity.
1917	295	1·405	99 ± 9·8	37·2	35·1
1918	193	1·377	95 ± 10·2	36·5	31·5
1919	334	1·370	95 ± 10·4	36·4	28·3
1920	234	1·408	93 ± 11·9	35·6	32·1
1921	272	1·436	96·9 ± 13·6	35·7	35·8
1922	319	1·415	108·7 ± 11·8	37·3	33·4
	1647	1·407	97·7	36·4	32·6

For tensile strength the same remarks hold as for crêpe. The rate of cure of smoked sheet shows an increase in the last few years, and more and more approaches that of thin pale crêpe. The principal causes are : more soaking in water to decrease the liability to mouldiness, and quicker drying in better-equipped smoke houses.

The six years' averages indicate for smoked sheet a slightly higher tensile strength (1·407 as compared with 1·403, therefore only a difference of 0·004 kg. per sq. mm.) combined with a 12·8 minutes' shorter cure. The conclusion that the tensile strength for both types of rubber is the same, independent of rate of cure, would, however, be incorrect. The samples originate from different estates and therefore from different lots of latex ; and the result may be influenced by factors such as the fact that in later years the younger estates have for the greater part started preparation in the form of smoked sheet. The samples of smoked sheet, therefore, may contain more rubber from relatively young trees, res[illegible] slightly lower tensile strength and quicker c[illegible]

Though, therefore, the large number of s[illegible]s reduces the errors of determination to a minimum, the nature of the samples renders the above figures unsuitable for strict theoretical conclusions.

Crêpe and sheet from the same latex.—To find the real difference it is necessary to compare samples of crêpe and sheet prepared from the same latex. Different experiments made in the course of years gave :—

TABLE III.

Experiment.	Crêpe Tensile strength	Crêpe Time of cure.	Sheet. Tensile strength.	Sheet. Time of cure.	Difference in tensile strength per 10 minutes
I.	1·42	96	1·43	88	0·013
II.	1·39	121	1·43	90	0·013
III.–VI.	1·36	106	1·378	80	0·007
VII	1·38	98·8	1·418	77·2	0·017
VIII	$1{\cdot}40^{5}$	115	$1{\cdot}42^{5}$	83^{5}	0·006
IX	1·42	105	1·47	83	0·023
	1·396	$106{\cdot}0^{5}$	1·425	83·6	0·013

Experiments III.–VI. relate to crêpe and unsmoked sheet prepared in the laboratory, the others to crêpe and smoked sheet prepared on estates.

It will be seen that the tensile strength for smoked sheet is always higher than for crêpe. The figures in the last column differ rather widely for the different experiments, the number of determinations in each case having been relatively small. The average difference (0·013 kg. per sq. mm.) coincides with the average obtained in the experiments to be discussed later.

Special experiments.—The foregoing experiments confirm the conclusion that the quicker curing sheet rubber shows a somewhat higher tensile strength than the slower curing crêpe. They allow of *no* conclusion as to the cause of this difference, which might be due to treatment of the rubber (crêpeing against sheeting), to the form of the rubber (larger relative surface of crêpe), or to longer heating during vulcanisation because of the difference in time of cure.

To decide this point special experiments were made, a series of crêpes and sheets (unsmoked) being prepared from the same latex in such a way that for each type different times of cure were obtained. Crêpes with a shorter time of cure than usual were obtained by keeping the coagulum for 24, 48, or 72 hours before crêpeing, so that a beginning of maturation set in : sheets with a longer time of cure than usual were obtained by soaking for 2 or 5 hours in water after milling, so that part of the serum substances was removed. It is, of course, extremely improbable that such simple operations as keeping the unmilled coagulum, or soaking the freshly rolled sheets in water, affect the rubber and alter its tensile strength.

A first series of four experiments gave the figures in Table IV., where the " quick curing " and the

'slow curing" samples of each type are taken ogether.

TABLE IV.

Averages from series 1697, 1710, 1735, *and* 1746.

Description.	Number of samples.	Tensile strength.	Time of cure.	Slope.	Viscosity.
Crêpe, quick curing	6	1·467	86·7	36·0	36·5
Sheet, ,, ,,	8	1·433	83·7^{5}	36·9	39·2
Crêpe, slow ,,	7	1·404	112	37·3	34·0
Sheet, ,, ,,	5	1·44	111	37·1^{5}	34·4

In the quick-curing group the tensile strength of he crêpes is higher, and in the slow-curing group the sheets show a better tensile strength. The figures are plotted in the accompanying figure and will be discussed later.

In a second series of experiments two coagula were prepared for crêpe and one for sheet on five consecutive days; one of the coagula for crêpe preparation was milled on the day after coagulation, and the other was taken from the serum and left on a board to mature for three days. The coagulum for sheet preparation was milled a few hours after coagulation. From each series the figures were taken either of one crêpe showing about the same time of cure as the sheet, or of the two crêpes, so that their average time of cure nearly corresponded with that of the sheet.

The result was :—

TABLE V.

Averages from five experiments (*Series Nos.* 1762 *and* 1779).

Description.	Tensile strength.	Time of cure.	Slope.	Viscosity.
Crêpe	1·43	81	36·8^{5}	38·5
Sheet	1·44	82^{5}	37·7	39·7

The average time of cure and the average tensile strength are very nearly the same, but the slightly quicker curing crêpe shows a slightly lower, and not a slightly higher tensile strength.

A third and more extensive experiment was therefore made in the same manner as the first one, one series being prepared from undiluted latex and one from 15% of latex, and each repeated four times.

The figures are given in Table VI. :—

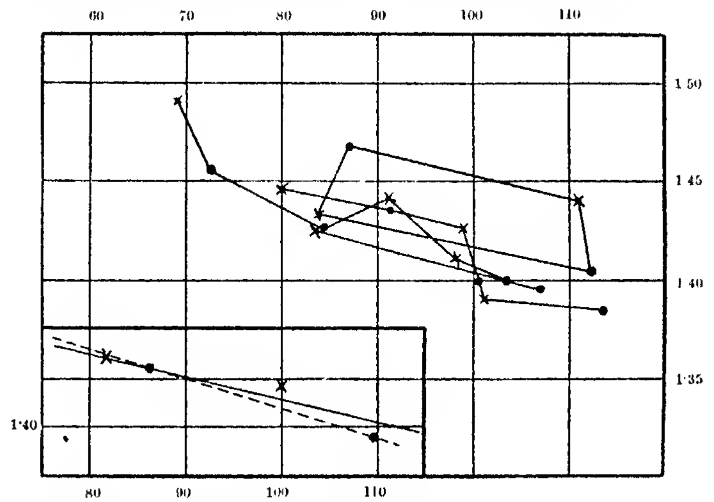
TABLE VI.

Averages from series 2279, 2299, 2285, *and* 2304.

Description.	Undiluted latex: Tensile strength.	Time of cure.	Slope.	Viscosity.	15% latex: Tensile strength.	Time of cure.	Slope.	Viscosity.
Crêpe, rolled same day	1·40	103^{5}	37·2	23·9	1·38^{5}	113^{5}	37·7	25·4
,, ,, next day	1·42^{5}	84^{5}	36·7	27·2	1·40	100^{5}	38·0	23·6
,, ,, after 3 days	1·47^{5}	72^{5}	37·1	29·7	1·43^{5}	91^{5}	37·1	26·6
Sheet, rolled next day	1·49	69	37·8	28·6	1·44^{5}	80	36·9	31·0
,, soaked 1 hour in water	1·44	91	36·4	25·3	1·39	101	38·3	26·3
,, soaked 5 hours in water	1·41	98	36·5	24·3	1·42^{5}	99	38·3	25·7

The figures for tensile strength and time of cure are plotted in the figure; though they do not lie on a straight line, it will be seen that there is no question of the crosses (sheets) always lying higher than the points (crêpe).

Summarising the results from Tables III.—VI., the average crêpes below and above 100 minutes and of sheets below and above 90 minutes furnish the following figures :—



Tensile strength at standard state of cure, plotted against standard time of cure (see Tables III., IV., and VI.). Inset, average figures (see Table VII.).

FIG. 1.

TABLE VII.

Description.	Number of cases.	Tensile strength.	Time of cure.
Crêpe, below 100 minutes	7	1·430^{5}	85·9
Crêpe, above 100 minutes	8	1·395^{5}	109·6
Sheet, below 90 minutes	10	1·431^{5}	81·7
Sheet, above 90 minutes	5	1·421	100·0

These figures are reproduced in the figure (inset); three points lie on a straight line (dotted line) with a slope of 0·014, the fourth lies slightly higher. The slope for the average line (straight line) is 0·012 kg. per sq. mm. for 10 minutes.

The conclusions therefore are :—

(1) The figures for tensile strength are affected by the duration of the cure ; in the testing method employed, an increase of 10 minutes in time of cure causes a decrease of about 0·012—0·014 kg. per sq. mm. in tensile strength.

(2) Sheet and crêpe, prepared from the same latex, have the same tensile strength when the above correction for difference in time of cure is taken into account.

With the aid of the above some special cases will now be discussed.

Rubber from young trees.

Young trees, not yet large enough to be taken into the tapping round, give a rather quick curing rubber with a low tensile strength, a low viscosity, and a high figure for slope, therefore of decidedly inferior quality. In different experiments sheet and crêpe from young trees have been compared and the following results found :—

TABLE VIII.

Experiment.	Crêpe. Tensile strength.	Crêpe. Time of cure.	Smoked sheet. Tensile strength.	Smoked sheet. Time of cure.	Difference in tensile strength per 10 minutes.
X.	1·23	77	1·27	59	0·018
XI.	1·29	82	1·34	58	0·021
XII.	1·38	97	1·45	64	0·021
XIII.	1·22	53	1·29	44	0·08
XIV.	1·26	77	1·32*	58	0·04
XV.	1·37	96	1·44*	68	0·021

The first three (X.—XII.) relate to one group of trees at the age of 3, 4½, and 7½ years. The difference in tensile strength between crêpe and smoked sheet for 10 minutes' difference in time of cure is, on the average, 0·020 kg. per sq. mm., therefore somewhat higher than the general average mentioned above. Plotting the points in the above figure, the first two experiments give lines with about the same slope as the others, but lying much lower on the paper, which shows that the tensile strength of this type of rubber is really inferior.

The last two experiments (XIV. and XV.) also relate to one group of trees at the age of 4½ and 8 years ; these experiments give a rather high figure for "difference," but the inferiority of tensile strength at the age of 4 years is again evident.

Experiment XIII. gives the highest figure, viz. 0·08 for the "difference," but this rubber was very quick curing : in this case a difference of 10 minutes is about 20% of the time of cure, instead of 10% as with ordinary rubber, and the correction-factor for quick-curing rubber would have to be determined separately.

Matured rubber.

It is well known that matured rubber vulcanises quickly and gives a slightly higher figure for tensile strength. It was necessary to ascertain what remains of this excess tensile strength when the correction for time of cure is taken into account. Table IX. summarises the results :—

TABLE IX.

Experiments.	Matured rubber Tensile strength.	Matured rubber Time of cure.	Ordinary crêpe. Tensile strength.	Ordinary crêpe. Time of cure	Difference for 10 minutes.
XVI.	1·37	91	1·36	139	0·002
XVII.	1·44	75	1·40	127	0·008
XVIII.	1·41	50	1·37	116	0·006
XIX.	1·41	75	1·37	116	0·01
XX.	1·474	28·2	1·443	106·9	0·004
XXI.	1·49*	40·3	1·40	113¼	0·013

Of these figures only those in experiments XVI. and XVII. relate to ordinary crêpe and crêpe from matured rubber, prepared from the same latex. Experiment XXI. comes very near to this condition, as it relates to slab rubber prepared on an estate over a period of five months, and to crêpe prepared on the same estate on other days or from another part of the latex. In the other experiments the average figures for ordinary crêpe for the same year have been used for the comparison.

It will be seen that the excess tensile strength of matured rubber is in two cases (exp. XIX. and XXI.) about equal to what might be expected ; in the other cases it is smaller than that calculated from the difference in time of cure, using the average figure of 0·012 kg. per 10 minutes. Of course, the correction figure for small times of cure such as 28 or 50 minutes may perhaps differ from the average correction factor found for times cure of from 70 to 110 minutes ; but if any conclusion is allowable from the above table it would be that the tensile strength of matured rubber, corrected for time of cure, is lower and decidedly not higher than that of ordinary rubber. To claim a superior quality for matured rubber from the tensile figures is, to say the least, premature.

Coagulation with alum and sulphuric acid.

Coagulants such as alum and sulphuric acid, when used in rather large amounts, produce a slow-curing rubber with a lower tensile strength than usual. As examples the following may be mentioned* :—

TABLE X.

Coagulant used.	Tensile strength.	Time of cure.	Ordinary crêpe. Tensile strength.	Ordinary crêpe. Time of cure.	Difference for 10 minutes.
Alum	1·33	210	1·42	85	0·008
	1·43	150	1·46	115	0·008
	1·43	202	1·48	115	0·003
	1·32	220	1,46	115	0·013
	1·30	101	1·42	110	0·004
Sulphuric acid	1·33	135	1·38	107	0·018
	1·39	106	1·42	92	0·021
	1·38	115	1·42	98	0·024
	1·27	116	1·36	98	0·05
	1·10	220	1·45	82	0·025
Hydrochloric acid	1·28	180	1·45	82	0·017
Crater water	0·98	208	1·35	115	0·04
	1·12	150	1·35	115	0·07
	1·0	235	1·35	115	0·08
	1·37	107	1·40	118	0·006

It will be seen that in the case of alum the decrease in tensile strength is less than might be expected from the increase in time of cure. The supposed deterioration of the rubber by alum is therefore not confirmed by these results ; it is hoped shortly to publish other proofs that alum leaves the real quality of the rubber unharmed, although it gives the rubber an abnormally low rate of cure.

Hydrochloric acid also, when used in excess, seems (from the one experiment mentioned above) to cause no decided deterioration ; as a coagulant, however, this acid is quite unsuitable (as is well known) as it causes the rubber to become tacky.

Sulphuric acid, used in large excess (a[illegible] or so[illegible] experiments mentioned in Table X.), caus[illegible] the [illegible] a deterioration, the decrease in tensile str[illegible]ength in all cases larger than calculated from [illegible]ents [illegible] the [illegible]ck curi[illegible]

* See Arch. v. d. Rubbercultuur, 1920, 4, 210.

correction-factor of 0·012. The influence of crater water (containing alum, sulphuric and hydrochloric acids) is still more deleterious.

Results obtained by other investigators.

The difference in tensile strength caused by a difference in time of cure may be found also in the results of other investigators, but the correction factor seems to be dependent upon the method of testing.

As average figures B. J. Eaton and co-workers† mention :—

Description.	Tensile strength.	Time of cure.	Difference for 10 minutes.
Slab rubber	1·51	75	0·006
Smoked sheet	1·46	165	0·053
Crêpe	1·30	195	

For the rather long cures necessary in this testing method (10% sulphur, 140°) the difference in tensile strength for 10 minutes between smoked sheet and crêpe seems to be much larger than in the present case, viz., 0·053 insread of 0·012; the figure would even be twice as large if 10% of the time of cure were taken instead of 10 minutes, which is in this case only 5% of the time of cure. The excess tensile strength of slab rubber is, as in the present case, smaller than that calculated from the difference between smoked sheet and crêpe.

Special cases.

In the course of years several complaints have been received from manufacturers about inferiority in tensile strength of rubber from estates which were known as good ones. In two cases samples were obtained from the rejected lots; the results obtained in testing these were compared with the figures obtained in the regular testing of samples from the estate in question, and gave the following :—

TABLE XI.

Case.	Description.	Tensile strength.	Time of cure.	Slope.	Viscosity.
I.	Rejected lot	1·40*	72	37½	35
	Ordinary figures	1·45	105	37	34
	,, ,,	1·43	95	38	44
II.	Rejected lot	1·30	120	35½	29
	Ordinary figures	1·42	>95	37	35
	,, ,,	1·45	115	36½	34

In the first case the sample (unsmoked sheet), which was sent to us by the manufacturer, got wet in transport and evidently matured to some extent; nevertheless the figure for tensile strength in our testing is quite good. In the second case (smoked sheet) the figure for tensile strength is also quite good, considering that the "rejected" rubber was more than a year old when tested. An explanation of the low figures found by the manufacturer's chemists could not be given; probably some of the many sources of error which make tensile strength determinations so tedious have been at play.

The above and similar cases raise the question as to the influence of the sea voyage on the properties of rubber. A deterioration—mostly called oxidation—of crêpe rubber on keeping is postulated by many authors. The present author has shown‡ that, when kept in the tropics, first quality plantation rubber does not show a deterioration or decrease in tensile strength even in the course of 3—4 years; the following figures show that crêpe rubber, during a voyage to Europe or America and back to the East, does not deteriorate to any marked degree. The samples were used for comparative testing experiments and were sent to different investigators, who, after making their tests on part of the sample, sent back the rest for a control test. The figures obtained on the part of the samples kept at Buitenzorg and on the parts sent to Europe or America and back are given in Table XII. :—

TABLE XII.

Experiment.	Description.	Tested.	Tensile strength	Time of cure.	Slope.	Viscosity.
XXII.	Original sample	Dec., 1916	1·45	130	36	43
	Same, kept in C.R.S.	March, 1917	1·42	135	36	—
	Same, to England and back	June, 1917	1·34	125	35½	44
	Same, kept in C.R.S.	June, 1917	1·37	125	35½	46
	Same, kept in C.R.S.	Nov., 1917	1·38	130		—
XXIII.	Original sample	June, 1920	1·30	115	37	20½
	To England and back	July, 1620	1·52	115	36½	22
	To America and back	July, 1920	1·31	120	36½	21
	Kept in C.R.S.	July, 1920	1·44*	115	36½	19½

In the first case the sample sent to England and back showed a slight decrease in tensile strength, compared with the sample kept at Buitenzorg, and this difference occurred regularly in all the comparative tests made in June, 1917 (of which the average figures only are mentioned in Table XII.). The sea voyage therefore seems to have had a decided, though small, deteriorating effect on the tensile strength; the other properties remained unchanged.

In the second case (experiment XXIII.) the results do not agree so well. The sample sent to America showed a low figure for tensile strength after its return, but the part that had travelled to England gave a very high figure; the average of these two figures of 1·41 is exactly the same as the average of the two figures for the part kept at Buitenzorg. It may be assumed that the high and low figures for tensile strength must be ascribed to experimental errors, especially so as the viscosity remained practically unchanged; it is evident that the figures do not point to a decided decrease in tensile strength or in the other properties caused by the sea voyage.

CONCLUSIONS.

The figures for tensile strength are influenced by the length of time that the rubber is heated during vulcanisation. An increase in time of cure of 10 minutes (about 10%) gave a decrease in tensile strength of about 0·012—0·014 kg. per sq. mm. (about 1%).

Taking into account this correction, the tensile strength for (quicker curing) sheet and (slower curing) crêpe from the same latex is found to be the same, so that there is no real superiority of smoked sheet over first quality crêpe in this respect.

Slab rubber (quick-curing matured rubber), after applying this correction, does not show a higher tensile strength than sheet or crêpe, and there is no reason to call it superior in this respect.

† Bull. No. 27, Dept. of Agric. F.M.S.
‡ Arch. v. d. Rubbercultuur, 1921, 5, 140.

Rubber coagulated with alum, despite its very long time of cure, does not show a deterioration in (corrected) tensile strength, and this property is not affected by the use of alum as a coagulant. Sulphuric acid, used in excess, seems to cause a larger decrease in tensile strength than corresponds with the increased time of cure.

Special experiments did not point with certainty to a deteriorating influence of the sea voyage on the tensile strength of crêpe rubber.

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THEORY OF ABSORPTION TOWERS.—A CORRECTION.

BY J. R. PARTINGTON, D.SC., AND L. H. PARKER, D.SC.

An error in the second calculation in our paper, "The Theory of Absorption Towers for Nitric Acid Manufacture" (J., 1919, 75 T), has kindly been pointed out to us by Mr. J. W. McDavid, whose corrected calculation we give below.

In the calculation it was shown that 1·125 lb. of water per minute were necessary to produce 100% nitric acid from the given stream of NO_2. The weight of 100% acid produced $= \frac{63}{9} \times 1{\cdot}125 = 7{\cdot}875$ lb., and to convert this to 50% acid a further 7·875 lb. are required. Hence the total water per min. $= 7{\cdot}875 + 1{\cdot}125 = 9{\cdot}00$ lb.

The actual water of dilution of this acid is 7·875 lb. and the weight of the acid leaving the first tower is the whole of the acid produced. The latter is obtained by converting 90% of the total weight of NO_2 to 50% nitric acid as follows:—

$$\frac{63}{46} \times \frac{10}{5} \times \frac{9}{10} \times 500 \times 0{\cdot}0128 = 15{\cdot}78 \text{ lb.}$$

Similarly if x = weight of HNO_3 entering first tower, the water used up in producing this acid is $x/7$. The water of dilution is therefore $9 - x/7$, and since the ratio $HNO_3 : H_2O = 3 : 7$, we have:—

$$\frac{x}{9 - x/7} = \frac{3}{7}$$

or $x = 3{\cdot}64$ lb. and $9 - x/7 = 8{\cdot}50$. Hence the weight of acid entering the first tower is $3{\cdot}64 + 8{\cdot}50 = 12{\cdot}14$ lb. The absorption in the first tower is therefore $7{\cdot}89 - 3{\cdot}64 = 4{\cdot}25$ lb. $HNO_3 = 3{\cdot}1$ lb. NO_2 per min. The concentration of the gas leaving the first tower is thus 5·15%, and hence the volume of the first tower is 343 cub. ft., and the total volume of the remaining towers, 867 cub. ft.

Mr. McDavid has also given an alternative method of calculation in which the nitric acid solutions are regarded as made up of N_2O_5 and H_2O. A 50% HNO_3 solution, for example, contains 42·86% of N_2O_5 and a 30% solution, 25·714% of N_2O_5.

In the problem under consideration, the total water present in each case is 9 lb. In a 50% HNO_3 solution 9 lb. are equivalent to 57·14% of the total weight, and therefore the weight of N_2O_5

$$= \frac{42{\cdot}86}{57{\cdot}14} \times 9 \text{ lb.} = 6{\cdot}75 \text{ lb. of } N_2O_5 = 7{\cdot}88 \text{ lb. of } HNO_3 = 15{\cdot}76 \text{ lb. of } 50\%\ HNO_3.$$

In a 30% nitric acid solution 9 lb. of H_2O are equivalent to 74·286% of the weight, and therefore the weight of N_2O_5

$$= \frac{25{\cdot}714}{74{\cdot}286} \times 9 \text{ lb.} = 3{\cdot}12 \text{ lb. } N_2O_5 = 3{\cdot}64\ HNO_3 = 12{\cdot}13 \text{ lb. } 30\%\ HNO_3.$$

Hence the weight of N_2O_5 absorbed in the first tower $= (6{\cdot}75 - 3{\cdot}12) = 3{\cdot}63$ lb. of $N_2O_5 = 3{\cdot}1$ lb. of $NO_2 = 4{\cdot}24$ lb. of HNO_3.

The concentration of gas leaving the first tower is therefore

$$\frac{6{\cdot}4 - 3{\cdot}1}{6{\cdot}4} \times 10 = 5{\cdot}15\%\ NO_2.$$

$$\therefore \log. \frac{10}{5{\cdot}15} = \frac{42 \times V}{50{,}000}$$

i.e., $V = 343$ cub. ft.

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KINETICS OF HYDROGENATION.*

BY E. J. LUSH, M.A., A.I.C.

In a previous communication† the author described a new process of hydrogenation of oils in which use was made of nickel turnings activated by being anodically oxidised and afterwards reduced in hydrogen in a suitable vessel; oil was hydrogenated by allowing it to flow over the catalyst thus produced in an atmosphere of hydrogen.

Drip method—186°—201° C.

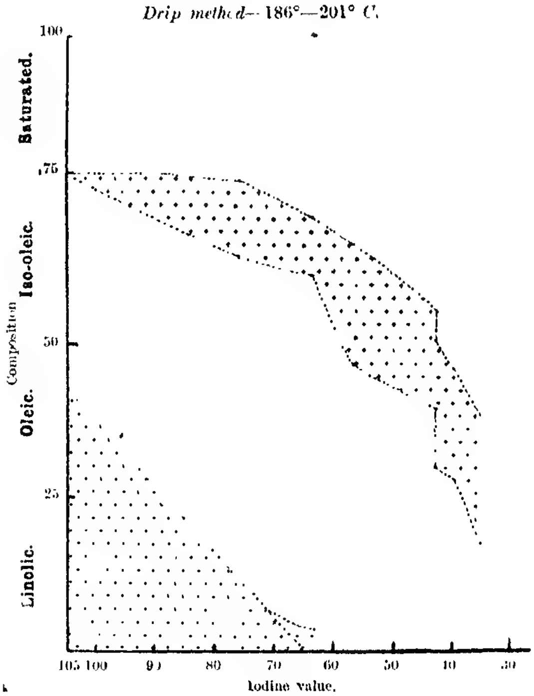

FIG. 1.

It was shown by graphs that the course of hydro-·nation, more particularly the formation of iso-leic acid, varied according to the mode of operation described respectively as the "drip" and "over-ow" methods. It was suggested that this difference ave support to the views of Moore‡ that the iso-leic acid resulted from the dehydrogenation of ewly-formed stearic acid.

The formation of iso-oleic acid has been further ivestigated, more especially with regard to the fect of temperature and pressure.

Figs. 1 and 2 show the effect of hydrogenation of otton oil at 190° and 150° C. respectively. At the higher temperature it will be seen that a greater amount of iso-oleic acid is formed, but that no increase in saturated acids occurs until the iodine value falls below 75. At 150° C. for the same drop in linolic acid there is less iso-oleic acid produced

Drip method · 150° C.

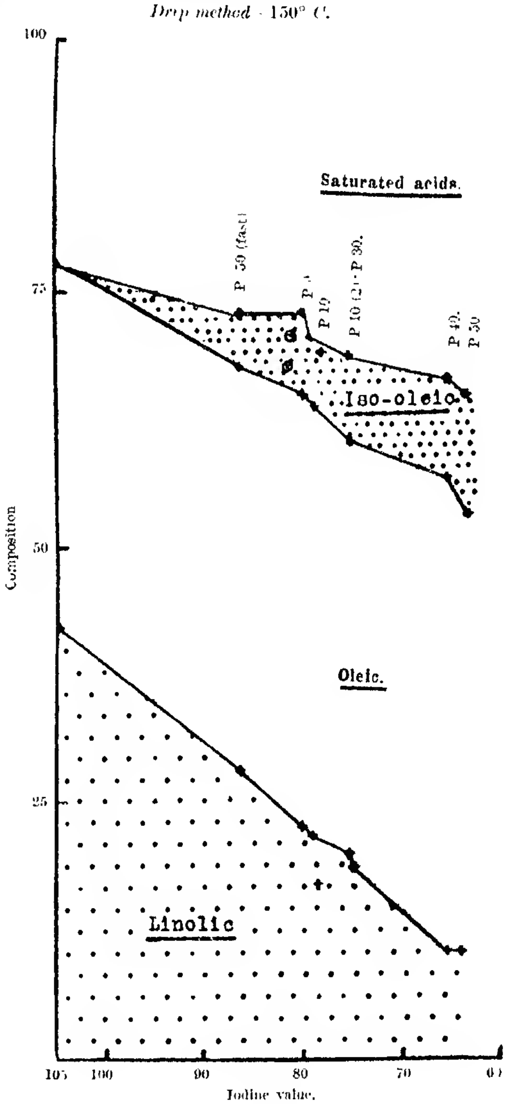

FIG. 2.

and a corresponding increase in saturated acids. At 110° C. the same effect is even more marked—as shown by * in Fig. 2, where the iso-oleic acid

* Read at a meeting of the Birmingham Section on Feb. 5, 1924.
† J., 1923, 219 T.
‡ J., 1919, 320 T.

content is reduced to 3% for an iodine value of 82. These results are consistent with the view that iso-oleic acid is a dehydrogenation product, and it is significant that lower temperatures should result in the relative increase of saturated acids and decrease of iso-oleic acid for the same percentage decrease in linolic acid.

The hydrogenation of pure linolic acid and its glycerides would probably give useful information as to the relation between selective hydrogenation and the formation of iso-oleic acid.

It will be seen from Fig. 2 that change of pressure between the narrow limits of 0 and 50 lb. per square inch has no appreciable influence on the nature or proportions of the products produced, the compositions lying on smooth curves. The same remarks apply to a change in the rate of flow of the oil through the plant between the rates of 12 and 26 lb. per hour.

It therefore seemed probable that it would be possible to measure the effect of pressure on the rate of hydrogenation by determining the hydrogen absorbed in a given time at various pressures.

The small plant in which this investigation was carried out (Fig 3) consisted of a pressure vessel, A, fitted with a graduated glass gauge, *g*, and connected to a hydrogen cylinder provided with a gas-regulating valve, by means of which any given pressure could

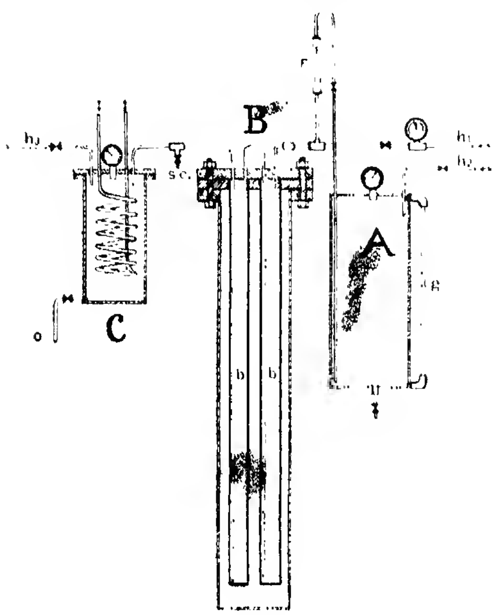

FIG. 3.

be maintained in the vessel. This pressure forced oil through a sight-feed, F, into the hydrogenation vessel, B. The hydrogenation vessel consisted of four tubes, *b*, 1⅜ in. diameter, each 3 ft. long, connected in series and fitting into a steam jacket connected to a small gas-fired steam superheater, C, by means of which any required temperature could be maintained in the tubes. The tubes were connected by a regulating valve to another hydrogen cylinder as shown.

By maintaining a constant pressure-difference between the two vessels, a constant flow of oil passed through the four tubes packed with catalyst; this flow was further regulated by a valve placed behind the sight-feed.

The hydrogen absorbed in any given time was measured by the iodine value of the oil collected in the receiver and run off from time to time by the small cock placed as shown on the return pipe to the pressure vessel. By a manipulation of pressures, the hydrogenated oil could, if necessary, be returned to the pressure vessel without coming in contact with the air.

It had previously been shown that when a constant flow of oil passed through the plant the product obtained had a constant iodine value over very long periods, and it was assumed from this that the factors influencing hydrogen absorption were under control.

When coconut oil, having an iodine value of 8, was passed through the plant at 10 lb. per hour the iodine value was reduced to 0·1, corresponding to 99·8% reduction; this was taken as evidence that all the oil had come into molecular contact with the nickel This may seem surprising. It has, however, been calculated that the average thickness of the oil film is less than 1 mm. and the distance travelled by each particle of oil not less than 3000 mm. under conditions promoting turbulence, thereby reducing oil diffusion effects to a minimum.

On the other hand, when cotton oil was passed through the plant, at the same rate as the coconut oil, the iodine value was not reduced below 25. Since it may be assumed that all the unsaturated oil came in contact with the metal surfaces, it was inferred that the nickel was unable to supply activated hydrogen fast enough to satisfy the requirements of the oil.

It was therefore of interest to study the effect of pressure on a system where hydrogen was rapidly supplied to the catalyst through a thin film of oil capable of removing the activated hydrogen as fast as it was formed.

To measure the effect of pressure, oil was passed through the plant at a constant rate at, say, 10 lb. pressure, for one hour, and the oil collected. The pressure was then raised by 10 lb. and the oil, after running to waste for the next ten minutes, was again collected for an hour at the increased pressure In this way the pressure was raised by 10 lb. at a time to 50 lb. By measuring the oil passed through in a given time and multiplying by the drop in iodine value, a measure of the hydrogen absorbed was obtained.

Table I. shows the result of the first run made to test the effect of pressure. In the last two columns are shown the numbers obtained by dividing the hydrogen absorbed at a given pressure, firstly, by that pressure, and, secondly, by its square root. It will be noticed that the numbers so obtained

decrease in each test where the first power of the pressure is used, but are fairly constant where the square root of the pressure is the denominator.

TABLE I.

Cotton oil hydrogenated at 180° C. at ascending pressures.

Pressure	Rate of flow of oil lb. per ½-hr.	Iodine Value	$\frac{H_2 \text{ abs}}{P}$	$\frac{H_2 \text{ abs}}{\sqrt{P}}$
10	7	66	1035	518
20	6.5	56.3	886	512
30	6.25	50.4	728	490
40	6.25	42.6	686	510
50	6.4	35.1	670	538

Average value of x in P^x 0.52.

By calculation it can be shown that x in $P^x = 0{\cdot}52$ will give the nearest constant. This is obtained from the equation:—

$$x = \log \frac{H_2 \text{ absorbed at } P_1}{H_2 \text{ absorbed at } P_2} \div \log \frac{P_1}{P_2}$$

The assumption involved in this calculation, viz., that the rate of hydrogenation is a linear function of time, will be referred to later.

TABLE II.

Cotton oil hydrogenated at 180° C. at descending pressure.

Pressure	Rate of flow of oil, lb. per ½ hr.	Iodine value	$\frac{H_2 \text{ abs}}{P}$	$\frac{H_2 \text{ abs}}{\sqrt{P}}$
60	6	39.3	500	429
50	6	42.4	559	453
40	6.25	51.6	550	407
30	6	60.0	573	386
20	5.5	65.4	590	350
10	5.5	72.1	677	339
6	6	76.0	1080	117

Average value of x in P^x 0.68.

Table II. shows the results obtained by lowering the pressure by 10 lb. per hour instead of raising it. By this means the effect of any change in catalytic activity can be measured, since in the one case it will tend to decrease the apparent effect of pressure and in the other will tend to increase it. It will be seen that a slightly higher value is actually obtained; this question of change in catalytic activity was, therefore, further investigated.

TABLE III.

Cotton oil hydrogenated at 150° C.

Pressure	Rate of flow of oil, lb. per ½-hr.	Iodine Value	$\frac{H_2 \text{ abs}}{P}$	$\frac{H_2 \text{ abs}}{\sqrt{P}}$
6	7	80.0	768	351
10	5.75	78.7	558	279
20	6.35	77.	176	281
30	6.5	74.8	407	277
40	6.25	65.5	425	317
50	6.8	65.8	397	322
50	13.4	81.3	379	308
10(2)	5.5	75.3	609	305

Average value of x in P^x 0.68.

For the experiment recorded in Table III. ascending pressures were used, as in the test detailed in Table I., and, after reaching a pressure of 50 lb., the rate of flow of oil was doubled both to measure its effect and also to have approximately the same iodine value as would be obtained later when the pressure was lowered.

It will be seen that:—

(a) the average value for x is in agreement with that obtained in the last experiment;

(b) doubling the rate of flow of oil has not altered the amount of hydrogen absorbed;

(c) there has been no loss in catalytic activity within the rather wide limits of experimental error.

It will be noted that the temperature of this experiment was 150° C. as against 180° to 190° C. for the two others.

TABLE IV.

Palm kernel oil hydrogenated at 180° C. with fresh catalyst.

Pressure	Rate of flow of oil lb. per hour	Iodine value	$\frac{H_2 \text{ abs}}{P}$	$\frac{H_2 \text{ abs}}{\sqrt{P}}$
50	6	0.7	131	106
40	6	0.2	160	118
30	6.3	1.4	198	135
20	6	3.5	196	114
10	6	4.2	254	128
50	6	1.8	121	98
50	12.4	7.5	138	115

Average value of x in P^x 0.11.

Table IV. shows the effect of pressure on the hydrogenation of palm-kernel oil down to low iodine values; as would be expected, a low value is obtained for x.

TABLE V.

Coconut oil hydrogenated at 180° C.

Pressure	Rate of flow of oil lb. per hour	Iodine value	$\frac{H_2 \text{ abs}}{P}$	$\frac{H_2 \text{ abs}}{\sqrt{P}}$
50	6	0.7	131	106
40	6	0.2	160	118
30	6.4	1.4	198	120
20	6	3.5	196	111
10	6	4.2	241	128
50	6	1.8	121	98.4
50	12.4	7.5	138	115

Average value of x in P^x 0.2.

Table V. The value for x obtained by the use of coconut oil, which has an initial iodine value of only 8, shows how the effect of pressure is overshadowed by "mass-action" effects, and indicates moreover that every particle of the oil comes in contact with nickel at some stage in its progress through the plant.

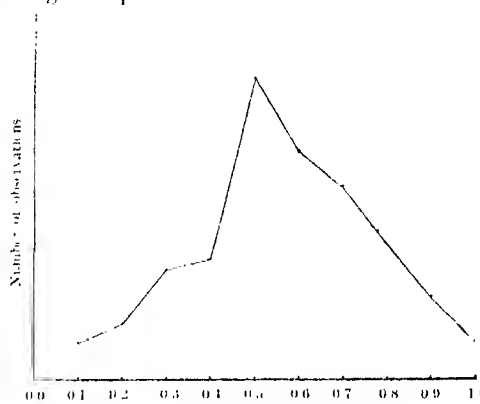

FIG. 4.

Fig. 4 shows a graphic representation of the results of numerous experiments to determine the value of x in P^x.

As one of the main objects of this investigation was to measure the influence of rate of flow of oil and pressure on the iodine value of the resulting product, experiments were undertaken in which

these two factors were varied simultaneously so as to maintain a constant iodine value.

TABLE VI.

Rate of flow calculated to x in P^x = 1 on cotton oil. Temp. 180° C.

Pressure	Rate of flow of oil lb. per hour	Iodine value	$\frac{H_2\ abs.}{P}$	$\frac{H_2\ abs.}{\sqrt{P}}$
10	5	41.3	1229	611
20	7	51.6	1015	603
30	9	56.2	924	616
40	11	57.8	894	664
50	13	59.3	862	691
10	5	46.6	1115	558
20	7	56.1	926	550

Average value of x in P^x 0.60

Table VI. shows the effect of making the rate of flow of oil proportional to the pressure. It will be seen that the iodine value of the resulting product rises with increase of pressure, as was to be anticipated from previous experiments.

TABLE VII.

Rate of flow calculated to x in P^x 0.5 on cotton oil. Temp. 180° C.

Pressure	Rate of flow of oil lb. per hour	Iodine value	$\frac{H_2\ abs.}{P}$	$\frac{H_2\ abs.}{\sqrt{P}}$
10	5	56.8	1010	480
20	5.8	50.6	911	537
30	6.6	55.0	735	480
40	7.4	57.7	615	452
50	8.4	52.3	668	503
10	5	51.2	1135	500

Average value of x in P^x 0.48.

Table VII. shows the effect of making the rate of flow of the oil proportional to the square root of the pressure. The results, while varying among themselves, show no tendency to vary with the pressure.

TABLE VIII.

Rate of flow calculated to x in P^x = 0.5 on ground-nut oil. Temp. 180° C.

Pressure	Rate of flow of oil lb. per hour.	Iodine value	$\frac{H_2\ abs.}{P}$	$\frac{H_2\ abs.}{\sqrt{P}}$
10	9	56.1	1225	614
20	10.6	57.2	1000	502
30	12	60.1	804	540
40	13.3	58.8	780	564
50	14.4	64.8	561	458
10	9	61.7	1026	514

Average value of x in P^x 0.4.

Table VIII. shows a repetition of the previous experiment with ground-nut oil; here again the effect of pressure is not marked.

It would, therefore, appear that in this method of hydrogenation for industrial purposes it can be assumed that the output of hydrogenated oil of a given iodine value will be proportional to the square root of the pressure.

A similar series of experiments has been undertaken to measure the effect of varying the rate of flow of oil between 5 lb. and 30 lb. per hour on the rate of hydrogen absorption. In general it has been found that between these limits the amount of hydrogen absorbed is independent of the rate of flow of oil and, therefore, of the iodine value of the oil, provided the iodine value does not fall below about 30 or the rate below 5 lb. per hour. This would indicate that the rate of hydrogen absorption is a linear function of time between those limits. This is in agreement with the experiments of other workers, though not necessarily for the same reason, and details of the experiment are, therefore, not of particular interest.

It is not surprising that dissimilar results should have been obtained by the use of a method in which the relationship between the nickel, hydrogen, and oil is varied in a different manner from that usually obtaining with powder catalysts.

The process of hydrogenation of oil may be divided into three stages.

The first stage consists in the solution of hydrogen in the oil and its diffusion to the surface of the catalyst; it is probable that this is in general the limiting factor in reaction velocity where powder catalysts in small percentages are employed.* In such a case the reaction velocity would be linear and proportional to the pressure.

The second stage consists in the condensation of the hydrogen on to the nickel and its appearance at the surface, or, possibly, evaporation from the surface, in an activated form. If the latter condition is the limiting factor and the activation consists in the production of atomic hydrogen, then the reaction velocity will be proportional to the square root of the hydrogen pressure and will probably be linear.

The third stage consists in the combination of the activated hydrogen with the ethylene linkages of the unsaturated oil, and if it were possible to measure this factor alone the reaction velocity would probably be independent of the pressure and represented by a curve of a modified logarithmic type.

It is the object of this communication to show that there is some evidence for the second stage of hydrogenation having been realised in practice.

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*The relatively small amounts of tristearin formed in the partial hydrogenation of triolein may be considered as chemical evidence of this.

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THE VAPOUR PRESSURES OF FUMING SULPHURIC ACID, AND THEIR APPLICATION TO THE PROBLEM OF THE ABSORPTION OF SULPHUR TRIOXIDE.

BY J. W. MCDAVID, D.SC., F.I.C., M.I.CHEM.E.

In the manufacture of fuming sulphuric acid by the contact process, the sulphur trioxide produced in the converter, after being cooled to some extent, is usually absorbed in a series of bubbling vessels containing sulphuric acid, or in towers in which sulphuric acid is circulated. In these absorbers the acid and gas generally travel countercurrent, that is, the gas richest in sulphur trioxide meets the strongest acid in the first vessel and then passes to the second absorber where it is brought into contact with a slightly weaker acid. This process is repeated throughout the whole series of absorption vessels, until finally the gas leaving the last absorber is practically free from sulphur trioxide.

It is well known that in order to remove the last traces of sulphur trioxide the acid in the last absorber should contain about 98·5% H_2SO_4. If stronger acid than this be used sulphur trioxide is not absorbed owing to the fact that the acid has a vapour pressure of sulphur trioxide. If, on the other hand, the acid in the last absorption vessel contains less than about 98·5% H_2SO_4, sulphuric acid mist is formed which is very difficult to absorb. In practice satisfactory results are obtained if the acid in the last vessel is kept about 97%–99% H_2SO_4. As a rule it is necessary to operate the absorption plant in such a way that the strength of the oleum delivered from it remains more or less constant, and while in the past it has been possible to achieve both these objects, they have very often been attained rather by good fortune than by a scientific study of the problem.

It occurred to the author that it was possible, by assuming a theoretically perfect absorption system, to determine exactly the conditions governing the production of oleum of any given strength, and that the results so obtained would be applicable, with a sufficient degree of accuracy, to most of the absorption systems employed in modern oleum plants.

The object of the present paper is to describe the method of calculation employed, to show how the conditions may be varied to meet any particular case, and to indicate how closely actual practice approximates to theory.

The method does not give any information regarding the size of absorption vessels required for any given output, but it may form a convenient starting point for experiments on this problem.

In attacking this problem of absorption it was obvious at the outset that a knowledge of the vapour pressures of oleum at different concentrations and temperatures was necessary, and as the results obtained by extrapolation from the figures given by Knietsch* were unsatisfactory, vapour pressure measurements were made over the range of temperatures and concentrations required. For this purpose a dynamic method was employed in which the conditions were similar to those which usually obtain in plant absorption systems.

A mixture of purified burner gas and air was dried by means of concentrated sulphuric acid and passed over a catalyst, so that practically 98% of the sulphur dioxide was converted into trioxide. The gas was then passed directly into a small bubbler containing sulphuric acid or oleum. The bubbler was placed in a thermostat, the temperature of which was kept constant to within about 1° C. The concentration of sulphur dioxide in the mixture was maintained as constant as possible by the aid of gas flow meters, the composition of the mixture being checked frequently by means of the Reich test. From the percentage of sulphur dioxide in the gas entering the catalyst tube and the percentage conversion, the concentration of sulphur trioxide in the gas entering the bubbler was determined. Samples of the acid used to absorb the sulphur trioxide were drawn from time to time and analysed until the composition was found to be constant, showing that equilibrium had been attained. The results of these determinations are given in Table I., while they are shown graphically in a more convenient form by means of the smoothed curves in the accompanying figure.

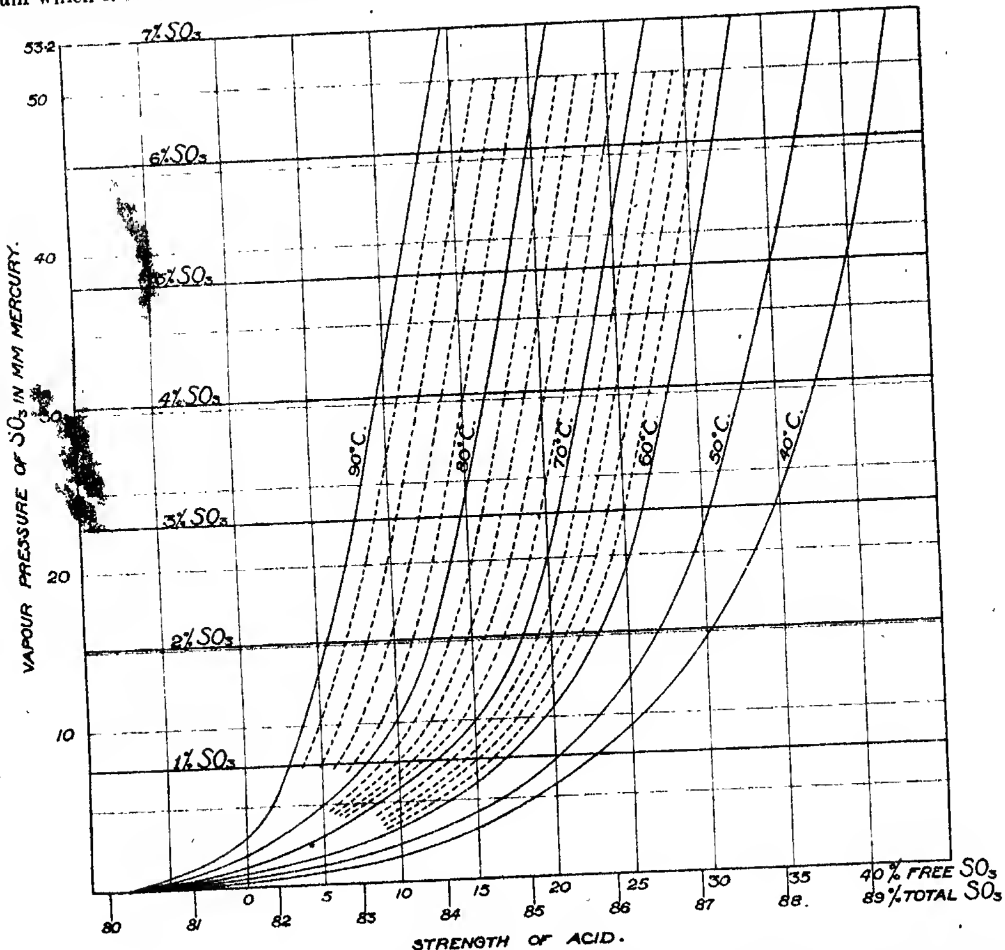
TABLE I.

Vapour pressures of oleum.

Concn. of SO_3 in gas entering absorber. % by vol.	Equivalent partial press. in mm. Hg.	Temperature of acid in absorber, °C.	Acid in absorber at equilibrium with gas. % H_2SO_4	% free SO_3
6·84	51·9	40	109·58	42·56
6·73	51·2	50	108·43	37·12
6·65	50·5	60	107·44	32·93
6·70	50·0	70	106·44	28·50
0·63	50·4	80	104·54	20·40
6·73	51·2	90	103·10	14·00
5·12	38·0	40	108·89	39·60
5·14	39·1	50	107·97	35·30
5·06	38·5	60	106·08	31·00
5·20	30·5	70	105·50	24·48
4·96	37·7	80	103·68	16·81
4·92	37·4	00	102·10	10·40
2·90	22·0	40	107·62	34·89
3·11	23·0	50	106·80	30·26
3·17	24·1	60	105·92	26·29
3·10	23·6	70	104·72	21·13
3·14	23·9	80	103·03	13·49
3·08	23·4	90	101·65	7·96
1·50	11·4	40	106·20	27·81
1·43	10·9	50	105·38	24·00
1·70	12·9	60	104·76	21·17
1·58	11·5	70	103·80	16·60
1·53	11·4	80	102·50	11·20
1·50	11·4	90	101·00	4·50
0·80	6·1	40	104·65	20·64
0·72	5·5	50	103·75	16·65
0·72	5·5	60	103·36	14·89
0·70	5·3	70	102·05	9·08
0·65	4·9	80	101·10	4·96
0·75	5·7	90	100·50	2·22

* Ber., 1901, 34, 4111.

It will be observed that on the figure, in addition to the vapour pressure curves, a number of horizontal lines have been drawn, denoting the percentage concentration by volume of sulphur trioxide corresponding to the pressures in mm. of mercury. By the aid of these horizontal lines it is possible to determine immediately the maximum strength of oleum which it is theoretically possible to produce from any gas at any temperature within the range given.



For example, to determine the maximum strength of oleum which can be produced from a gas containing 3% SO_3 at a temperature of 50° C., find the strength of oleum corresponding to the point where the 3% SO_3 line cuts the 50° C. isothermal. This point corresponds to 30·5% free SO_3, which is therefore the maximum strength of acid which can be produced under those conditions.

In order to apply these vapour pressure data to the solution of general problems of sulphur trioxide absorption, it is necessary to make two assumptions, based on the original assumption of a theoretically perfect absorption system. In the first place it is assumed that the concentration of the acid is constant throughout the whole absorber, whether the latter be of the bubbler or tower type, and further that this concentration is the same as that of the acid leaving the absorber. In a well designed apparatus this is practically true, especially in the bubbler type, while in towers it is almost equally true provided that the rate of circulation of acid is great compared with the rate at which the acid is forwarded from one tower to the next.

Secondly, it is assumed that the gas leaving each absorption vessel is in equilibrium with the acid contained in that vessel, that is, that the partial pressure of the sulphur trioxide in the gas leaving the absorber is equal to the vapour pressure of the oleum in the absorber. Here again, if the absorption apparatus is well designed and is not overloaded this assumption will be approximately correct.

The course of absorption is then found to depend on: (1) The total weight of sulphur trioxide entering the system in a given time; (2) the concentration of sulphur trioxide in the gas entering the system; (3) the strength of the oleum being produced; (4) the strength of absorption acid fed into the last absorber of the system; (5) the temperature of the acid in each absorption vessel. If these conditions are fixed, the number of absorption vessels required for complete absorption can readily be calculated.

The amount of sulphur trioxide absorbed in the first vessel will be equivalent to the difference between the partial pressure of the sulphur trioxide in the gas entering the absorber and the vapour pressure of the oleum contained in that absorber, which in turn depends on the temperature of the acid. The quantity of sulphur trioxide unabsorbed in this vessel will, of course, be equivalent to the vapour pressure of the oleum in the vessel.

The weight of oleum leaving the first absorber, which is the whole of the production, can readily be obtained by calculation from the weight of sulphur trioxide entering this absorber and from the strength of absorption acid fed to the last vessel. For example, if the oleum being produced contains 20% of free SO_3 and the acid fed to the absorption system contains 95% of H_2SO_4, a simple arithmetical calculation shows that for every ton of SO_3 entering the system 2·89 tons of 20% oleum are produced. At the same time the weight of absorption acid required is found to be 1·89 tons of 95% H_2SO_4. From the weight of sulphur trioxide and oleum leaving the first vessel and the weight of sulphur trioxide entering this vessel, it is possible by equating input to output to determine the weight and strength of the acid entering the first absorption vessel from the second vessel. The course of absorption in the first vessel is therefore determined.

According to one of the assumptions made, the acid contained in the second vessel is of the same strength as that which is passed on from the second vessel to the first, and the strength of this has been determined above. If now the temperature in the second vessel is fixed, the vapour pressure of this acid can be determined from the graphs and hence the quantity of sulphur trioxide passing unabsorbed through the second vessel can be found. The quantity of sulphur trioxide entering the second vessel is that which passes unabsorbed through the first, and the weight of acid leaving the second is that which enters the first. Therefore, by equating input and output in the second vessel the weight and strength of acid leaving the third vessel and entering the second can be determined. The above process is repeated for the third vessel and is continued until the whole of the sulphur trioxide is absorbed. This will not occur until an absorber is reached which contains acid of not more than 98·5% H_2SO_4. It may happen that the calculation shows that the acid in the last vessel must be of considerably lower strength than 98·5% H_2SO_4, in which case absorption might be unsatisfactory owing to the formation of mist. In such a case the conditions must be altered in such a way as to produce the required result. This point will, however, be dealt with more fully at a later stage.

The method of calculation outlined above will be more clearly followed by the aid of the following examples.

Example 1.—To determine the number of absorption vessels required to deliver 20% oleum from a plant producing 10 tons of sulphur trioxide per day, the concentration of SO_3 in the gas being 7%, the strength of the absorption acid 97% H_2SO_4, and the temperature in each of the absorption vessels 76° C.

Calculation shows that the weight of 20% oleum produced from 10 tons of sulphur trioxide and 97% sulphuric acid is 33·96 tons containing 28·97 tons of total SO_3.

From the curves the vapour pressure of 20% oleum at 76° C. is found to be 34·6 mm., and this is the partial pressure of SO_3 in a gas containing $34{\cdot}6 \times 100 \div 760 = 4{\cdot}55\%$ SO_3.

Hence the gas leaving the acid in the first absorber will contain 4·55% SO_3. Assuming that the change in the total volume of the gas is negligible (it can, of course, be allowed for if necessary), the weight of sulphur trioxide in the gas leaving the first absorber is, since a 7% SO_3 gas represents 10 tons, $4{\cdot}55 \times 10 \div 7 = 6{\cdot}50$ tons of SO_3.

Equating the total materials leaving the first absorber to the total materials entering we have:—

	Total Tons.	SO_3 Tons.	H_2O Tons.
Weight of acid leaving 1st vessel .. .	33·96	28 97	4 99
,, ,, SO_3 as gas ,, ,, ...	6 50	6 50	—
Total materials leaving 1st vessel .. .	40 46	35 47	4·99

This is equal to the materials entering the first vessel, and since the weight of SO_3 entering in the form of gas is 10 tons, the weight and composition of the acid entering from the second vessel can be obtained by difference, thus:—

	Total Tons.	SO_3 Tons.	H_2O Tons.
Total materials entering 1st vessel ..	40·46	35·47	4·99
Weight of SO_3 as gas ,, ,, ,,	10·00	10·00	—
Hence weight of acid ,, ,, ,,	30·46	25 47	4·99

The acid entering the first vessel thus contains $25{\cdot}47 \div 30{\cdot}46 \times 100 = 83{\cdot}6\%$ $SO_3 = 10{\cdot}8\%$ oleum, and this is therefore the strength of the acid in the second absorber.

The vapour pressure of 10·8% oleum at 76° C. = 8·4 mm., which is equivalent to $8{\cdot}4 \times 100 \div 760 = 1{\cdot}11\%$ SO_3, and this represents $1{\cdot}11 \times 10 \div 7{\cdot}0 = 1{\cdot}58$ tons of SO_3, which is the amount which escapes the second vessel and passes on to the third; again, equating input and output in the second vessel we have:—

	Total Tons.	SO_3 Tons.	H_2O Tons.
Weight of acid leaving 2nd vessel	30 46	25·47	4·99
,, ,, SO_3 gas ,, ,, ,, ...	1·58	1·58	—
Total materials leaving 2nd vessel ..	32 04	27·05	4·99
Weight of SO_3 gas entering ,, .. .	6 50	6·50	—
∴ Weight of acid ,, ,, ,, ...	25·54	20·55	4·99

∴ Strength of acid entering the 2nd vessel = 80 47% SO_3 = 98·58% H_2SO_4.

Hence the strength of acid in the third absorber is 98·5% H_2SO_4, and since this has no vapour pressure,

theoretically the whole of the remainder of the SO_3 will be absorbed in this vessel. In other words, three absorption vessels in series are required to complete the absorption.

Since the vapour pressure of oleum depends to such a large extent on the temperature, it is obvious that the efficiency of absorption in the first vessel and consequently the number of absorption vessels required in any particular case, depend upon the temperature at which this absorption takes place. For example, if the temperature of absorption is 60° C. instead of 76° C., as in the problem solved above, it would be found that two vessels in series were sufficient to give complete absorption, as the strength of the acid in the second vessel would be 98·9% H_2SO_4, which exerts practically no vapour pressure of SO_3. On the other hand, if the temperature of absorption were 80° C., four vessels in series would be necessary.

It can also be shown in this way that the weaker the absorption acid employed the higher is the temperature at which absorption can be allowed to take place for a given number of absorption vessels. For example, using a water feed, absorption at 77° C. would be complete in two vessels, whereas, as has been shown, three vessels are required using 97% C.O.V. at 76° C.

As has already been mentioned, it is essential that the strength of acid in the last vessel should be 98%–99%. If calculation gives a stronger acid than this then obviously either another absorption vessel is required or a lower temperature must be employed in the earlier stages of absorption. Another method is to use a lower strength of absorption acid and repeat the calculation. If, on the other hand, calculation shows that the acid in the final stage contains less than 98% of H_2SO_4, then either the temperature in the earlier stages should be raised, or it should be lowered sufficiently to bring the acid in the last stage but one down to 98% H_2SO_4, when the last absorber can be cut out. Variation in the strength of the absorption acid here will also have a similar effect.

Example 2.—It is required to produce 25% oleum in a series of three absorption vessels from a gas containing 7% SO_3 and a feed acid containing 95% H_2SO_4. Determine convenient temperatures at which the first and second absorbers must be maintained.

There are an infinite number of combinations of temperatures which will satisfy the conditions of this problem, and any two of these may be selected. This will be more clearly seen when the example is worked out.

Since the number of absorbers is fixed at three, it is convenient in this case to commence the calculation with the input to and output from the last absorber; 95% H_2SO_4 is fed into this absorber, and in order to obtain the best absorption the acid in this vessel should be maintained at about 98·5% H_2SO_4.

[illegible]orking out this example the actual weight of [illegible]duced per day is not required, but any con[illegible] figure, such as 10 tons per day, may be [illegible]sumed. Calculation shows that 10 tons of SO_3 require 15·89 tons of 95% H_2SO_4 to produce 25·89 tons of 25% oleum. A further calculation shows that 15·89 tons of 95% H_2SO_4 must absorb 2·32 tons of SO_3 in the third absorber to produce 98·5% H_2SO_4, and this must be the total amount of SO_3 entering the third vessel, since absorption is complete here.

Equating input and output for the last vessel we have :—

	Total Tons.	SO_3 Tons.	H_2O Tons.
Acid entering 3rd vessel	15·89	12·33	3·56
SO_3 „ „ „	2·32	2·32	—
∴ Acid leaving 3rd vessel =	18·21	14·65	3·56

Now if 10 tons of SO_3 are equivalent to 7% by volume, 2·32 tons=1·62% by volume=12·3 mm. Hg partial pressure.

The acid in the second vessel must therefore have a vapour pressure equivalent to 12·3 mm. of mercury and the strength of this acid will therefore depend on the temperature. This is obvious by referring to the vapour pressure curves.

We can therefore at this point assume any convenient value for the temperature of the acid in the second vessel. For example, assume that the second vessel is at a temperature of 65° C., then the acid contained in it must consist of 19% oleum (=85·1% total SO_3), for this is the acid which at 65° C. exerts a vapour pressure of SO_3 equal to 12·3 mm.

In the second vessel 18·21 tons of 98·5% sulphuric acid are converted, by the absorption of sulphur trioxide, into 19% oleum, and to accomplish this, 5·59 tons of SO_3 are required. A total of 23·80 tons of 19% oleum thus flows from the second vessel to the first.

Equating input and output in the second vessel we have :—

	Total Tons.	SO_3 Tons.	H_2O Tons.
Acid leaving 2nd vessel	23·80	20·24	3·56
SO_3 „ „ „	2·32	2·32	—
	26·12	22·56	3·56
Acid entering 2nd vessel	18·21	14·65	3·56
∴ SO_3 entering 2nd vessel =	7·91	7·91	—

7·91 tons of SO_3 are equivalent to 5·54% by volume or to a partial pressure of 42·1 mm. 42·1 mm. must therefore be the vapour pressure of the acid (25% oleum) in the first vessel, and by referring to the curves it is found that the temperature at which 25% oleum has a vapour pressure of 42 mm. is 70·5° C. Hence, if the first vessel is kept at 70·5° C., and the second at 65° C., the results desired will be obtained.

Any number of other solutions of this problem can be obtained in a similar manner by assuming other temperatures for the second vessel. Since the amount to be removed by the third vessel is fixed, it follows that if the temperature in the first vessel is raised the temperature in the second vessel must be lowered, and *vice versa*.

There are some practical advantages to be obtained in carrying out absorption in only two stages.

Suppose, for example, that in the above problem the absorption is to be carried out in only two absorbers. In this case there is only one temperature which will satisfy the conditions laid down. The

second vessel must now contain 98·5% H_2SO_4, and therefore the acid and gas balance for this stage is the same as for the third stage in the previous calculation. There are thus 2·32 tons of SO_3 passing from the first absorber to the second, and this amount is equivalent to a vapour pressure of 12·3 mm. The temperature of the 25% oleum in the first vessel must therefore be such that its vapour pressure is 12·3 mm.; a temperature of approximately 50° C. satisfies this condition.

Attention must be drawn to the fact that while the temperature of the acid is approximately uniform in each vessel of an absorption system of the bubbler type, this is not quite true when dealing with towers. In the latter case it is the temperature of the acid in the region of the gas outlet that controls the amount of sulphur trioxide which passes to the next effect. The temperature at the acid outlet cannot, however, be disregarded altogether, since it is this temperature which controls the maximum strength of acid which it is possible to produce.

Practical results obtained.

It is of interest to compare the practical results obtained on a large-scale absorption plant consisting of three bubbling vessels working under ordinary routine conditions, with the calculated results obtained by the method given above.

The results given on the left hand side of Table II. were determined by actual experiment, while those on the right-hand side were calculated using the figures given in brackets as data. Thus in the first example given in the table the course of absorption in three vessels has been calculated for the case of a system producing oleum containing 85·27% of SO_3 from a gas with an SO_3 content of 6·7% and a feed acid containing 77·66% of SO_3, the temperature in the first absorber being 71° C. and in the second 63·5° C.

TABLE II.

Comparing practical results obtained on an absorption system with the calculated results.

Expt. no.		Practical results. Absorber no. 1.	Absorber no. 2.	Absorber no. 3.	Exit.	Calculated results. Absorber no. 1.	Absorber no. 2	Absorber no. 3.	Exit.
1	% SO_3 in gas entering ..	6·7	2·18	0·15	0·07	(6·7)	2·76	0·11	nil.
	Strength of acid (total SO_3)	85·27%	81·2%	77·6%	—	(85·27)	81·68	77·90	
	Temp. of acid	71° C.	63·5°	27·5°		(71° C.)	(63·5°)		
	% SO_3 in acid fed			77·66				(77·66)	
2	% SO_3 in gas entering ..	7·14	1·34	nil.	nil.	(7·14)	1·92	nil.	nil.
	Strength of acid (total SO_3)	85·03	81·1	77·9		(85·03)	80·41	77·0	
	Temperature of acid	69° C.				(69° C.)			
	% SO_3 in acid fed			77·96				(77·96)	

The calculated results in Table II. agree very well with those actually determined, and it is interesting to observe that in both cases absorption is shown to be complete in the second vessel, and that the third vessel under these conditions is superfluous.

Whilst the method described above does not give any information regarding the size of absorption vessel required for any given output, it is of some assistance in the design of plant, since it defines the amount of absorption which takes place in each vessel. This being known, the heat liberated in each vessel can be determined from the temperature of the gas entering the first vessel and by the aid of Porter's data,* and so the amount of cooling liquid required in each absorber can be estimated.

The practical work in connexion with the vapour pressure determinations was carried out by Mr. W Green, to whom the author conveys his thanks He also desires to thank the management of Messrs Nobel Industries, and especially Mr. W. Rintoul O.B.E., F.I.C., for granting permission to publish the results of this work.

THE EVAPORATION RATE OF SOME SOLUTIONS.

BY L. S. BAGSTER.

A considerable mass of information is available as to the rate of heat transfer in vacuum evaporation, but most of the data refer to water. The present work was undertaken in the hope of obtaining information relative to the new factors introduced by dissolved substances.

The apparatus used was of copper (see Fig. 1), and consisted of a unit constructed to reproduce as nearly as possible the effect of a single tube of a calandria evaporator. The evaporating tube, A, 61 cm. (2 ft.) long and 5·1 cm. (2 in.) in diameter, was surrounded by an outer tube 7·6 cm. (3 in.) in diameter. The ends of the annular space, which served as steam jacket, were closed by flat plates 3 mm. thick. Steam was admitted to the jacket by the pipe, B, and distributed by the small branch pipes along the length of the jacket. Condensed steam was discharged through the valve, C. The valve, D, served as a vent to prevent accumulation of air in the steam space. The outside of the steam space and the admission and escape pipes were surrounded by a jacket packed with a mixture of asbestos and magnesia, furnishing a layer of insulation about 1 in. thick, thus ensuring that the only appreciable heat transfer was through the wall of the evaporation tube and the top and bottom tube plates. The evaporator unit was enclosed in a cylindrical vessel, 26 cm. diameter and 150 cm. high, the outside being covered with magnesia boiler lagging. This vessel contained the solution to be evaporated. The top of the vessel contained a splash retainer and was connected to a multitubular condenser. Condensate was collected in a large

* Trans. Faraday Soc., 13, 373–400.

calibrated bottle, attached to which was a removable receiver into which could be drawn the condensate after measurement, without disturbing the continuity of evaporation.

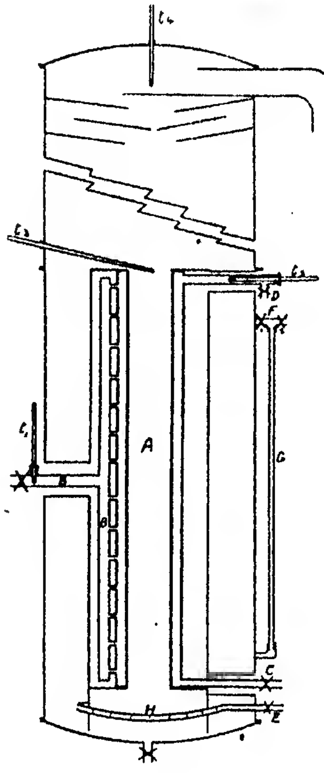


Fig. 1.

A gauge-glass, G, was attached to the body of the evaporator for controlling the liquor level. This gauge was fitted at the top with valves, F_1, F_2, which allowed the admission of air to clear the glass of liquor, thus permitting its being filled with fresh solution if necessary. Steam pressure and temperature were controlled by two hand valves in series, the temperature being read by the thermometers (t_1 on the inlet pipe and t_2 on the vent pipe). The pressure was controlled by a valve in the pipe leading to the air pump, which was opened until the pump could reduce the pressure beyond the desired value. Air was then admitted by a needle valve to the suction pipe connecting the apparatus to the first valve and air pump, until the desired vacuum was reached. Both steam pressure and vacuum could be closely maintained for long periods with little attention. To maintain constant steam conditions and to prevent accumulation of water in the steam space, steam was kept blowing from the vent valve, D, and along with the condensed steam, from the drip valve, C. In working with solutions it was necessary to maintain a constant composition of liquor, replacing the water as fast as it evaporated; this was done by admitting condensed steam from C at a temperature just below that of the liquor, by means of the needle valve, E, and the perforated pipe, H, maintaining constant level on the gauge, G. During evaporation the vapour carried through the tube, A, a violent spray of liquor, which fell through the annular space between the heating section and the wall of the containing vessel, mixing with the added water from H. This method of working eliminates any effect due to heat of solution. The temperature of the boiling liquor was read on the thermometer, t_2, having its bulb set over the top of the evaporator tube and kept wet by the spray. The corresponding temperature of the vapour was obtained from the thermometer, t_4, in the opening of the vapour outlet pipe.

It has been shown by Webre (J. Ind. Eng. Chem., 1918, **10**, 191) for the calandria type of evaporator that over a certain range of immersion of the evaporator tubes in the liquor, the heat transfer varies but slightly, and takes place from the tube wall to the liquor sprayed over it by the rapid stream of vapour. In the present case preliminary tests with water and sugar solution showed a nearly constant evaporation rate for immersions varying from about 25 cm. to 40 cm. The measurements were all carried out with a depth of 33 cm.

The various factors that influence heat transfer in vacuum evaporation have often been discussed (see Badger and Shepard, Chem. and Met. Eng., 1920, **23**, 237). It is well known that the rate of evaporation depends largely on the rate of movement of evaporating liquor over the heating surface, and hence it would be expected that the viscosity of a solution would influence the rate of evaporation. For the present work solutions of several very soluble substances having different viscosities were selected, the rate of evaporation being determined over as wide a range of concentration as possible in each case. To secure comparative results the steam temperature was always maintained at about 105° C., being held constant during an experiment. The liquor was maintained always with a surface boiling temperature of 80°, the temperature being maintained for solutions of different concentration by variation of the pressure. There was thus secured a nearly constant temperature difference between steam and liquor, and variations in the quantity of water evaporated are then due to other factors.

The results of a series of determinations of the amount of evaporation are given in the accompanying table, where each figure is the mean of several determinations agreeing to about 1%. The compositions are expressed as percentages by weight of dissolved substance. The temperatures have been corrected for thermometer errors.

The results are given in grams of water evaporated per hour per degree temperature difference, and were determined on runs of 10 or 15 minutes, according to the rate of evaporation. The actual quantities evaporated can be calculated from the temperature figures in the table. Included in the figures is a small correction for heat loss from the evaporato

body. This was determined by passing dry steam through the body and measuring the volume of condensed water deposited, which, under the working conditions, was about 100 grams in 10 minutes.

Min. density at 20°.	Percentage composition.	Evaporation. Grams per hr. per 1° C.	Absolute viscosity at 80°	Surface tension. Dynes at at 80°	Vapour temperature	Mean steam temperature.	Mean liquor temperature	Volume percentage of water.
				Water.	°C	°C	°C	
—	—	765	0·00356	62	80	104·8	80·8	
				Sugar.				
1·080	15	755	—	63	79·75	104 8	80 9	90
1·115	27	740	0·0072	64	79 4	105	81	81
1·165	37	660	0 0113	–	79	105	81	73
1·210	46	550	0·0190	66	78 6	105 2	81·05	65
1·263	56	455	0 0371	69	77·3	105·3	81·1	56
1·300	62	395	0·0725	—	76·5	105·3	81·25	49·5
1·330	67	300	0·1516	—	74·8	105·3	81·3	44
				Glycerol.				
1·027	12·5	750	0·0044	—	79	104·8	80 85	90
1·060	25	680	–	61	78	105·1	80·9	80
1·090	36	635	0 0078	—	77	105·1	81·05	70
1·129	50	540	0·0127	60	75	105·2	81 1	50 5
1 162	62	465	0 0196	—	72	105·3	81·25	41
1 184	70	405	0·0280	59	70	105·3	81·35	35 5
1·207	79	345	0·0475	—	65	105 3	81 65	25 3
				Sodium nitrate.				
1·085	12·5	795	0·0040	64	78·8	104·8	80·95	95
1·185	25·5	780	0 0053	67	77	104 8	81·1	89
1 280	36	720	0 0066	70	75	104·8	81 2	82
1 372	45·5	675	0 0091	73	73 7	104 9	81·4	75
(1·45)	54	600	0·0132	—	71	105	82·1	66·5
				Sodium sulphate.				
1·142	15	775	0·0057	65	78 8	104·7	80 95	97 5
1 280	35·5	715	0 0098	73	77 5	104·8	81 1	82 5

The true temperature difference between steam and liquor is obviously not represented by the difference between steam temperature and the surface temperature of the liquor, as at the bottom of the evaporator tube the boiling temperature of the liquor will be increased owing to the extra pressure of the liquid. The average temperature of the liquid must be considered, and to determine this the bottom temperature was calculated as follows. The thermometer in the head of the evaporator gave the boiling temperature of water at the pressure in the evaporator. The excess pressure due to the head of liquid could be calculated from its weight and density, and from "Landolt-Börnstein Tabellen" the boiling temperature of water under the excess pressure at the bottom was obtained. As the boiling temperature increase is small, the difference between boiling temperature of water and of solution will be nearly the same at the top and bottom of the tube, hence by adding to the calculated boiling temperature of water at the bottom the difference between the boiling temperature of water and solution at the liquor surface, the boiling temperature of the liquor at the bottom was obtained. The mean liquor temperature is the mean of the top and bottom temperatures and is the value used in calculating the evaporation rate per degree.

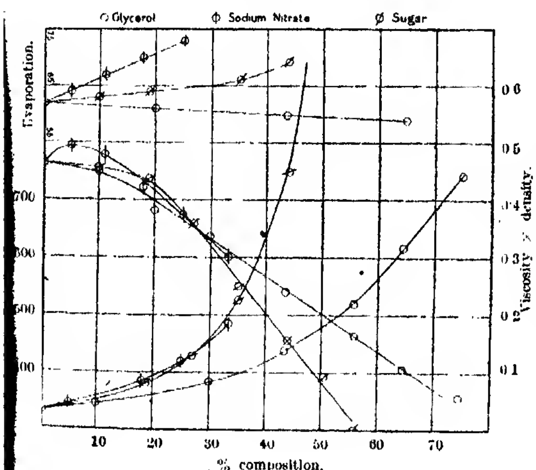


Fig. 2.

The value given for water is not the maximum quantity possible, but was determined after the tube had been tested and allowed to stand for some months. A surface film developed which somewhat reduced the rate of evaporation, but the value remained practically constant during the course of the experiments. This water value was determined before and after every series of measurements and several times during a day's run.

Included in the table are values for viscosity and surface tension, both of which appear to affect the evaporation rate. The viscosity determinations were made at 80° by means of an Ostwald capillary viscosimeter standardised by water. The densities at 80° necessary for viscosity calculations were obtained (by extrapolation if necessary) from data in "Landolt-Börnstein," the decrease in density from 20° being about 3% in most cases. The surface tensions were measured at 80° by a modified capillary tube method, measuring by water gauge the air pressure necessary to depress the meniscus to a mark on the capillary.

The substances tested were first-grade commercial cane sugar, pure glycerol, commercial sodium nitrate, and commercial sodium sulphate. The solutions were prepared by weight and samples drawn during measurement were tested by density, and in the case of sugar, by rotation measurement. The percentage compositions by weight for sugar solutions of varying density were taken from Geerligs' "Cane Sugar," for glycerol from the figures of Gerlach and Skalweit collected in Lamborn's "Soap, Candles, and Glycerine," and for the sodium salts were obtained from Comey's "Dictionary of Solubilities."

From the percentage compositions and densities of the various solutions the volume percentages of water and the molecular concentrations have been calculated and three sets of curves drawn, showing the relation between evaporation and composition expressed in the three forms. Viscosity and surface tension values are included in each set. As the resistance to flow of the solutions up the evaporator tube may be regarded as proportional to viscosity and density, the quantity "viscosity × density" is shown on the curves and will be referred to as "viscosity" in the discussion.

It might be expected that increase in viscosity would lead to decrease in rate of evaporation, and increase in concentration might be expected to

produce a similar result, partly at least on account of displacement of water by dissolved substance leading to lesser rate of contact between water and heating surface. It will be shown presently that the effect of concentration is most nearly represented by the volume percentage of water, so that in the curves of Fig. 3 where concentration is represented by water volume the deviation of the curves from one another requires further discussion. Viscosity of itself is insufficient to account for the variation in the case of the dilute solutions, where sodium nitrate, with a

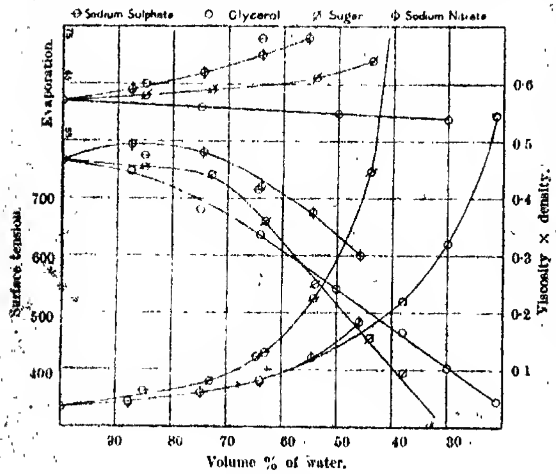


Fig. 3.

viscosity greater than water, shows actually a greater rate of evaporation (a similar result is seen from the table for sodium sulphate, which was not included on the curve to avoid confusion), while the more viscous sugar solutions show a greater rate of evaporation than the less viscous glycerol solutions. These results are consistent with the idea that surface tension is a controlling factor when viscosity and concentration are small, higher surface tension leading to greater evaporation. Greater tension may be expected to cause quicker breaking of bubbles and films with quicker re-establishment of contact between solution and heating surface and consequent greater rate of heat transfer. The actual rates found are, of course, due to surface tension modified by viscosity. Sodium sulphate, with a greater tension than the nitrate, has the lesser evaporation rate corresponding with a greater viscosity, while the sugar solutions, though the tensions are slightly greater than water, have smaller rates, again corresponding with greater viscosity. In the case of glycerol solutions the lower viscosity is insufficient to counteract the effect of lower surface tens[illegible] the curve falls below that of the sugar solution[illegible]

In the case of t[illegible] concentrated solutions where, judging by th[illegible] dilute solutions, surface tension may be co[illegible] of less relative importance, volume percentage [illegible]ter and viscosity seem to be the controlling factors, percentage or molecular concentration having less influence. It will be seen in Fig. 3 that sodium nitrate and sugar solutions of the same viscosity have, for a considerable range, nearly the same volume percentages of water and evaporation rates, though the nitrate solutions have much the greater molar concentration. On the other hand, in the case of glycerol and nitrate solutions of the same viscosity it will be seen from Fig. 4 that, allowing for the dissociation of the nitrate, its actual molar concentrations are greater than for corresponding glycerol solutions, yet the evaporation rates for the nitrate are much greater, corresponding to greater volume percentages of water. In the case of glycerol and sugar solutions of the same volume percentage of water, the evaporation is less for the more viscous sugar solutions, though the sugar solutions have the smaller molar concentration.

Except in the case of very concentrated sugar solutions, where increase in concentration leads to great increase in viscosity, reduction in volume percentage of water, even with the added effect of increase in viscosity, causes a much lesser proportionate reduction in the rate of evaporation. For example, reduction of the water volume by 30% in the case of glycerol only leads to 17% reduction in evaporation rate. This may be due to non-volatile material transferring heat to water not in contact with the heating surface.

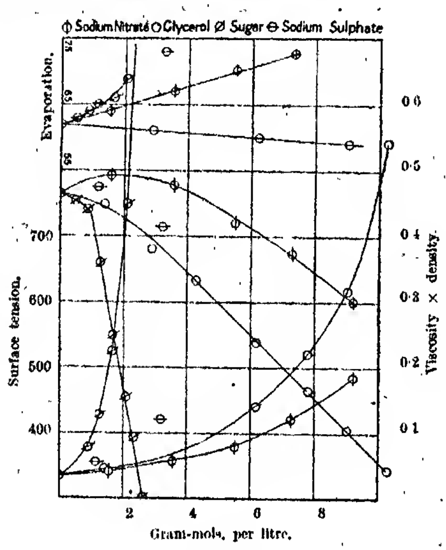


Fig. 4.

There seems to be little direct connexion between weight percentage and evaporation rate, except in so far as concentration change is connected with factors already discussed. The percentage composit[illegible] curves are included as they may have practical[illegible]orated

It is hoped to extend this work, but it [illegible]nd were concluded from the present results that [illegible]rding tension, volume percentage of water, and viscosity, are factors controlling rate of evaporation of solutions in tube evaporators, and that molar and percentage compositions are of less importance.

The author desires to thank Mr. E. Duus for carrying out some preliminary tests, and to acknowledge indebtedness to the Trustees of the Walter and Eliza Hall estate, who equipped the Industrial Chemistry Laboratory in which the work was carried out.

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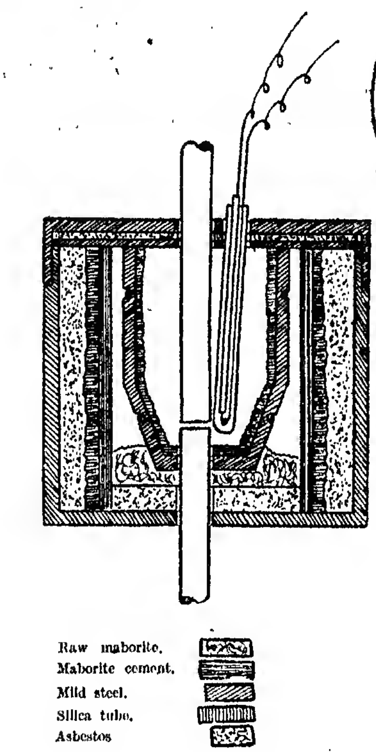
SOME PROPERTIES OF SOFT SOLDERED JOINTS.

BY T. B. CROW, M.SC., M.INST.MET.
(*Bowen Research Scholar in the University of Birmingham.*)

The operation of soft soldering is of such wide ndustrial application that it is surprising to find an .lmost complete absence of quantitative information n the subject. Much information[1] of a general haracter is available; this is, in most cases, concerned ither with the practical applications of the process r with formulæ for the preparation of solders and luxes. It does not appear that work has been done rith the objects of (1) examining in detail the effect f variations in the soldering conditions upon the esulting joins; (2) developing theories which will xplain the observed results; and (3) applying the iformation gained to the study of other soldering rocesses. A research with these objects in view has herefore been undertaken, and the following is a rief account of some of the results. The work is till in progress, and it is hoped that further informaion may be to hand in due course.

I. General.

In joining two metals or alloys by means of soft older, using flux and a soldering iron[2] or blow lamp, he following are the variable conditions:—(1) omposition of solder used. (2) Thickness of solder lm between the faces to be joined, and form of the in. (3) Nature of the metals to be soldered. l) Temperature of molten solder. (5) Initial condion, both physical and chemical, of the surfaces) be joined and of the mass of the metal beneath iose surfaces. (6) Length of time to which the metals re exposed to the molten solder. (7) Material used s a flux. (8) General manipulative procedure. (9) ther variables. In order to find out which combinaon of the above variables will give a join having the est mechanical properties, a very large number of ins was made under known variable conditions, ıd subsequently tested in tension and in shock. he general scheme of making a join was as follows: wo straight rods, made of the metal or alloy ıder examination and sufficiently long to enable ıe joins to be made and the tests carried out, ere firmly supported in a heavy cast iron stand o as to be vertical and co-axial) with their ends almost touching. Surrounding these ends was a crucible of such size as to contain more than enough molten solder to immerse them completely to a depth of not less than ½ inch, and also to contain the hot junction of a thermo-couple, suitably protected. The crucible itself was totally enclosed in an outer container, and the annular space thus formed was filled with asbestos lagging, and contained (in the shape of a resistance winding) the means of supplying the necessary heat to melt the solder and hold the work at any desired temperature for any length of time. The crucible was charged with a definite weight of solder in small pieces, together with a liberal amount of flux, and heated. The desired temperature above the melting point was maintained for a known period, and then the whole was allowed to cool until completely solidified. The constructional details of the furnace are shown in Fig. 1.



Sectional view of furnace etc. for making soft-soldered joins.

FIG. 1.

II. Variation of width of gap.

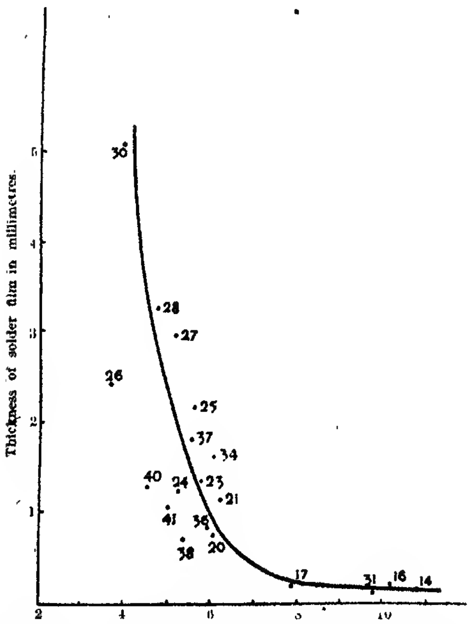
To investigate the effect of variation in the thickness of the solder film upon the tensile strength of the join, twenty-three joins were made (only nineteen of which were finally available for testing), with gaps varying from 0·2 to 5·1 mm., the following factors being kept constant throughout:—Soft solder of eutectic composition (Sn 62·93%, Pb 37·07%; m.p. 183·3°). High-conductivity copper rod, in a partially cold

[1] See bibliography at end of this paper.
[2] The expression "soldering iron" is conventional and will be adhered to throughout this account. A soldering copper is, of course, referred to.

worked state; ¼ in. diam. Faces "butt," and clean. Flux used, zinc chloride, in powder, and also as a thick water paste. Temperature of joining, 275° C. Time allowed at 275°, ten minutes. Table I. and Fig. 2

TABLE I.

Gap (mm.).	Yield point, Tons per sq. in.	% Elongation on 1 in.	Tensile strength, tons per sq. in.
0·2	Nil	Nil	10·8
0·2	,,	,,	9·8
0·25	,,	,,	7·9
0·3	,,	,,	10·1
0·74	,,	,,	5·3
0·8	,,	,,	6·0
0·9	,,	,,	5·9
1·1	,,	,,	5·0
1·2	,,	,,	6·2
1·3	,,	,,	5·2
1·34	,,	,,	4·5
1·4	,,	,,	5·8
1·7	,,	,,	6·0
1·9	,,	,,	5·6
2·2	,,	,,	5·6
2·45	,,	,,	3·6
3·0	5·1	2·4	5·1
3·3	4·6	2·6	4·7
5·1	3·6	4·6	4·0



Tensile strength compared with thickness of solder in the join.
FIG. 2.

show the values and curve obtained for the tensile strength of the soldered rods, considered as test pieces of homogeneous material. In Table II. these

TABLE II.

	Copper.	Solder.
Yield point	12·1	2·5
Tensile strength	15·6	4·1
% Elongation on 1 in.	47	*

* Not determined owing to too severe deformation of the fractured ends.

values are compared with the ordinary tensile strength of the materials which comprise the joined rod—namely, the solder and the copper—after bringing them by previous treatment to the same condition as if they had been treated in the joining process itself. From these tables it appears that:—

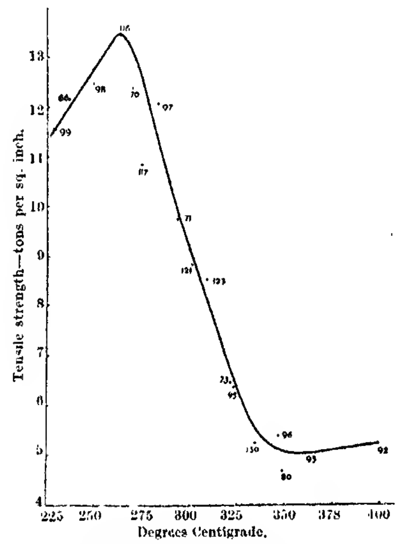
(1) The join having the thinnest film of solder in the gap is the strongest.
(2) The highest tensile strength obtained was less than the yield point of the copper.
(3) Elongation and yield points were only measurable with joins having a considerable thickness of solder in the gap.
(4) The strength of a join having 5·1 mm. of solder was substantially that of pure solder, although the yield point was higher.

III. Variation of joining temperature.

In this set of experiments, the film thickness was kept approximately constant between 0·1 and 0·15 mm., and joins were made at temperatures ranging between 230° and 415° C. The time allowed at the joining temperature was twenty minutes, and eutectic solder and zinc chloride were used as before. A different copper rod was used, and after treatment at 415° C. in the joining furnace, exactly as if it were being used in making a join, gave:—yield point, 23·4 tons per sq. in.; tensile strength, 25·0 tons per sq. in.; elongation (on 1 in.), 16%. The rates of

TABLE III.

Average steady temp., ° C.	Energy required to fracture specimen, ft.-lb.	Average steady temp., ° C.	Energy required to fracture specimen, ft.-lb.
237	0·075	350	0·1
262	0·1	360	0·1
284	0·1	362	0·1
297	0·05	385	0·075
302	0·075	415	0·075
317	0·075		



Tensile strength of joins compared with temperature.
FIG. 3.

heating and cooling were accelerated to suit the increasing joining temperatures by the use of suitably increased currents during heating and the

partial opening of the furnace top during cooling, so that a constant time was maintained between fusion and solidification of solder.

Several joins were made at temperatures considerably above 415° C., but these had to be abandoned, because so much copper rod had been dissolved by the "solder" as to make it impossible to prepare a satisfactory test piece from the resulting join. The shock tests were carried out with an Avery Izod impact machine. The plane of the join was coincident with that of the upper faces of the grips, which had been specially made to take a round specimen of $\frac{5}{16}$ in. diameter. An 11 ft.-lb. hammer was used, released from a position corresponding to a kinetic energy content of 1 ft.-lb. only, at the moment of impact. Table III. shows that all the specimens required only from 0·05 to 0·1 ft.-lb. to break them, irrespective of joining temperature. With a thicker solder film joins would probably give higher impact values, and work is in view upon this point.

The results of the tests in tension are set out in Table IV. and Fig. 3. The curve shows definitely

TABLE IV.

Temp. of joining, ° C.	Tensile strength, tons per sq. in.	Temp. of joining, ° C.	Tensile strength, tons per sq. in.
230	11·6	310	8·6
238	12·2	323	6·4
252	12·5	325	6·3
266	13·5	337	5·3
272	12·4	348	5·4
275·5	10·9	350	4·7
285	12·1	362	5·0
290	9·8	400	5·3
302	8·8		

Yield-point and elongation *nil* in every case.

that under the conditions in which the experiments were made, a temperature of about 265° C. gives the strongest joins. Joins made between 230° and 280° were quite strong. Above this temperature there is a very definite falling off in strength from some 11 to about 5 tons per sq. inch.

IV. Action of flux.

A few preliminary experiments were made to ascertain the action of flux (zinc chloride) in soft soldering.

Samples of zinc chloride were heated to about 400° C. in the presence of (*a*) eutectic solder alone; (*b*) copper rod alone; (*c*) solder and copper together. Subsequent analysis revealed no change in the composition of the solder, and no trace of copper, tin, or lead in the flux. Since fused zinc chloride is a very active electrolyte, it is reasonable to assume that no electrochemical action will take place when resin, tallow, etc. are used as fluxes.

If it is assumed that, apart from any physical action, the action of zinc chloride in soldering is simply to prevent chemically clean surfaces from becoming oxidised, or to remove any oxide which may be there to begin with, then if joins are made:—(1) with clean copper, using flux; (2) with copper, having oxidised surfaces, using flux; (3) with copper, with chemically clean surfaces, using no flux, but carrying out the operation in a non-oxidising atmosphere, and keeping other conditions constant in each case, such joins ought all to be equally found in mechanical properties. That this was substantially true will be seen from the results of Table V., from which it appears that chemically clean metallic surfaces can be satisfactorily soldered without the use of flux

TABLE V.

Condition	Steady temp. ° C.	Tensile strength, tons per sq. in.
Clean copper, using flux	262	6·1
	262	5·9
	264	5·8
Oxidised surface, using flux	260	6·5
	255	6·2
Clean copper, no flux, but CO_2 atmosphere*	275	5·8
	277	5·8
	277	3·8

* Owing to the cooling action of the stream of CO_2, a temperature some 10° higher was used

V. Microstructure of joins.

A number of joins were made at temperatures ranging between 237° and 497° C., and submitted to micro-examination. The specimens were so cut as to enable the excess of solder around the join to be examined, as well as the join itself, and polished on selvyt cloth, using "Silvo" metal polish. With this treatment the whole of the structure could be shown up faintly without the use of an etching reagent. A freshly made 10% solution of ammonium persulphate was frequently used, however, which darkened the solder and any free lead that was present, but which (owing to protective electrochemical action) developed no structure upon the cupriferous materials present. The following is a brief *résumé* of the results:—

(1) *Joins made between 237° and 293° C.*—The bounding line between the unchanged copper and the other constituents was extremely well defined. This boundary probably is not a sectional view of the original end of the copper rod, but appears to represent the furthest point to which diffusion has proceeded into the copper. In the centre portion of the join and occupying the greater part of the

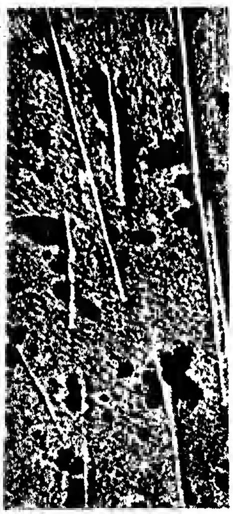
Joined at 260° C. × 400.
FIG. 4.

Half-join at 340° C. × 400.
FIG. 5.

gap is a band of eutectic solder having the typical structure. Between this and the copper boundary above referred to is a layer of a greyish material, and adjoining this, on the side nearest the solder, but scarcely visible, is a black fringe (see Fig. 4).

(2) *Joins made between* 325° *and* 360° *C* were similar to those described above, except that immediately adjacent to the copper, and between it and the grey layer, was a blue band. Also the black fringe was more decided and, as temperature increased, there were increasing numbers of black globules in the general solder mass on the sides of the joined rod (see Fig. 5, which shows *one* half the join only).

(3) *Joins made between* 402° *and* 497° *C.*—In these cases the solder mass around the join (and also the join itself, to a small extent) contained large numbers of long needle-shaped crystals white at the edges, but mauve in the interior. It was noticed that in these joins considerable solution of the copper had taken place, leaving an unaltered portion of rod of considerably reduced diameter (see Figs. 6 and 7, which show the needles and dark globules



Joined at 497° C. × 50.
FIG. 6.

Joined at 497° C. × 200.
FIG. 7.

at low and at high magnification respectively). If it is assumed that these needles crystallise out at a temperature above the general solidifying point of the solder, then their presence in the actual gap would prevent the copper ends being brought close together. The result would show as a thick film of solder in the gap, and is well illustrated in Fig. 9, which shows sections of two joins, made at temperatures of 265° and 497° C. The extent of the solution of the copper rod in the case of the high-temperature join will be noted.

It may be concluded that at moderate temperatures the tin of the solder diffuses into the solid copper forming a grey tin-copper alloy, leaving an excess of lead which separates out as a thin black fringe. At higher temperatures, the diffusion is more rapid and more extensive, forming, in addition to the grey material, a blue one, which is probably richer in copper. Much lead will, in consequence, separate, and this is seen as a thicker black fringe, or in globules, according to the amount. At higher temperatures still, copper is dissolved by the tin, and needle-shaped crystals of duplex composition separate out on cooling. It would appear that the blue alloy is connected with the falling off in tensile strength of the joins in which it occurs, as shown from Fig. 3.

To ascertain whether the "blue" and "grey" alloys were of constant or gradually changing composition proceeding outwards towards the copper itself, and also, if possible, to gain some information as to their composition, copper rods were allowed to "soak" in molten solder, of eutectic composition, at definite temperatures for $1\frac{1}{2}$ hours and allowed to solidify *in situ*. Four experiments were performed, two at 250° and two at 435° C, corresponding to the temperatures of formation of the grey and blue constituents, respectively. One specimen from each set was cut through longitudinally on a diameter of the rod and examined microscopically. Diffusion was found to be quite insufficient to permit of a layer of any particular constituent being turned off and analysed. Scratch hardness tests showed appreciably different values as the various bands were crossed. Scratch widths were:—copper, 0·42 mm.; solder, 0·55 mm.; grey constituent, 0·34 mm.; blue constituent, 0·21 mm. The "blob" of solder around the two remaining specimens was analysed, samples being taken from such portions as would be uncontaminated with the diffusion products immediately adjoining the rod itself. At 250° no copper was present, but at 435° C, 8·9 and 4·05% of copper was found in the top and bottom portions of the "blob" respectively, indicating that segregation of the needle-shaped mauve crystals to the top had taken place. The experiments just described are not conclusive but indicate lines of procedure for future work.

(*To be continued.*)

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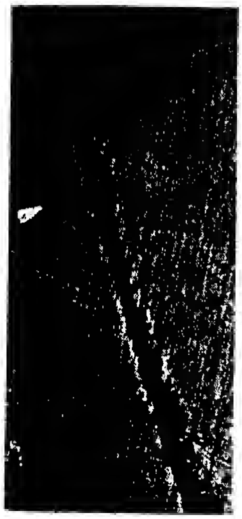
SOME PROPERTIES OF SOFT SOLDERED JOINTS.

BY T. B. CROW, M.SC., M.INST.MET.

(*Continued from p.* 68 T.)

The observations recorded suggested the possibility of squeezing out all the solder in the gap and of obtaining what would really amount to an autogenous welding of the layers of the grey material. Whether this can be done or not will depend upon two factors at least, namely: (1) the extent to which the surfaces to be joined approach a true plane surface, and (2) the nearness to which the welding temperature of the grey constituent is approached. In all the experiments already described, the upper half of the rod was pushed down upon its partner, and twisted to and fro at the end of the ten or twenty minutes steady period. The process was repeated at 200° C. Contraction between 200° and the melting point would cause a gap which would fill with solder. If, therefore, the rods were pushed together at a temperature of (say) 1° above the melting point, the gap ought to be considerably reduced and all the solder squeezed out. A photomicrograph of such a join is shown in Fig. 8. It will be seen, when compared with Fig. 4, that the gap has been reduced considerably, and although union between grey layers has not been effected, nor the solder entirely squeezed out, a repetition of the experiment with more accurately faced up rods and a suitable temperature might lead to more positive results. The tensile strength of such close joins as above prepared showed no increase over that of ordinary joins.

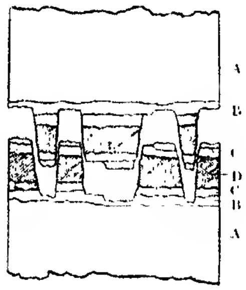


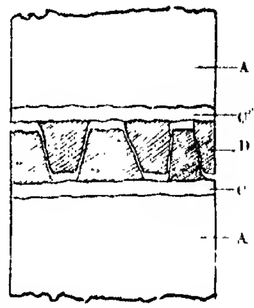
Joined at 260° C. × 400.

FIG. 8.

Joins at 265° C. and 497° C. × 3. Oblique illumination.

FIG. 9.





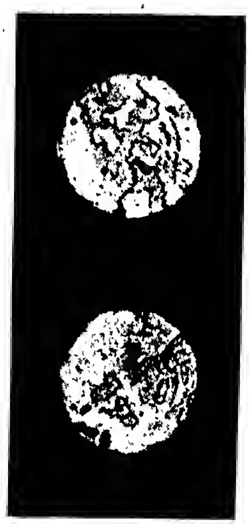
A Copper. B Blue constituent. C Grey constituent. D Eutectic solder.

Typical fracture of a join having grey and blue constituents.

Typical fracture of a join having grey constituent only.

The thickness of the joins is exaggerated.

FIG. 10. FIG. 11.



Joined at 230° C. × 4. Oblique illumination.

FIG. 12.

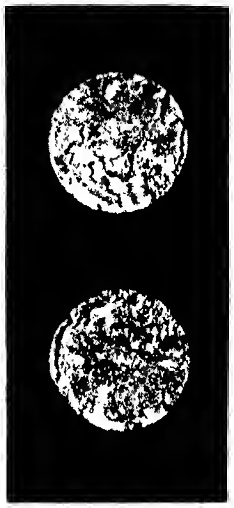
Joined at 290° C. × 4. Oblique illumination.

FIG. 13.

VI. Fracture.

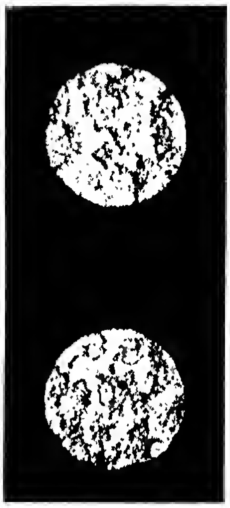
The interesting point arises as to exactly where the join fractures, *i.e.*, whether in the mass of a constituent or at a junction of two constituents. The fracture of joins of Section III. showed (with unaided vision) no coppery appearance, but consisted of two well-defined areas—a dull and a moderately bright

portion. Corresponding portions of the fracture in each half of the test piece were bright and dull, indicating that fracture took place at the surface of separation of solder and grey material. Also fracture



Joined at 325° C. × 4.
Oblique illumination.

FIG. 14.



Joined at 400° C. × 4.
Oblique illumination.

FIG. 15.

extended across the eutectic solder to a similar place on the other side. This is shown in Fig. 10, which is typical of a join containing no blue constituent. Figs. 12–15 illustrate fractures of joins made at increasing temperatures, in which the gradual change in the character of fracture will be noted, increasing areas of stony appearance (typical of Cu_3Sn) being seen with increase of temperature. In fact, in the case of high-temperature joins, fracture largely occurred in the blue material itself, but also partly at the separation of blue and grey constituents. This is shown in Fig. 11.

VII. *Conclusions etc.*

(1) The tensile strength of joins increases with diminution of thickness of solder film in the join. Tensile strength of all joins was less than the yield point of the copper, but the strongest join had a tensile strength of some 2½ times that of the solder.

(2) Where a constant thickness of solder film of 0·1 to 0·15 mm. was maintained, joins made at 265° C. were the strongest in tension; those made at temperatures appreciably higher than 280° C. were considerably weaker, a brittle constituent being observable. Joins made at different temperatures were equally weak under impact.

(3) The action of zinc chloride is to prevent oxidation by preventing access of oxygen, or to dissolve oxide if it is there at the start. It has no electrochemical action. Joins made on clean copper surfaces, in carbon dioxide, without using flux, were of normal tensile strength.

(4) Diffusion of the tin of the solder into solid copper takes place, giving micro-constituents which are grey or blue according to the temperature. At temperatures up to 360° C. little or no solution of the copper takes place, but at 435° C. it is quite rapid. Scratch hardness tests showed the blue constituent to be the harder.

(5) Fracture of tensile bars took place at the junction of the grey material and the solder in the case of low-temperature joins. In high-temperature joins fracture occurred partly in the blue constituent itself and partly at its junction with the grey.

Work is still in progress or in view upon the general lines indicated at the beginning of this paper and also upon various special points mentioned.

In conclusion the author wishes to express his appreciation of the kindness of Dr. W. E. Sumpner, Principal of the Municipal Technical School, Birmingham, for permission to carry out work in the Metallurgical Department; of Prof. Turner, Messrs. D. H. Ingall, Joseph Lones, and W. E. Thorneycroft for helpful assistance, and of Messrs. W. R. Barclay, W. H. Tait, C. C. Bamford, and Dr. R. S. Hutton for their assistance in the supply of suitable materials.

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AN APPARATUS FOR THE ACCURATE VOLUMETRIC DETERMINATION OF TIN IN CANNED FOODS.

BY E. J. B. WILLEY, B.SC.

The increasing use of foodstuffs packed in hermetically sealed tinplate containers has led to the serious consideration upon the part of the Public Health Authorities of the possible dangers arising out of the almost invariable absorption which takes place of tin and other metals from the can, and subsequent ingestion of the contaminating metallic compounds. This has, in turn, directed attention to the various gravimetric and volumetric processes which have been proposed for the determination of tin in small amounts.

Of the gravimetric methods the consensus of opinion would appear to indicate that the most satisfactory determination of tin is afforded by igniting the foodstuff with sulphuric acid and (in small quantities at a time) nitric acid, addition of alkali

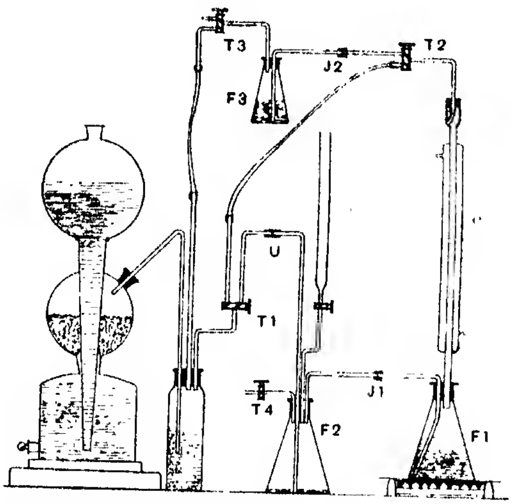
to give a solution of about 2% acidity (after boiling off any remaining nitric acid), precipitation of the tin as sulphide with hydrogen sulphide, followed by treatment of the filtered precipitate with dilute sodium hydroxide and re-precipitation of the tin sulphide from the alkaline solution with acetic acid. The sulphide precipitate is allowed to stand until it has settled, and is finally ignited and weighed as stannic oxide. The principal disadvantage of this method is that in dealing with small amounts of tin it becomes necessary to take a large quantity of foodstuff (say 100 g.) in the first place, in order to reduce any error in the final weighing of the few milligrams of stannic oxide which are obtained, thus lengthening greatly the initial ignition. Again, the re-precipitated tin sulphide may often take a long time to settle and this lengthens the determination still more. There is also the danger, in the case of foodstuffs containing more than the usual amounts of silica, calcium salts, or phosphates, of the tin sulphide precipitate being contaminated with quantities of these substances; the silica in particular, being appreciably soluble in dilute alkali, is dissolved and is precipitated with the tin sulphide. This has, upon a few occasions, been experienced in this laboratory.

On the other hand if appropriate steps are taken to guard against these possible errors, such as a second re-precipitation of the tin sulphide or, in doubtful cases, treatment of the stannic oxide precipitate with hydrofluoric acid after ignition in a platinum crucible, the method is capable of extremely high accuracy.

The volumetric methods for determining tin depend upon the reduction of the tin to stannous chloride and its subsequent titration, either directly or indirectly, with an oxidising agent such as iodine, potassium permanganate, ferric chloride, etc. The first named is most generally used. These, while excellent *per se* and capable of giving accurate results under very carefully controlled experimental conditions, suffer as laboratory processes from the great difficulty which is experienced in obtaining a quantitative reduction of the tin to the bivalent condition, largely owing to the ease with which re-oxidation takes place. Low results are, in consequence, obtained.

That the oxidation of the stannous salt prior to titration is recognised as the principal source of error in an otherwise accurate and convenient method for determining tin, is shown by the directions to be found in almost all of the published processes for preventing access of air to the reduced solution, and Sellars has designed an apparatus to obviate this difficulty (*cf.* Scott, "Standard Methods of Chemical Analysis," 1918). His device has not, however, been found to be impeccable when applied to the determination of very small quantities of tin such as are usually present in canned goods, or when tested against pure tin salts using the gravimetric process as the standard. On the other hand, the tin may be directly determined in the group II. precipitate by means of iodine, since no substances capable of interfering with the subsequent titration are likely to be present in more than traces.

In the apparatus to be described, the whole of the operations of reduction and subsequent titration are carried out under slight pressure and in an atmosphere of carbon dioxide. Back-oxidation thus being rendered practically impossible, the determination may be carried out upon a much smaller sample owing to the decreased error factor, and by its use the author has obtained results agreeing very closely with those obtained gravimetrically from a larger sample.



A Kipp apparatus, arranged to give a supply of carbon dioxide from marble and hydrochloric acid, is connected as shown to a wash-bottle containing lead acetate solution and packed with small pieces of broken glass. This has been found to give an extremely efficient gas-washing arrangement. A two-way tap, T1, fitted to the rubber stopper of this wash-bottle, is connected *via* the stout pressure tubing union, U, to the 300-c.c. Erlenmeyer flask, F2, and by a second piece of pressure tubing to the second two-way tap, T2.

Connexion between the wash-bottle and the third two-way tap, T3, is also provided, as shown, by a piece of pressure tubing. The Erlenmeyer flask, F2, is fitted with a stopper bored to take four tubes, viz. (1) that from the Kipp wash-bottle; (2) that leading *via* the ground joint, J1, to a second 300-c.c. wide-necked conical flask, F1, which is supported over an iron plate above a gas ring; (3) the tip of the burette tap; and (4) the small tap, T4. In the determination F2 is immersed in a white glazed pneumatic trough containing cold water.

The flask, F1, carries the condenser, C, and the delivery tube from F2. To the top of the condenser (double-surface type) is fitted a rubber stopper carrying the two-way tap, T2. One branch of T2 is connected *via* the ground joint, J2, to a third 300-c.c. flask (supported by a clamp from the retort stand which holds the condenser, C) and the other to the second branch of T1. Finally a third tap, T3, is provided in the stopper of F3 and one

branch is connected as already mentioned to the wash-bottle whilst the other is arranged to communicate with the atmosphere.

The determination of tin in canned foods is effected by the use of the apparatus as follows :— A 25-gram sample is ignited as for the gravimetric process and the tin is precipitated as sulphide in the usual manner. The precipitate is filtered off at the pump by means of an asbestos pad supported by a perforated disc. The washed pad of asbestos and precipitate are transferred to a 200-c.c. conical flask, 10 c.c. of hydrochloric acid, 0·25 g. of potassium chlorate, and 75 c.c. of water are added, and the whole is boiled vigorously for 15 min. to dissolve the tin and oxidise any sulphur which may be present. The solution is then filtered, transferred to a wide-necked flask of the type already mentioned, and boiled again with the addition of a further 3 c.c. of hydrochloric acid to decompose any remaining chlorate and also to expel chlorine etc. Boiling is allowed to proceed until the volume of the solution is about 20 c.c., when it is stopped ; 10 c.c. of starch solution are then placed in F2, the stopper is placed in position, and the pressure tubing · union, U, connected up. A piece of zinc foil about 4½ by 2 in. and weighing some 3 g., is placed in the flask containing the tin solution (F1) and 20 c.c. of strong hydrochloric acid are added. F1 is placed in position on the hot plate above the gas ring, the joint, J1, is connected, and a rapid current of carbon dioxide from the Kipp sent through the apparatus to expel most of the air, T1 being turned to allow passage of the gas through F2, F1, up the condenser, and to atmosphere *via* T2, which should not yet be connected to F3. After two or three minutes, 50 c.c. of freshly boiled water are placed in F3, T3 is opened to atmosphere, and J2 connected up so that the carbon dioxide now bubbles through the water in F3 and out to atmosphere. The gas current is then diminished so that about two bubbles per second pass through the wash-bottle, and the gas ring is lit to heat the solution in F1, which is then boiled gently for 30–35 min., a slow current of carbon dioxide being maintained as before At the end of this time the gas is turned off and T3 shut off entirely for about a minute. T1 and T2 are then reversed to apply the carbon dioxide pressure to the top of the condenser so that the liquid in F1 is forced up the tube connecting F2 and F1 and into the starch solution in the first-named flask, T4 being opened to allow the displaced carbon dioxide in F2 to escape. When all the solution has run into F2, T4 is closed and T1 shut off entirely. T2 is then brought to its original position (*i.e.*, giving connexion between the condenser and F3) and T3 is reversed to allow carbon dioxide from the Kipp apparatus to enter F3 above the water surface and thus to force the liquid through T2 to the condenser and into F1.

The carbon dioxide in F2, having been somewhat heated at first when the solution from F1 was blown into the flask, will now contract due to cooling taking place, and this, together with the carbon dioxide pressure, will force the rinsing water into F2, thus removing the last traces of stannous chloride solution from F1. When F1 is again empty, T1, T2, T3 are opened to allow carbon dioxide to pass through the apparatus as in the reduction and in a rapid stream to mix and cool the solution in F2. The gas is allowed to run for two minutes or so if necessary, but the author has found that the liquid in F2 is usually cool enough to be titrated when all the wash-water from F3 has been blown into it. Iodine is then run in from the burette until a permanent blue coloration is obtained, the current of carbon dioxide keeping the solution in a state of agitation. In his determinations the author uses $N/200$ iodine, in which case for a 25-g. sample the percentage of tin is obtained by substituting in the formula, c.c. of iodine used × correction factor 118·7 ÷ 100,000.

The apparatus has for some time now been in use in this laboratory, where numbers of routine determinations of tin are made, and has given excellent results. For example, to two samples of a meat preparation known to be free from tin a solution containing the equivalent of 0·00957 g. Sn was added. The result by the gravimetric method (mean of two) was 0·00957 g. Sn, and by the volumetric method using the above apparatus, 0·00958 g. Sn.

The time required for a determination of tin by this method, inclusive of the ignition period, is about six hours.

The author's acknowledgments are due to Messrs. Angus Watson and Co., Ltd., in whose chemical laboratory the above apparatus was designed and tested, and to Mr. H. Pearman for the sketch which illustrates this description.

THE CORROSION OF MUNTZ METAL IN SEA WATER.

BY W. DONOVAN, M.SC., AND T. E. PERKS.

In 1918 the Public Works Department, New Zealand, experienced trouble with some Muntz metal sheathing on Otaika Bridge, owing to its rapid disintegration, and asked for an investigation into the cause of the occasional rapid corrosion of this metal in sea water. It was suggested that slight differences in the chemical composition might account for differences in the resistance of the metal to the action of the sea water.

To facilitate the investigation, the following twelve samples were submitted :—

1 and 2. Disintegrated within two years on Otaika Bridge, above low water. (Brackish.)

3. Seven years in position, Kioreroa Bridge.

4. In position since 1915. (Locality not stated.)

5. New metal now being used.

6. Metal supplied in 1916 and unused.

7 and 8. Seven years in position, Kioreroa Bridge.

9. In position on Wool Wharf, Wellington, from 1880 to 1912.

10. In position since 1863, Queen's Wharf, Wellington.

11. New metal received within the last two years. (P. H. Muntz and Co.)

12. In position for 25–30 years, Opua Wharf, North Auckland.

These gave the following results on analysis :—

Sample no.	Cu.	Zn.	Pb.	Sn.	Fe.	As.
1	69·67	29·53	0·47	0·25	0·16	Undet.
2	67·15	31·84	0·82	0·20	0·13	Undet.
3	60·44	38·41	1·06	0·10	0·14	0·05
4	64·22	35·82	0·48	0·16	0·13	0·06
5	60·90	37·64	1·07	0·05	0·16	0·05
6	60·12	38·51	0·90	0·33	0·12	0·18
7	60·12	38·59	1·20	0·08	0·11	0·04
8	65·36	34·28	0·30	0·10	0·03	0·06
9	61·30	37·76	0·57	0·13	0·10	0·05
10	61·46	37·79	0·47	0·07	0·08	0·05
11	61·00	37·87	0·70	0·16	0·12	0·09
12	61·56	37·60	0·73	0·08	0·05	0·05

The manganese in all the samples is less than 0·01%.

It is evident from the table that in addition to Nos. 1 and 2, which were practically disintegrated, the copper content of Nos. 4 and 8 was higher and the zinc less than in unused metal, indicating corrosion by loss of zinc (with apparent enrichment of the copper). The comparative brittleness of these samples and their appearance under the microscope gave confirmatory evidence of this.

The samples may be divided into four classes :—

(1) Unused metal, of recent manufacture (Nos. 5, 6, 11).

(2) Corroded metal (presumably of recent manufacture) (Nos. 1, 2, 4, 8).

(3) Good quality metal, in use 7 years (Nos. 3, 7).

(4) Good quality metal, in use 25 years and over (Nos. 9, 10, 12).

Apart from the copper and zinc content, there is apparently no relation between the chemical composition of the metals examined and their corrodibility.

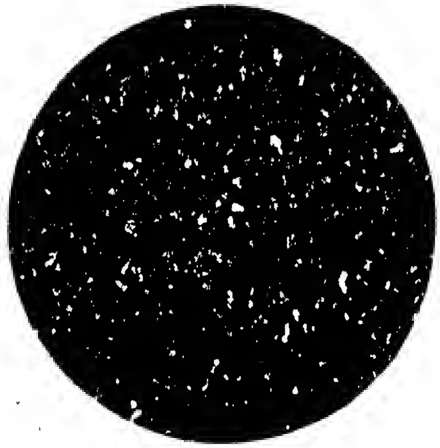
Micrographical examination.

The samples were submitted to micrographical examination, with a magnification in all cases of 80 diameters and oblique illumination, after polishing in such a manner as to reduce cutting, overheating, and surface flow to a minimum. The etching reagent finally adopted was ferric chloride and hydrochloric acid (Desch, "Metallography," 1910 edition, p. 147), all samples being "developed" in a photographic dish at the same time so as to obtain equal periods of etching in a standard solution.

Heat-treatment of sheathing.—A study of Shepherd's constitutional diagram of the zinc-copper alloys in conjunction with the remarks of Rosenhain ("Introduction to Study of Physical Metallurgy") on the subject, suggested the heat treatment of sheathing with a view of observing the manner in which the α and β phases varied at different temperatures. A small sample of finely crystalline Muntz metal sheathing was taken and portions were subjected to various temperatures for one hour and then quickly cooled, polished, and etched, with the results shown in Figs. 1 and 4.

Fig. 1 illustrates the untreated Muntz metal, showing both α and β phases, the α phase predominating. Samples heated to 400° and 500° C. differed so little from the untreated metal that their photomicrographs are not included.

Fig. 2 shows the result of heating to 600° C. It will be noticed that there is here a critical stage in



Untreated. × 80

FIG. 1.

600° C. × 80

FIG. 2.

which neither α nor β is dominant, each tending to merge with the other. In future an alloy in which this change $\alpha \rightleftarrows \beta$ appears will be referred to as being in a state of "transition."

Fig. 3 shows the sample after having been heated to 700° C. for one hour. The β phase predominates and α is intercrystalline. For simplicity the phase which preponderates will be termed the "dominant phase."

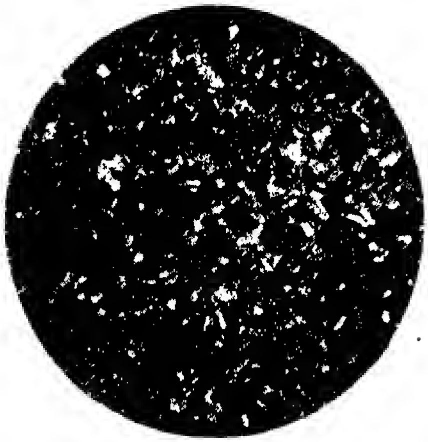
Fig. 4 shows the almost complete conversion of the sample to pure β as a result of heating to 800° C., the intercrystalline α being in very small amount.

These results were confirmed by the treatment of a variety of sheathings ; they show the manner in which heat treatment affects the constitution

of the alloy and indicate that the heat treatment to which a Muntz metal has been subjected may be determined by a study of its microstructure.

The microstructure of samples 1 to 12 (Table I.) will now be considered.

Sample 1 (Fig. 5) and *Sample* 2.—Here the dominant phase was α with intercrystalline β. So badly disintegrated were these alloys within two years' service that the selection of a representative area was difficult; coppery patches will be observed on both sides of the photograph. The porosity of the metal would either indicate overheating and volatilisation of zinc in patches during manufacture, or unusually severe conditions of usage.*



700° C. × 80

FIG. 3.

800° C. × 80

FIG. 4.

Sample 3.—α was dominant with β intercrystalline and in small proportions (as Fig. 1).

* This is referred to in the accompanying paper, "The Corrosive Action of Brackish Water on Metals," by T. E. Perks.

Sample 4 was quite brittle. It consisted of a moderately large amount of intercrystalline β with large corroded α crystals.

Sample 5 (new metal) consisted of α crystals dominant, with a considerable amount of intercrystalline β. The solution of this β phase will hasten exfoliation of the α crystals and the alloy cannot be considered a good one.

Sample 6 resembled sample 5, but exfoliation will probably be more rapid. Probably this sample was manufactured too hastily, rapid cooling from a rather high temperature giving too high a proportion of β.

Sample 7.—The dominant phase was α, while the intercrystalline β did not completely isolate α crystals, as with samples 1, 2, 5, and 6.

Sample 8 was quite brittle and consisted of dominant β with intercrystalline α.

Sample 9 (32 years' service) consisted of dominant α, uniform and finely crystalline. Exfoliation a minimum.

Corroded metal. × 80

FIG. 5.

Sample 10 (49 years' service) consisted wholly of the transition stage (Fig. 2). Electrolytic action between the α and β phases would be negligible and also exfoliation.

Sample 11 (new metal) was identical with sample 9.

Sample 12 (25–30 years' service) was very similar to samples 9 and 11.

From this point the investigation was continued into a further series of Muntz metal bolts and sheathings; the results obtained generally confirmed those given above.

In all bolts which had corroded there existed a central core of unaltered Muntz metal surrounded by a shell of the coppery coloured, corroded portion. Such corrosion renders the threads of bolts extremely brittle and may even extend completely through the bolt, causing it to snap under strain. The depth of corrosion generally depended on the duration of immersion.

The authors have found great variation in the character and proportion of the phases present in numerous samples of Muntz metal bolts and sheathing. Indeed, uniformity in manufacture would appear to be by no means the rule. Whether the α or β phase is dominant will depend solely upon the heat treatment of the alloy during manufacture, and it seems probable that sufficient scientific control of the product is not adopted. Bengough and Hudson state (J., 1909, 657) that, in order to put the metal on the market in its best possible physical condition, particular attention should be paid to its final rate of cooling.

The authors have noticed that, in Muntz metal manufactured many years ago, so far as their observations have gone, either α and β merges into the other (transition stage) or α is dominant with β in minor proportions. Such a product has received thorough annealing at a low temperature with gradual cooling, thereby ensuring the reduction of the proportion of β present in favour of α. It seems probable that the minor proportion of β ound in the resistant samples, while not sufficient o cause marked exfoliation of the dominant α rystals, will by being first attacked (Desch, J., 1915, 260), protect these from immediate corrosion. The conversion at 470° C. of the α into $\alpha+\gamma$ as lescribed by H. C. H. Carpenter (J., 1912, 133) vould still further reduce the proportion of β present nd so tend to produce a more resistant alloy.

Of many modern samples of Muntz metal examined he dominant phase is too commonly β, or, if not hat, the proportion of β present is so high as to solate α crystals from one another and cause rapid isintegration. Mathewson and Thalheimer (J., 1916, 064) recommended for a 61% brass, a cooling ate of 20° C. per minute down to quenching at 50° C.; for 61—63% brass, a rate of only 5° C. own to quenching at 550° C. is preferable. Similrly with Muntz metal, for the best results the rate f cooling should be slow.

Apparently the manufacturer to-day hastens production and produces an alloy high in β by treating t too high a temperature and pickling too suddenly, ving the growth $\alpha \rightarrow \beta$ no time to develop. We elieve that this is a more adequate explanation of ie inferior quality of some Muntz metals manuctured of recent years than that it is due to the e of electrolytic copper instead of the less pure nelted copper.

The following tabulation of the examination of me thirty samples (bolts and sheathing) of used untz metal gives the relationship between the ase which predominates and the corrodibility of e alloy :—

Dominant phase.	Condition.	Period of use.	Number of samples.
α	Good	12–58 years	12
β	Bad	5–25 years	15
nsition	Good	39–57 years	3

Summary.

So far as they go, these results tend to show at :—

1. Dominant β always results in rapid corrosion. is confirms the work of Bruhl, who found that the effect of high temperatures of annealing followed by quenching and rolling was to increase the rate of corrosion (J., 1911, 1164). In the alloy produced in this way β predominates. Desch has also noted the preferential corrosion of the β phase (J., 1915, 260).

2. Dominant α is very resistant if the proportion of β is insufficient to hasten exfoliation.

3. The transition stage is the least corrodible, probably because electrolytic action between the α and β phases will be a minimum in such an alloy.

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THE CORROSIVE ACTION OF BRACKISH WATERS ON METALS.

BY T. E. PERKS.

In a paper on the corrosion of Muntz metal by W. Donovan and T. E. Perks (p. 72T), dealing with the relation between the micro-structure of Muntz metal and its "corrodibility" or resistance to corrosion, it was shown that, in general, where the β phase was intercrystalline and in small proportions, the alloy had for many years withstood the action of sea water without marked deterioration. Where the metal consisted of α crystals with a large proportion of intercrystalline β, which would cause exfoliation of the α crystals, rapid corrosion had taken place. It would hardly be predicted, however, that the alloy, not constitutionally sound, would completely disintegrate within two years of service, and it became evident that some other factor in corrosion was to be looked for. Enquiry showed that the two samples (*loc. cit.*, Nos. 1 and 2) had been subjected to the action of the brackish waters of a tidal river where no contamination by sewage or by factory wastes would occur. The excessively corrosive action of brackish waters has been known for many years, and it was suggested by the Corrosion Committee (J., 1916, 471) that the dilution of salt with fresh water, by giving rise to greater ionic dissociation, increased the attack upon a metal immersed in the mixture. This assumption seems hardly adequate to explain such rapid corrosion, and the following theory is now advanced (which will be called the "theory of varying salinity").

It is an established fact that a difference of potential exists between two solutions of the same salt of different concentration; suitable connexions being made, an electric current will flow through the circuit. From this fact it was assumed that, in the case of estuarine waters, where at frequent times the fresh water flows over the salt, the water would be found to be in layers of varying salinity. This being so, a sheet of Muntz metal (ensheathing a wooden pile, for example), exposed to these layers of varying saltness, would establish the necessary circuit and an electric current would flow through the metal. Milton and Larke (Proc. Inst. Civ. Eng.,

1903, 154) have shown, by experiments with an applied electric current, that electrolytic action alone, even with exceedingly minute currents, may result in severe corrosion or decay. This would greatly hasten corrosion and thus explain the excessively corrosive action of brackish waters. Before taking samples of tidal river waters, some experiments were made to demonstrate this action. Two polished strips of Muntz metal, one placed in a porous pot containing salt water of a concentration about equal to that of sea water (approximately 3% NaCl) and the other in very slightly salt water surrounding the pot, developed a difference of potential varying from 9 to 16 millivolts. These strips when both immersed in the same salt solution showed no difference of potential. After experimenting thus in a variety of ways it became apparent that a quite easily measurable current would be established through a Muntz metal sheet immersed in brackish water. It may be pointed out that in tidal rivers the water is seldom, if ever, uniformly brackish.

past the metal and that brackish water in layers of varying salinity might be an important factor in corrosion.

The apparatus was then used to test the corrodibility of the first twelve samples described in the preceeding paper, all being immersed together and examined at regular intervals. The results showed the correctness of the statement previously made that samples rich in β or with predominant β are the more corrodible. For example, No. 11 withstood the test well, as did Nos. 9, 10, and 12, but Nos. 4, 5, 6, and 8 corroded rapidly. This further establishes the urgency of correct heat treatment.

These experiments suggested a possibility of comparing the corrodibility of samples by measuring the voltage developed by each under standard conditions. It was impossible to obtain consistent results either with a quadrant electrometer (which should have obviated complex polarisation effects), or with a high-resistance galvanometer, and it was found that the results could be varied by the manner in which the strips had been polished. Curves

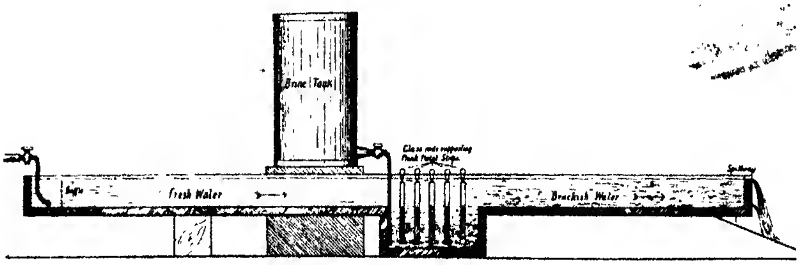

FIG. 1.

An attempt was then made to simulate the conditions found in tidal rivers. A wooden race (see Fig. 1) was constructed, six feet long, having an internal cross-section of 3 in. deep by 2 in. wide. Four feet from the inflow end was a brine pit, giving an additional depth of four inches. This pit was supplied with 3% solution of common salt from a cistern while the race was kept supplied with tap water at the rate of a litre per minute. At the brine pit, therefore, there was a layer of fresh water flowing over a layer of salt water of approximately the same strength as sea water. A sample of the water was taken at each inch of depth over the brine pit at frequent intervals; a typical reading expressed in c.c. of silver nitrate was as follows:—1 in. from surface, strength=0·1 c.c. $N/10$ $AgNO_3$; 2 in., 0·3 c.c.; 3 in., 0·7 c.c.; 4 in. 2·9 c.c.; 5 in. 3·6 c.c.; 6 in. 4·7 c.c. It will be seen that the definition between the salt and fresh layers was very sharp. Strips of polished Muntz metal were now suspended in the pit so that a portion of each was in the fresh and a portion in the salt water. In thirty minutes the corrosion was visible to the naked eye. Strips left in the salt solution alone for the same time showed no change. This experiment demonstrated that the electric current was not prevented by the flow of the water

showing rate of polarisation were also obtained which, while similar, bore no relation to the properties of the alloy observed in practice. Further experiment along these lines might succeed in producing intelligible results, but Desch has pointed out the difficulty of such a task (J., 1915, 259).

It now remained to sample the waters of a tidal river at various depths. This was done at the mouth of the Hutt River, which empties into Wellington harbour. The samples were taken at successive depths of 5 feet each, in a clean, dry bottle. Owing to the rise of a strong southerly wind blowing against the river it was necessary to remain three quarters of a mile off shore. One set of samples was taken here, the next set six fathoms nearer the shore. Immediately a sample was taken its temperature was observed and the chloride present determined in order to discover whether the boat was sufficiently near the river mouth and whether the rough weather had seriously interfered with the experiment. All samples were securely corked and both chlorides and oxygen present carefully determined in the laboratory. There was no variation in the oxygen present in successive samples and the figures are not included. The following results give the salinity at successive depths of five feet:—

Three quarters of a mile off shore.

Depth	Temperature	Chlorine calc. as sodium chloride.
Surface	12·00° C	1·7%
5 feet	12·25° C	2·1%
10 feet	13·50° C	2·6%
15 feet	13·00° C	2·8%
20 feet	13·00° C	2·9%
23 feet (bottom)	13·00° C	3·0%

Six fathoms nearer the river mouth.

Depth	Temperature	Chlorine calc. as sodium chloride.
Surface	12·00° C	1·5%
5 feet	12·00° C	1·7%
10 feet	12·50° C	2·6%
15 feet	12·75° C	2·7%
20 feet (bottom)	13·00° C	3·0%

These tables show that, despite the stormy weather, the waters are not uniformly intermingled, but are in fact in layers of varying salinity. Waters in such condition will, as already shown, exert a very corrosive action upon Muntz metal or, obviously, upon any other metal.

Fig. 2 incorporates these results and shows very clearly that a pile sheathed with Muntz metal and immersed between depths of five and ten feet would

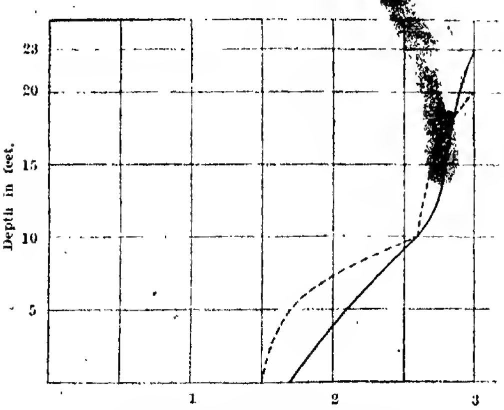

FIG. 2.

e, in these instances, subject to an appreciable otential difference between the top and bottom of the heet. It must also be emphasised that wherever alt and fresh waters mingle there will be no udden uniformity established and that currents, ayers, and eddies of water of varying salinity will xist. The author believes that this theory of rying salinity will help to explain the excessively rrosive action of the brackish water of tidal rivers of admixtures of sea water with the storm and her effluent waters of a seaport town.

The author is indebted to Dr. J. S. Maclaurin, Dominion Analyst, for permission to publish these esults; also to Mr. G. C. Burton, of this laboratory, or assistance in sampling the Hutt River water.

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THE DETERMINATION OF CADMIUM IN SPELTER AND ZINC ORES.*

BY C. E. BARRS, A.I.C.

In the sale of spelter it is often stipulated that cadmium is not to be taken as zinc; also, if the metal is to be used for rolling into sheet, it is important that the cadmium content, as well as the other impurities present, should be known accurately. Since the separation of cadmium from zinc is usually attended with more or less difficulty, it was thought that a description of the following method, with results obtained, might be useful.

Method for spelter.

Ten grams of the carefully sampled metal are dissolved cautiously in 30 c.c. of nitric acid (d 1·420) and 100 c.c. of water. When all is dissolved it is diluted to 250 c.c. with warm water, and ammonia (d 0·880) added until the zinc hydroxide precipitate is redissolved; the solution is then heated to coagulate the remaining precipitate, which is filtered off and washed with a 5% solution of ammonia. Should the precipitate be very bulky it is as well to redissolve and reprecipitate it. The filtrate is then heated until nearly boiling, and whilst stirring, 2 c.c. of a 50% solution of sodium sulphide are added. The addition of sodium sulphide is repeated, with stirring, until a small excess of zinc is precipitated. The liquid is heated on a sand-bath for at least one hour, with occasional stirring, the precipitate filtered off without washing, and washed back into the same beaker, the filter cleaned with, and the precipitate dissolved in nitric acid; 15 c.c. of sulphuric acid (1 : 1) are added, and the mixture evaporated until sulphur trioxide fumes are evolved, when 25 c.c. of water are cautiously added, and heat is applied until all soluble salts have dissolved. When the mixture is cool, the precipitate is filtered off, and washed with 5% sulphuric acid, sufficient concentrated sulphuric acid is added to make the filtrate 20% acidity, and after warming to 60° C. hydrogen sulphide is passed for a few seconds to precipitate most, but not all of the copper. The liquid is gently heated, and the precipitate, when coagulated, is filtered off and washed with 2% sulphuric acid solution. (If the amount of copper is small it is preferable to precipitate it with the cadmium.)

The filtrate is then diluted to at least 250 c.c. with water, and hydrogen sulphide passed in until the precipitate settles out well. If after passing the gas for twenty minutes no precipitate has appeared, one or two drops of ammonia (1:1) may be added to facilitate the precipitation. The solution is filtered, and the precipitate washed with 2% sulphuric acid solution containing a little hydrogen sulphide, washed back into the same beaker, dissolved in a little nitric acid, evaporated if necessary, and filtered through the same filter paper into a large previously weighed silica crucible, and washed with 5% nitric acid. The contents of the crucible are then evaporated with 1 c.c. of sulphuric acid (1 : 1), ignited gently at first, then at a red heat, cooled in a desiccator, and weighed.

* Read at a meeting of the London Section on Jan. 7, 1924.

A few drops of nitric acid (1:1) and 3 c.c. of warm water are then added to the crucible, and heat is applied until any copper oxide has dissolved; the solution is titrated for copper by the iodide method in the usual manner. The result calculated to copper oxide (CuO) and deducted, together with the weight of the crucible, from the above weight = cadmium sulphate. The weight of cadmium sulphate multiplied by 0·5391 = cadmium.

Method for ores.

The finely-crushed ore (2–5 g.) is attacked with sufficient hydrochloric or nitric acid, or a mixture of both, to decompose it. The mixture is evaporated to complete dryness, treated with 25 c.c. of hydrochloric acid (1:1), and heated until all soluble matter has dissolved. The insoluble residue is filtered off and washed with 8% hydrochloric acid. The filtrate is neutralised with ammonia, and acidified with hydrochloric acid, so that there is 1 c.c. of acid per 100 c.c. of liquid; hydrogen sulphide is then passed until an excess of zinc sulphide is precipitated, after which the beaker is set aside in a warm place for one hour, with occasional stirring. The precipitate is filtered off and washed with 0·5% hydrochloric acid containing hydrogen sulphide, washed back into the same beaker, and dissolved in nitric acid, with the addition of a few drops of hydrochloric acid, if necessary. When dissolved, ammonia is added in slight excess the solution heated and sodium sulphide added, and the analysis proceeded with as in the spelter method

The spelter and ores used for this work already contained some cadmium, but additional weighed quantities of the latter, were added to the spelter and ores, when they were being dissolved. In the case of C, D, CI, and DI, further quantities of lead, iron, and copper were also added at the commencement of the analysis, in order to see what effect, if any, such impurities would have on the results. In C and D only one precipitation of iron was carried out.

Tin is very occasionally met with in spelter, and in view of this a small quantity of this metal was added in E and F, in addition to those impurities mentioned for C and D.

The results are tabulated below.

A special alloy of cadmium and spelter containing 0·395% of cadmium (prepared by Messrs. Locke, Lancaster and W. W. and R. Johnson and Sons, with special precautions against volatilisation losses), was also tested by the above method. The amount of cadmium found was 0·403% and 0·407%, whilst that found by their chemist using a different method of analysis was 0·390%.

	Spelter (Zn 99·8%) + cadmium.		Same spelter + 0·1 g. Pb, 0·05 g. Fe, 0·01 g. Cu, and cadmium.				Same, with addition of of 0·05 g. Sn.		Zinc ore (blende). Trials with 2 g.			Zinc ore (calcined calamine). Trials with 2 g.		
	A.	B.	C. (One pptn. of iron).	D. (One pptn. of iron).	C.I. (Two pptns. of iron).	D.I. (Two pptns. of iron).	E. (Two pptns. of iron).	F. (Two pptns. of iron).	G.	H.	I.	J.	K.	L.
Cadmium present, g.	0·0102	0·0102	0·0102	0·0102	0·0102	0·0102	0·0102	0·0102	0·0100	0·0100	0·0100	0·0155	0·0155	0·015[illegible]
„ added, g.	0·0538	0·0580	0·0566	0·0548	0·0513	0·0556	0·0517	0·0517	Nil	Nil	0·0050	Nil	Nil	0·005[illegible]
Total Cd. present, g.	0·0640	0·0682	0·0668	0·0650	0·0615	0·0658	0·0619	0·0619	0·0100	0·0100	0·0150	0·0155	0·0155	0·020[illegible]
„ „ found, g.	0·0641	0·0683	0·0652	0·0637	0·0615	0·0650	0·062[illegible]	0·0616	0·0102	0·0098	0·0139	0·0154	0·0156	0·020[illegible]

In conclusion, the author's thanks are due to Messrs Daniel C. Griffith and Co., in whose laboratory most of this work was done, and who kindly gave permission for the paper to be published.

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THE SPONTANEOUS COMBUSTION OF COAL.*

BY J. IVOR GRAHAM.

The spontaneous combustion of coal is a serious roblem involving either directly or indirectly danger o life or limb, and also considerable financial loss. 'his latter is the case whether the phenomenon ccurs on the surface, underground, or amongst oal cargoes. The danger arising from the occurrence f spontaneous combustion underground was brought efore the public a few months ago by the serious xplosion which occurred at Maltby Main Colliery, s a result of which 27 men lost their lives during perations which were being carried out to save , considerable portion of the pit from complete loss hrough the spread of fires and heatings. The actual xplosion would appear to have been one of fire-amp, the explosive mixture becoming ignited at a re which was evidently burning in a more distant art of the workings. In the Cadeby disaster in 912, 35 persons lost their lives as a result of the rst explosion and 53 by the second—including three alued members of the Mines Inspectorate. The s of life through gassing and explosions resulting m spontaneous fires underground has been heavy, d the danger from this cause is likely to increase years go on, owing to the necessity for deeper ning under conditions of higher natural tempera-re and greater pressure on the strata above and low the underground workings. The dangers ising from spontaneous combustion at sea are ident. Heating of coal stacked on the surface at s works, coal wharfs, etc., is rarely responsible · casualties, since the direct danger of carbon noxide poisoning does not occur in the same way is the case in a confined atmosphere underground— even in ships' holds. In a "gassy" pit in addition re is the very serious aspect of a firedamp explo-n and/or a still more disastrous coal-dust explosion. the financial side the question of spontaneous mbustion assumes a most important aspect. seemingly small underground heating may cost colliery several hundreds of pounds. In many es large areas of coal are lost through a heating ving taken place sufficiently serious to necessitate complete sealing off of an underground district d abandonment of this for years, if not for ever. h occurrences have, unfortunately, been many the local coal field. The financial loss due to ntaneous combustion at sea is also very consider-le, and the casualties occurring on British ships ne have been given as between 50 and 100, with total annual shipping loss of 200 vessels. The estion of safe storage of coal on the surface is one considerable importance for gas-works and other industrial concerns where there is the necessity for storing large quantities of fuel.

Dudley (1665, *Metallum Martis*) refers to spontaneous combustion underground, and Plott (Professor of Chemistry, Oxford) in his *Natural History of Staffs*, 1686, describes in some detail the firing of coal, mentioning Dudley's work. The explanation of the phenomenon has been sought for many years by chemists, physicists, mining men, and others. The oxidation of pyrites—especially marcasite—was for long accepted as the main cause of spontaneous combustion (Plott); later, the absorption of oxygen by the coal or parts of the latter, bacterial action, and the oxidation of other inorganic material apart from pyrites have been put forward to explain the cause of heating. Berzelius concurred in Plott's view that pyrites is the responsible agency, and this idea prevailed until the middle of the 19th century, when De la Beche and Playfair (1846-50) discussed the causes of weathering and spontaneous combustion of coal, and suggested that in stacks fine coal is as likely to give trouble as pyrites. The pyrites theory appears to have been doubted by Percy (Chem. News, July 9, 1864), who definitely ascribed to coal the responsibility for spontaneous heating. A complete bibliography is not possible here, but mention should be made of the work of Richter (Dingl. Polyt. Journ., 1868, 1869, 1870, **190, 193**), who found that oxygen was absorbed by coal at first rapidly and later more slowly. He also discovered that coal can take up large quantities of carbon dioxide.

The next most important piece of work was carried out in 1879, by Fayol † who conducted experiments on a larger scale. His main conclusion concerning the stacking of coal was that it was necessary to exclude the coal from the action of air either by storage in air-tight vessels or immersion in water.

The general conclusions arrived at by Fayol from his experiments were that no rise of temperature occurs with a thin layer of slack, but that the temperature increases with the height of the heap (2 metres is safe). He also investigated the theory that spontaneous combustion was, to a certain extent, promoted by the presence of moisture, and came to the conclusion that "the influence of wet weather on the heating of heaps of coal has not been sufficiently marked to be observable."

In 1898 Dr. J. S. Haldane (Haldane and Meachem, Trans. Inst. Min. Eng., 1898, **16**, 457-492) carried out a very important investigation at Hanstead Colliery and in his laboratory at Oxford. He came to the conclusion that the rate of absorption of oxygen by coal varies with the percentage of oxygen

* Read at a meeting of the Birmingham Section on January 15, 1924.

† "Études sur l'Altération et la Combustion Spontanée de la Houille Exposée à l'Air." Bull. Soc. Ind. Minérale, 1879, II., **8**, [3], Paris.

D

in the air, that the rate of absorption of oxygen is doubled for every rise of 30° C., that this rate decreases as time goes on, and that the absorption takes place at the coal surface and does not penetrate deeply. Haldane was the first to observe the production of carbon monoxide during the oxidation of coal at ordinary laboratory temperatures, although underground this gas was absent in Hamstead Colliery—a result which has been confirmed by the present author.

Lewes in (1890 (J. Gas Light., **55**, 645) discussed at length the work of Percy, Richter, and others, and the influence of pyrites on spontaneous combustion. Lewes was not in full agreement with Richter regarding pyrites, believing that its function was to break up the coal during oxidation.

In 1909 Sir R. Threlfall (J., 1909, 759–773) gave a valuable digest of the findings of the Royal Commission which sat in New South Wales, 1896–1900, on "Ships carrying coals"

Since 1905 a considerable amount of work has been carried out, and an excellent publication by J. B. Porter, on "The weathering of coal," summarises the greater portion of work carried out up to the year 1914, including also a number of laboratory experiments carried out at McGill University, Montreal. The main factors then known to influence the spontaneous heating of coal were that oxygen is necessary for such heating, and that oxidation must take place under conditions such that the resulting heat cannot escape as rapidly as it is produced.

From 1908, onwards, considerably more attention appears to have been given to the subject by chemists. Dennstedt and Bünz (Z. angew. Chem., 1908, 1825–35) carried out a number of tests on different coals by passing a stream of oxygen over the powdered sample at temperatures of 135° C. and 150° C. These results indicated that their coals could be divided into four classes :—

(1.) Those coals in which the temperature never rises above that of the bath.
(2.) Coals which rise only slightly above the bath temperature.
(3.) Coals which rise fairly high, but will not ignite unless the oxygen supply is carefully increased with the rise in temperature.
(4.) Coals which ignite easily—as a rule in about 2 hours.

According to these investigators, self-ignition increases in a ratio corresponding to the amount of moisture in air-dry coal—which moisture they imply is water of constitution. They conclude that humic acids are formed as a result of oxidation and that these acids are exceedingly hygroscopic. They determined the Maumené value for their samples (*i.e.*, rise of temperature on mixing the dried coal with concentrated sulphuric acid) and also noted that the coals dried in a current of carbon dioxide gave a rise in temperature when mixed with cold water which was proportional to the increased liability to spontaneous ignition.

Boudouard (Compt. rend., 1908–9, **147**, **148**) discusses the production of ulmins during the weathering of coal and the connexion of the latter with loss in coking power (Rev. Mét., 1909, **6**, 446–458).

Dennstedt and Bünz concluded that neither the mineral constituents (pyrites) nor organic sulphur or nitrogen influence spontaneous combustion. They point out that this property depends on (1) the friability and (2) the moisture content of the coals. (Their work will be referred to again later.)

Parr and Kressman (Univ. of Illinois Bull. 46, 1910) carried out a number of tests in bins on Illinois coal, coming to the conclusion that in general pyrites masks the effect of oxidation of the coal substance. With regard to the latter they consider there is a critical temperature above which oxidation will proceed independent of external conditions until firing takes place.

Up to 1913 most of the laboratory researches in the oxidation of coal were concerned with the behaviour of coal at temperatures above 100° C. Such experiments carried out at elevated temperatures do not, however, throw a great deal of light on the actual course of spontaneous heating of coal.

Experiments were undertaken at the Doncaster Coal Owners' Laboratory in 1913 to trace the oxidation of various parts of the Barnsley Seam (which in South Yorkshire is very prone to take fire spontaneously) at temperatures varying from that existing normally underground (30° C.) in deep mines up to a temperature of 150° C. The results of these have been given in papers published in the Transactions of the Institute of Mining Engineers (1913 *et seq.*). In these tests the influence of pyrites was eliminated so far as possible by careful sampling of the coal and also by determination of the sulphate before and after oxidation.

TABLE I.

Comparison of rates of oxidation of the different portions of the Barnsley seam at various temperatures.

Absorption in c.c. at N.T.P. per 100 grams of sample

		Hards	Jacks	Cannel	Barnsley softs	Top softs	Shale
At 30° C. after	2 hrs.	20	18 4	17·3	21 7	-	5 2
	12	7·2	6 3	6·2	9·3	—	1 9
	48	3 2	2 6	2·6	3 6	—	0 8
	96	1·9	1·8	1·7	2·3	—	0 5
At 50° C. after	2 hrs.	50·7	30·9	37 6	51·0	47 3	13·0
	12	14 7	9·4	10 1	14·3	14 4	3 5
	48	5·3	3·8	4·4	6·2	5 2	1 5
	96	3·4	2·3	3·0	3·6	3·6	1·0
At 70° C. after	2 hrs.	51·0	60 5	59·0	79·1	73·4	18·7
	12	21·7	21·0	18·3	39 4	31·5	7 8
	48	8·0	8·0	10·7	12·6	11 6	8 6
	96	5·2	6·1	8·4	6·9	8 4	4·0
At 100° C. after	2 hrs.	160	157	146	207	208	55 (about)
	12	52·4	53·2	51 2	70·5	75·2	—
	48	19·2	23 5	26 0	27·0	32·1	—
	96	12·9	18·4	22 4	17 8	22·1	8 (about)
At 120° C. after	2 hrs.	411	285	(320)	(335)	(380)	-
	12	110	94	118	124	124	—
	48	49·6	40·4	53 8	48 5	55	—
	96	28·4	29·3	41 0	29 0	41 3	—
At 140° C. after	1½ hrs	—	620	770	869	891	—
	2	741	—	—	—	—	—
	12	170	192	242	263	246	—
	48	79	84·7	113 5	110·8	108	—
	96	52 5	57·2	80 2	69 5	71	—
		%	%	%	%	%	%
For experiments at 30° C.	H_2O	7	5 5	4	9	—	3 3
	Ash	3	17 0	14	6	—	72 0
For experiments at 50° C.	H_2O	8	5·8	3 25	7·80	9 83	4 8
	Ash	3·5	25·8	2·20	4·25	3 85	63 2
For experiments at 70° and 100° C.	H_2O	7	6·44	4·24	9 81	9·06	5·28
	Ash	3	13·10	4·80	2·70	6·20	68·0
For experiments at 120° and 140° C.	H_2O	7	6·35	4·00	8·60	9·85	—
	Ash	3	15·25	2·30	3·00	2·05	—

Experiments were carried out on the relative rates of oxidation in a current of air of the various portions into which the Barnsley seam could be easily separated. These include (in order of their position in the seam)—(1) top softs, (2) black shale from dirt band, (3) Barnsley hards, (4) Barnsley softs, (5) Jacks, and (6) cannel. Mother-of-coal, mineral charcoal, or fusain was also tested—this sample being taken from the top softs. The samples were tested for oxidation in the moist condition (water, 9-7%). In every case the rate of absorption was found to diminish rapidly with time.

The oxidation of these samples is of interest when looked at from the point of view of Stopes' classification (Proc. Roy. Soc., 1919, B90, 470) of the ingredients of coals—since the hard coal experimented with was identical with durain, whilst the Barnsley ... "top softs" were mostly composed of ... mixed with vitrain. The "top softs" probably contain rather more of the vitrain than the Barnsley softs. Table I shows the rate of absorption of oxygen at $1\frac{1}{2}$ or 2, 12, 48, and 96 hours respectively at the several temperatures, together with analyses showing ash and moisture content of these samples. The rate of absorption and total volume of oxygen taken up increase with rise of temperature. The form of the curve, however, was found to be much the same at the various temperatures examined.

The influence of fineness of division of coal was also tested. The rate of absorption, though increasing with fineness of division, was not found to be proportional to the mesh of sieve used. For example, the rate during the first 120 hours of oxidation of Barnsley hard coal of 30- to 60-mesh was on the average 80% of that of coal passing 200-mesh (Winmill, Trans. Inst. Min. Eng., 46, 563). Similar results were obtained by the present author for the influence of size on the relative amounts of various gases adsorbed by coal—indicating that the available surface of the particle is much greater than that calculated from external dimensions. It was evident that for practical purposes rates of absorption could be determined on samples sieved through a 60- or 90-mesh screen. The absorption of oxygen was found by Winmill to vary according to the equation

$$\text{Absorption} = K\sqrt{\text{partial pressure of oxygen.}}$$

From this equation it is evident that to prevent oxidation, the supply of oxygen would require to be completely stopped, *e.g.*, 5% of oxygen would still cause oxidation at half the rate of ordinary air.

One of the most important results of the Doncaster laboratory experiments was Winmill's determination of the heat produced during oxidation. The determination was made in a Dewar flask as calorimeter, fitted with thermometers and a regulator which controlled the temperature of the oil bath in which the flask was immersed. The regulator could be set so that as the temperature of the contents of the flask rose, that of the bath followed 0·5° C. or even less below. The heat production during oxidation of coal at 40° (soft coal) and 55° C. (hard coal) was found in each case to equal 2·1 calories per c.c. of oxygen absorbed. This is approximately half the heat produced when 1 c.c. combines with coal during complete combustion at high temperatures. With the aid of this value and on the assumption that it held good up to 120° C., it was possible to obtain an approximate value for the rate of heating of coal from the curves for rates of oxidation at different temperatures, assuming no heat loss and in the first instance no moisture present.

These results made it clear how spontaneous combustion occurred. A rapid absorption of oxygen at a normal temperature, *e.g.*, 30° C., would raise the temperature of the coal if the heat were not dissipated. The coal at the elevated temperature would absorb oxygen at an increased rate with further production of heat, the latter raising the coal to a still higher temperature, and so the cumulative effect would go on until the coal actually fired.

Approximate calculations have been made for the time taken for the various samples of coal experimented with to become heated spontaneously to 120° C. At this temperature there is no doubt that the further supply of oxygen would cause the material to fire in a short time. These calculations were based on a value of 0·3 for the specific heat of coal and on the assumption that the rate of oxidation of the dried material would be the same as that of the sample as tested, *i.e.*, with natural water content. Although subsequent experiments have shown these assumptions to be incorrect, the calculation figures may be of interest as giving an indication of the relative times taken by the various portions of the Barnsley seam to reach a temperature of 120° C. starting from 30° C.

A high rate of oxidation of the coal is not, however, the only factor governing the liability of a coal to spontaneous combustion. It is clear that a most important property is that of friability, since results of various investigators (especially Winmill) on the effect of size, and also the author's experiments on the impermeability of coal, show that the production of fine dust is a necessary factor. For example, the cannel coal experimented with showed quite a considerable oxidation, but it is extremely unlikely that this material by itself would be responsible for heating owing to its extremely strong texture. Barnsley softs, $35\frac{1}{2}$ hours; top softs, $37\frac{1}{4}$; Barnsley hards, $53\frac{1}{2}$; cannel, 77; "Jacks," 82; black shale, 422 hours to reach 50°.

An interesting experiment was carried out by Winmill on the rate of heating of Barnsley soft coal. The coal dust was dried *in vacuo* and oxygen admitted only just so fast as it was absorbed by the coal until the temperature reached 90° C., when a slow air current was maintained in order to sweep out the products of oxidation. The experimental results are given in Table II.

TABLE II.

Rate of heating of dried Barnsley softs in oxygen.

After		Temperature, ° C.	After		Temperature, ° C.
0	..	30	12 hrs.	..	62
1 hr.	..	33	16 ,,	..	92
2 ,,	..	35	20 ,,	..	145
4 ,,	..	30	24 ,,	..	195
6 ,,	..	43	24 ,, 10 min.	..	Fired
8 ,,	..	48	—	..	—

During the heating of undried coal, however, a very considerable loss of heat occurs through evaporation of the contained water. The moisture content of the coal is, therefore, a very important factor. This point will be discussed later.

Influence of pyrites.

Many investigators (Plott, Parr and Kressman, and at one time J. S. Haldane) have believed pyrites to be the principal cause of trouble, whereas others, including Richter, Fayol, and Lowes, considered that it played a secondary part. It was generally thought that the two principal forms, cubical pyrite and orthorhombic marcasite, differed considerably in their ease of weathering—the latter being affected by oxygen and moisture much more rapidly than the former. That the pyrites theory was not necessary to explain all cases of spontaneous combustion was clear from the Doncaster Laboratory experiments on samples from the Barnsley seam. In other cases, however, the facts pointed to the pyrites being the principal contributory cause. For example, associated with some seams are bands of inferior material containing pyrites, and in many cases such seams are found to be particularly liable to heating.

Winmill measured the rate of absorption of oxygen by pyrites at 30°, and found that when finely ground *i.e.*, to pass a 60-mesh sieve, the material oxidised rapidly. Fineness of division was shown to be of much greater importance than in the case of coal.

Several different varieties of pyrites were tested by Winmill (Trans. Inst. Min. Eng., 1916, **51**. 500–509), who also examined the influence of fineness of division on rate of oxidation. Some of his results are given in Table III., in which is also given for comparison the rate of oxidation of Barnsley hard coal samples composed of particles of similar size.

TABLE III.

	Pyrites				Coal	
	Sample 1.		Sample 2.			
After Hr.	All passing 60-mesh	Passing 10 mesh Lying on 30-mesh	All passing 200-mesh.	Passing 10-mesh Lying on 30-mesh	All passing 200-mesh.	Passing 10-mesh Lying on 60-mesh
	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.
2	31.5	15.5	25.6	1.6	20·	13.4
4	23·6	13.5	17.3	1.2	11.9	10.4
8	16·9	12.4	13.8	0.75	9·7	6.7
12	13.9	11.9	12·0	0.65	7.2	5.0
24	10·8	10·4	9.4	0·55	4·8	3.8
48	9.0	8·8	8·0	0.45	3·2	2.5
96	8.65	7.0	7·2	0.40	1·9	1·5
Total oxygen abs. in 96 hrs.	1065	853	913	53	453	—

Pyrites sample no. 1 was from a North Staffordshire seam and occurred mixed with carbonaceous matter to the extent of 81·3% FeS_2; the oxygen absorption is, however, calculated to 100% pyrites. Sample no. 2 was from the Barnsley seam, and was found in large crystalline masses which remained untarnished over long periods of time. Winmill's results show that the second sample, although in the coarse condition absorbing relatively little compared with the Staffordshire variety, when ground to pass a 200-mesh sieve absorbs oxygen at much the same rate as the Staffordshire variety passing 60-mesh. The rate of absorption of oxygen by coal sieved in a similar manner to no. 2 pyrites sample indicates clearly how the fineness of coal particles has a much smaller influence on rate of absorption. Winmill states that by washing the pyrites with dilute hydrochloric acid and thus removing the products of oxidation, the power of absorbing oxygen is very largely restored. The absorption of oxygen by coal cannot be renewed in this way, although Tideswell and Wheeler have found that by heating the sample after oxidation to a temperature of 200° C. *in vacuo* the oxidation complexes, or some of them, are decomposed, and the affinity of the material for oxygen at ordinary temperatures is renewed—a most important result which will be discussed later.

The reaction generally believed to take place during the oxidation of pyrites is given by the equation :—

$$2FeS_2+7O_2+2H_2O=2FeSO_4+2H_2SO_4$$

Ferric sulphate may also be formed, but not generally to any considerable extent until all pyrites has disappeared since ferric sulphate will be reduced by pyrites. Moisture is essential for the reaction. The author has confirmed Winmill's results, having found that even the most stable form of pyrites when powdered to pass a 200-mesh sieve absorbs oxygen rapidly. The heat produced during th oxidation of pyrites has been calculated by Parr and Kressman (Univ. of Illinois Bull., 1910, **8**, no. 16, 33) indirectly from Sommermeier's figures for the heat of combustion of ferric sulphide to ferric oxide and sulphur dioxide. The value obtained corresponds to 4·1 cals. per c.c. of oxygen absorbed during the atmospheric oxidation of pyrites. Winmill determined the value experimentally at 40° C. in the apparatus which was used for the similar determination of the heat produced during the oxidation of coal. He obtained a mean value of 4·5 calories with an error of 1·3 cals. He considers the value under mine conditions to be 4·3 cals. per c.c. of oxygen absorbed. This is just twice the heat production found during the absorption of a similar amount of oxygen by coal. These results are most important, as they indicate in a very clear manner when and how pyrites may be a dangerous factor in spontaneous combustion; when it is finely broken up or disseminated through carbonaceous material, rapid absorption of oxygen may occur with considerable evolution of heat, and consequent temperature rise. Since the rate of oxidation of pyrites has been found by Winmill to be doubled for a rise of 10° in temperature, this absorption of oxygen by pyrites will bring about a much more rapid rise of temperature than the oxidation of carbonaceous material alone. The facts that the rate of oxidation of pyrites at any given temperature does not fall off with time so rapidly as that of coal, and also that the oxidation may be increased by washing away the products (ferrous sulphate etc.), tend to render the presence of finely disseminated pyrites exceedingly dangerous. Reference has already been made to the belief that cases of spontaneous combustion in coal piles are more prevalent after showery weather. The author believes that a probable explanation of this is that oxidation of pyrites is accelerated through the removal of the products, and the warm solution of these draining to other parts helps to start the oxidation of fresh

material, probably pyritic in nature, at a higher temperature. It is obvious that even a small amount of pyrites, owing to its rapid oxidation, may raise the temperature of carbonaceous matter to a point at which it will absorb sufficient oxygen to carry on the combustion of the mass *per se*.

In the researches carried out in the Doncaster Laboratory and later in Birmingham, it was generally found more convenient to use coal samples crushed to pass a 60-mesh sieve, since the early experiments showed that the difference in rate of absorption of dust of this fineness and that passing 200-mesh was the same within experimental error. A vessel containing a known weight of coal dust mixed with glass wool was immersed in a thermostat, and a steady stream of fresh air from outside drawn by means of an aspirator through the mass of coal. The glass wool ensured that the air current did not follow definite channels in the dust, but percolated the mass of the coal. Samples of the issuing air stream were taken at intervals and analysed in the laboratory form of Haldane gas analysis apparatus, for carbon dioxide, combustible gas, oxygen, and nitrogen. At the higher temperatures of oxidation, tests for carbon monoxide were carried out in a modification of the Haldane apparatus designed for the purpose.* From the analyses of the samples and a measurement of the rate of flow of the aspirator, the rate of oxidation at any time could be calculated. As the rate of absorption of oxygen diminished, the rate of air flow was slowed down in order to obtain sufficient vitiation of the air to render the errors of analysis as small as possible. In carrying out oxidation in oxygen it has been found to be more convenient to use a more direct method in which the oxygen is pumped backwards and forwards from a reservoir to the reaction flask by means of a simple intermittent-pressure device worked by a water siphon, the gases being withdrawn at intervals from the reaction flask and reservoir, measured, and analysed.†

The author has recently used a third method for measuring rates of absorption and also total oxygen absorbed, in which a simple form of circulation apparatus is employed which can easily be fitted up in any laboratory. A full description of this is to be published shortly. Circulation is produced through the reaction vessel and a Winchester bottle by pumping the gases backwards and forwards with the aid of the above-mentioned system from a burette through small mercury valves arranged so that the current of gas always passes in the one direction. The burette and Winchester are immersed in a well-stirred water bath, or preferably a thermostat the temperature of which can be read to 0·02° C. The reaction vessel is immersed in a thermostat at the desired temperature and connexion made with capillary tubing. The total volume of apparatus is known, and volume readings may be taken at any time and also samples withdrawn for analysis. Very careful temperature and pressure readings are, of course, essential. Circulation at a rate up to 5000 c.c. per hour may be produced.

In 1915 Winmill (Trans. Inst. Min. Eng., 1915–16, **51**, 493) examined over 45 different samples of coal and associated material from different parts of the British Isles. In his results, which are for oxidation at 30° C., and in some cases 60°, he differentiates between the total absorption of oxygen and that used in the oxidation of pyrites, the amount of the latter being determined from the increase of sulphate content. Comparison of the various samples is made by the amount of oxygen absorbed in 96 hours. Those from the Barnsley seam showed absorption of from 300 to 500 c.c per 100 grams. Anthracite samples showed an absorption of 272 and 381 c.c. respectively at 30° C. At 60°, however, the anthracite appeared to absorb very little more than at 30°, thus differing very considerably from the Barnsley coal. South Wales steam coals gave figures varying from 79 c.c. to 134 c.c., whilst a temperature of 60° C. produced only a slight increase in the amount absorbed.

Northumberland and Durham coals with two exceptions gave absorptions of under 300 c.c. at 30° C., whilst at the higher temperature in the one case examined twice as much oxygen was absorbed. The Main seam and the Yard coal showed absorptions of 527 and 623 c.c. respectively, the latter taking up 1305 c.c. at 60° C. A certain amount of pyritic oxidation occurred with the former, whilst a sample of waste coal from this seam showed a total oxygen absorption of 511 c.c., pyrites being responsible for almost half of this. The higher rate of oxidation was however, not always found to be accompanied by prevalence of spontaneous combustion underground, since mining conditions may be such as to preclude the possibility of much small coal being left underground in the waste. On the other hand, the samples from the Main seam were from one of the few pits in which gob fires occur, although in normal working these appear to be rare. Samples taken from the Bullhurst seam showed absorptions varying from 81 c.c. to 167 c.c. at 30° C.; at 60° C., however, the absorption appeared to be nearly double—thus differing from the anthracites and South Wales coals. The cause of trouble in the Bullhurst seam appears undoubtedly to be due to pyritic oxidation; when this reaction has raised the temperature to a certain point, the oxidation of the coal will then produce sufficient heat for the combustion to continue. On the other hand the samples of coal from the Thick seam of South Staffordshire all showed absorptions of 300 to 530 c.c. Such absorption, especially the latter amount, classes the coal as dangerous. Of the samples from Ayrshire two showed high absorption—Bottom coal and Middle coal 502 c.c., Top coal (No. 3 seam) 392 c.c., whilst at 60° the first-mentioned sample absorbed 1100 c.c. The "smithy" coal which was suspected showed very little absorption (124 c.c.). The time/absorption curves were all of the same type, *i.e.*, showing rapid initial absorption which fell off quickly with time.

* Graham and Winmill, Chem. Soc., Trans., 1914, 105.

† Graham and Hill, Trans. Inst. Min. Eng., 1918, "Oxidisable Constituents of Coal, Part II."

Winmill summarises his conclusions as follows :—

(1.) Coals like anthracite and Welsh steam coals, which have a small definite capacity for oxygen, which is not altered by increase of temperature (at any rate up to 60° C.) and cannot therefore fire spontaneously.

(2.) Coals which have a low rate of oxidation, the capacity for which does increase with temperature, but are not liable to spontaneous combustion unless mixed with pyrites.

(3.) Coals which have a sufficiently large rate of oxidation to give rise to fires without the intervention of any other substance.

Those coals considered by Winmill not liable to fire usually absorb less than 200 c.c. of oxygen in 96 hours at 30° C., and those liable to fire well over 300 c.c.

The influence of moisture on rate of oxidation and on spontaneous heating.

An examination of the literature of the subject up to 1909 reveals a pronounced opinion in favour of the idea that moisture exerts a marked accelerating action on the liability of coals to fire both during shipment and more especially when dumped in large piles. Threlfall, referring to the English Commission of 1876, stated that an examination of the evidence showed this to be very largely a matter of impression only. In 1914 (Trans. Inst. Min. Eng., 1915, 49, 35) the author endeavoured to decide the matter by carrying out experiments upon the rate of oxidation of Barnsley hard coal.

Oxidation at 30° C.—(1) After heating at 100° *in vacuo*, the subsequent oxidation being carried out in dry air: Oxygen absorption found in 96 hours = 258 c.c. (2) Undried sample, subsequent oxidation in a current of air saturated with water at 30° C.: Oxygen absorption = 414 c.c. (3) Sample heated for 10 hours *in vacuo*; subsequent oxidation in air saturated with water at 30° C.: Oxygen absorption = 440 c.c. (4) Undried sample containing 7% of water in air from outside: Oxygen absorption = 435 c.c. (5) Sample dried *in vacuo* over sulphuric acid for 5 days, oxidation in dry air: Oxygen absorption in 96 hours = 265 c.c. (6) Sample dried *in vacuo* over sulphuric acid for 4 days, then heated 5 hours *in vacuo* at 100° C., oxidation in current of dry air: Oxygen absorbed in 96 hours = 270 c.c.

Oxidation at 50° C.—(7) Dried *in vacuo* over sulphuric acid (28 days), oxidation in dry air: Oxygen absorbed in 96 hours = 658 c.c. (8) Dried *in vacuo* over sulphuric acid (24 days), heated *in vacuo* at 100° C. for 20 hours, followed by oxidation in dry air: Oxygen absorption = 650 c.c. (9) Dried *in vacuo* over sulphuric acid (28 days), oxidation in current of air saturated with water at 50° C. Oxygen absorption in 96 hours = 945 c.c. (10) Undried sample containing 8% of water: Oxygen absorption = 850 c.c.

These results are taken from rate of oxidation curves and given in c.c. at N.T.P. per 100 g. of dry dust for 96 hours' oxidation.

The rates of oxidation of (2), (3), and (4) were almost identical, whilst (1), (5), and (6) had practically the same value, which is, however, approximately two-thirds of the rate with moist air. Similarly (7) and (8) were identical and about two-thirds of the value of (9).

These results were in agreement with those of Mahler, who found that coal when heated under pressure in the Mahler bomb absorbed more in the moist condition than when dry. The experiments of Richter (1870) gave contrary results (see later). Mention must be made here of the work of Katz and Porter (1917), who compared the oxidation of two coals at 25° C. (Illinois and Pittsburgh coals) over a prolonged period (100 days), in the dry and moist condition, the former condition being attained by desiccation over phosphoric oxide *in vacuo*, or in nitrogen, whilst the moist samples were air-dried. 100-gram samples (ground to pass 80-mesh but stopping on 100-mesh) were placed in flasks of 4½ litres capacity, which were immersed in a thermostat at 25° C., and connected to a manometer in which changes in pressure were noted at intervals. Dryness favoured the rate of oxidation of the Illinois coal, whilst the Pittsburgh coal oxidised slightly more slowly when dry than when moist.

The question of the difference in rate of oxidation of coal dry or moist is of more interest theoretically than practically, since coal in its natural condition, either underground or when stored in piles, will as a rule contain moisture in quantity to produce the maximum rate of absorption. The actual heating of coal will of course be retarded, since in the first place the greater the moisture content the higher will be the specific heat of the material and, what is more important, this moisture has to be completely evaporated before the material rises in temperature above 100° C.—a process requiring a considerable proportion of the heat produced even by a readily oxidisable coal (the evaporation of 10 grams of moisture from 100 grams of coal would require an amount of heat equivalent to that produced by the absorption of approximately 3 litres of oxygen).

These experiments were carried out not only for the purpose of ascertaining the influence of moisture but also to decide the question of the part played by bacteria in the reaction. The shape of the oxidation curves in the first instance and the fact that the persistence of this shape is evident at temperatures up to 160° C. are strongly against the view that bacterial action is responsible except to an exceedingly small extent. In a recent paper on the spontaneous combustion of hay (Fuel, Dec., 1923) J. S. Haldane has shown the typical shape of a curve obtained with oxidation which results from bacterial action.

In the author's experiments the fact that coal sterilised at 100° C. gave the same absorption (when oxidised under similar conditions in regard to moisture) as the unsterilised material clearly showed that bacterial action played no part in the oxidation of Barnsley coal. On the other hand Potter* concluded that slow oxidation of amorphous carbon and coal occurs at temperatures up to 40° C. through the agency of bacteria (*Diplococcus*). The insufficient precautions apparently taken to prevent oxidation of his samples during sterilisation will explain the

*Proc. Roy. Soc., 1908, B 80, 239.

absence of any appreciable amount of chemical oxidation taking place at low temperatures, although in his experiment at 100° C. one would have expected a measurable amount of carbon dioxide to be produced during the 20 days of his experiment. The quantities of carbon dioxide given off as a result of bacterial decay were exceedingly small,' and heat produced in such a way is negligible compared with that from the chemical oxidation of a coal freshly exposed to oxygen, even though the household coal used was somewhat coarse (viz., passing a sieve of 10 meshes to the inch and retained on one of 20).

From the practical point of view, it would thus appear that bacterial action may be safely excluded as a factor of any importance in the spontaneous nbustion of coal.

Adsorption of gases by carbon.

All coals, like charcoal, have adsorptive capacity for ies. This property has been studied in detail for ·ious gases under varying conditions of temperae and pressure, on moist and dry samples of coal. e amount of gas taken up is for the less readily ıorbed gases a linear function of the partial pressure.

TABLE IV.

Methane adsorbed at 30° C. per 100 g. of dried coal 'sture content 1·0%) 200-mesh fineness, under 1 atmosphere pressure.

	Barnsley hards	Barnsley softs	Welsh steam	Ayrshire mid seam	Cannel	Fusain
	184 c.c.	219 c.c.	252 c.c.	166·5 c.c.	134 c.c.	100 c.c.
content ..	4·7	2·8	4·7	6·2	1·9	3·2
r. ..	1·3	1·28	1·31	1·32	1·305	1·55

Adsorption of various gases by 100 g. of coal dust, 200-mesh fineness, H_2O -1%.

SO_2	CH_4		CO		O_2		N_2		H_2	
30°	30°	100°	30°	100°	30°	100°	30°	100°	30°	100°
c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.
1965	18·9	5·4	8·1	1·6	154	18	6	1·4	0·7	0·35
3500	85·9	25·	38·3	8·0	520	81·7	29·6	5·5	3·5	1·95
4100	—	47·6	71·2	15·9	800	148	57·6	11·5	6·8	3·8

t was not, of course, possible to determine the orption of oxygen directly, owing to the imposlity of differentiating between adsorption and nical oxidation. An indirect determination of the ›unt which would probably be taken up by fresh l was made by ascertaining the adsorptive capacity ›xidised dust for oxygen and nitrogen; and from ›mparison of these with the figure for the amount nitrogen taken up by the unoxidised material, igure of 65 c.c. adsorbed per 100 grams under tm. of oxygen at 30° C. is obtained. When the tial pressure is one-fifth of this (*i.e.*, for the amount ›xygen in ordinary air) it may be expected that quantity of oxygen adsorbed by coal will be about c.c. per 100 g. of dry dust. It was found that ist coal dust (*i.e.*, containing about 10% of isture) in general reduced the adsorbing capacity the dust to one-third of the value shown by the ›d material.

t will be seen that the actual volume of oxygen orbed by coal is small and that in the main the ›tion is a chemical one. At the same time it is lent that adsorption plays an effective part in reaction by bringing the oxygen molecules into mate contact with the readily oxidisable conuents. The heat produced by the adsorption of oxygen is very small—being, according to some experiments of the author's, about one-twentieth of that produced during the chemical oxidation. Partington's suggestion (1919) that adsorption alone is responsible has been shown not to be in accordance with experimental evidence (Wheeler, Chem. Soc. Trans., 1918).

References have already been made to the view that the moisture content (and especially that after air-drying) is a criterion as regards the liability of coals to spontaneous combustion. It seems clear that moisture (as found by an ordinary moisture determination at 105°) may be held by the coal in one or more of three different ways:

(1.) *Chemically-combined* owing to the existence in the coal of certain substances which combine with moisture to form compounds of the nature of hydrates. Some of these on heating to a temperature of about 100° C. appear to decompose with evolution of moisture.

(2) *Adsorbed moisture* retained on the free surfaces of the coal. With a considerable amount of adsorbed moisture the coal may still be quite dry to the touch.

(3) *Adherent or capillary moisture*—adventitious moisture—producing a feeling of dampness, or making the sample visibly wet.

It seems to be well established that part at any rate of the absorption is connected with the presence of substances which on heating evolve moisture—substances which are supposed by many (Dennstedt and Bünz etc., *loc. cit.*) to be of humic or ulmic (Schrader) nature and which give on oxidation hygroscopic acidic substances.

It seems probable that in the bituminous coals of high moisture content these substances may be present, whilst in coals such as South Wales steam they appear to be almost entirely absent.* Possibly the increased rate of oxidation of the moist sample may be connected with the oxidation of hydrated compounds, the formation of the hydrate, which is so readily decomposed by heat or desiccation, being necessary before such oxidation can take place. Adsorption alone cannot be responsible for high water content if the adsorption curve for gases can be compared with those for water—South Wales anthracite adsorbed slightly more gas than the Barnsley softs, whereas its moisture content after air-drying is about 1%, that of the Barnsley softs being about 5½% under laboratory conditions.

The author's experiments upon the products of oxidation at temperatures of 100° C. and below have shown that a considerable proportion of the oxygen absorbed reappears as moisture. During the first 5 hrs. at 50° C. 28·5%, and after about 100 hrs. nearly 40% of the oxygen which had disappeared has reappeared in the form of moisture. It is probable that the oxygen reappearing as moisture in this way first forms hydroxyl groups and that these are subsequently split off at a temperature of 110° (the coal being heated to this temperature for the determination of moisture). Earlier experiments

* It should be noted that in the author's experiments on the influence of water on the rate of oxidation, the moisture content of the original coal on air-drying was higher than that of the coals used by Katz and Porter, who obtained conflicting results.

had shown that the products of low-temperature oxidation consisted of small quantities of carbon dioxide and monoxide. The production of these expressed as a percentage of the oxygen absorbed increased with time at any one temperature, and also increased with temperature. Thus for Barnsley coal oxidised at 30° C., the amount of carbon dioxide produced expressed as percentage of the oxygen absorbed equalled :—

	30° C.	50° C.	70° C.	100° C.
At 4th hour	2·9	3	3·8	4
At 120th hour	4·2	7·7	12·5	20

The production of carbon monoxide in the initial stages of oxidation at 20° was 0·5% of the oxygen absorbed, rising to 0·7, whilst at 30° it was 1·0.

The average production of carbon monoxide expressed as percentage of oxygen absorbed over the first 100 hours of absorption has been found to be as follows :—

Temperature ° C.	CO produced as % of oxygen absorbed.
20	0·7
30	1·0
70	2·0
100	2·8
120	5·0
140	7·0

Oxidation of a sample of coal from the mid-seam Ayrshire showed (at 30° C.) a carbon monoxide production varying from 1·2% during the first 50 hrs. of oxidation to 2·0% after nearly two years' oxidation at about 20° C. and subsequent oxidation for 44 hours at 30° C. The carbon dioxide production after this prolonged oxidation was less than 20% of the oxygen absorbed.

With other coals, however, a smaller proportion of carbon monoxide has been found. Thus samples from the South Staffordshire thick coal (Brazill section) were found by the author to give carbon monoxide corresponding to 0·3% of the oxygen absorbed at 30° C. whilst similar results were found with fusain (Trans. Inst. Min. Eng., 1923, 66, [12] 41) and anthracite. Judging also from the vitiation of the air at the coal face in the Warwickshire thick coal seams, and the eight-foot coal in South Staffordshire, these coals appear to give considerably less carbon monoxide for a definite absorption of oxygen than does the Barnsley coal. Knowledge of the carbon monoxide and dioxide production relative to the oxygen absorbed is, of course, essential before deductions can be made from analyses of samples underground concerning the approximate temperature which coal or carbonaceous matter buried in the waste has reached.

Influence of composition.—(*a*) *As shown by ultimate analyses.*—Wheeler has shown that the temperature of ignition of coal dust is influenced by the oxygen content—the greater the latter the lower the temperature of ignition. Winmill's results also indicate, with one or two exceptions, that the greatest oxygen absorption and greater liability to spontaneous combustion is to be found with those coals containing a high percentage of oxygen. For example, the oxygen percentage of the Barnsley seam coals was between 11 and 13. The high percentage must not be taken by itself as the deciding factor, but, as both Wheeler and Winmill have pointed out (these investigators being thus in agreement with Dennstedt and Bünz), a high oxygen percentage probably indicates the presence of oxygenated compounds which are readily oxidi-able at ordinary temperatures. It seems probable also that these oxygenated compounds have the property of holding moisture as a loose chemical compound. From the experimental evidence available the author has no doubt that there are slight differences in constitution in the readily oxidisable constituents of various coals liable to spontaneous combustion and most probably in the proportion in which they are present.[1]

(*b*) *As shown by solvent action of pyridine.* Bedson, the pioneer as regards the use of this solvent for coals, believed that the extract, described as resinous, contained the substance responsible for the ready oxidation of certain coals. Lewes[1] and J. B. Porter[2] concurred in this view. Dennstedt and Bünz[3] examined the action of several solvents and concluded that the portion insoluble in pyridine was responsible for the main heating effect observed for the lignitious coals examined, as tested by their method, which involved heating in a current of oxygen at a high temperature. On the other hand Nübling and Wanner[4] found that the residue obtained by them had a higher ignition temperature than the original coals, whilst the extract had lower. Some careful experiments were carried out by J. Hill and the author[5] to ascertain the part played in low-temperature oxidation by the α and the $(\beta+\gamma)$ constituents, *i.e.*, the portions respecting insoluble and soluble in pyridine. Barnsley soft coal was extracted with pyridine in an atmosphere of nitrogen under reduced pressure and at a temperature of about 40° C. in order to avoid decomposition (*cf.* J. Harger, J., 1914, 389, and Illingworth, Trans. Sth. Wales Inst. Min. Eng., on the increased solvent action of pyridine at high temperatures).

The results (Trans. Inst. Min. Eng., 1917, 54, 197) showed clearly that the "α" compound—or insoluble portion—still contained the constituents responsible for spontaneous combustion. These experiments were confined to coal from the Barnsley seam; other coals of different type have been and are being investigated to determine whether the results obtained for Barnsley coal are in general true for all coals.

(*c*) *The macroscopic separation of coal.* The part played by the various ingredients of Stopes' classification has already been referred to. The four ingredients, durain, clarain, vitrain, and fusain, have been carefully examined by Tideswell and Wheeler, and by Lessing, by distillation and coking and as regards ash composition; from their results Tideswell and Wheeler advance the view that the first three differ in proportion of reactive and "inert" material, rather than in any distinctive types of

[1] The Spontaneous Combustion of Coal—Fuel Bulletin No. 1.
[2] "The Carbonisation of Coal."
[3] "The Weathering of Coal" (*loc. cit.*)
[4] "Die Gefahren der Steinkohle.—2. Die Selbstentzündlichkeit," Z. angew. Chem., 21, 1825.
[5] "Beitrag zur Selbstentzündlichkeit der Kohlen." J. Gasbeleucht., 68, 516.
[6] Trans. Inst. Min. Eng. 1917, 54, 197-224.

compounds. Oxidation tests support this view. The part played by fusain has recently formed the subject of a paper by the author (Trans. Inst. Min. Eng., 1924, 61, 41—57) and it would appear from the discussion, in which Drs. Wheeler and Tideswell took part, that this fourth ingredient of the Stopes classification may differ considerably as regards low-temperature oxidation. Such difference is perhaps more helpful than otherwise in the general elucidation of the problem, as it would appear to be bound up with difference in composition—Wheeler and Tideswell's sample showing a higher percentage of hydrogen possibly indicating the presence of a compound ontaining hydroxyl grouping). In general, however, t has been made clear that the average sample of usain (mother of coal or mineral charcoal) absorbs ery little oxygen in comparison with the other four ngredients, and that from the chemical point of iew this ingredient is not a primary cause of pontaneous combustion.

Space will not permit further discussion concerning he nature of the solid products of oxidation and he relation of these to the ulmins (*cf.* Boudouard, *oc. cit.*). Mention should be made, however, of the ork being carried out by Fischer and his co-workers t the Kaiser-Wilhelm Institut für Kohlenforschung, Iülheim-Ruhr, on the formation of coal. Their xperiments on high-pressure oxidation of coal, gnite, peat, etc., and the interesting observation f Schrader that the rate of oxidation of lignite and oal is considerably accelerated in the presence of lkali, render further investigation of ulmins most lesirable. There now appears to be a good deal of vidence showing that these substances play an mportant part, and similar investigations such as hose of Wheeler and Tideswell (Chem. Soc. Trans., 922, **121**, 2345) and others on these compounds and he constitution of coal will without doubt throw furher light on the chemical nature of the comounds undergoing spontaneous oxidation, and ender intelligible the experimental results already btained by the various investigators.

From the practical point of view, knowledge of he liability or otherwise of a coal to ignite sponaneously is obviously of great importance.

Schaper (Chem.-Ztg., 1919, 43, 401) indicates hat where the "ignition temperature" method is sed great care must be taken to commence the est at the same temperature if comparable results re to be obtained. This will be readily intelligible fter studying the figures (Table I.) showing rate of xidation of the various samples at different temeratures.

Actual measurement of the absorption of oxygen several temperatures (*e.g.*, 30°, 60°, and 100° C.), ugh, of course, taking considerably longer to carry , gives information of a more satisfactory charcter than the rapid test of "ignition temperature," ince the latter gives no indication of the behaviour f the coal at the lower temperatures—a behaviour hich is of the greatest importance in order to decide hether the coal can absorb oxygen at a rate sufficient o generate more heat than that which will be issipated by conduction or in other ways.

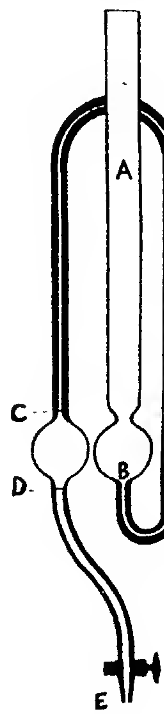
It must be remembered, however, that the physical properties of the coal, especially in relation to its behaviour during crushing, are just as important as the chemical property responsible for rapid rate of oxidation. The most readily oxidisable coal, if it is of strong texture capable of withstanding considerable pressure and grinding without the production of small coal and dust, will not readily fire.

A MERCURIAL VISCOSIMETER COMPENSATED FOR DENSITY.

BY F. M. LIDSTONE.

The viscosimeter to be described in this note is a modified form of one of which an account has already appeared (J., 1917, 270; 1918, 148 T).

Although not quite so simple in construction, it possesses two distinct advantages over the earlier type, viz.: (1) It is not necessary to know the density of the liquid as the head of the latter is nil. (2) The greatly increased length of the upper capillary, since it does not affect the head, enables accurate determinations to be made with thin liquids, such as water.



To use the viscosimeter the method of procedure is the same as before, viz., clean mercury is sucked up to just above B, and the stop-cock closed. A measured quantity of the liquid, very slightly in excess of the capacity of the bulb, is poured into A

and the temperature adjusted by means of the water jacket. The stop-cock is then opened and the stop-watch started when the mercury-oil meniscus passes C and stopped when it passes D. If the two bulbs are approximately of the same shape and size, the level of the liquid in AB will, as it falls, always keep approximately in line with the level of the mercury in CD, thus eliminating the head of liquid and leaving only the head of mercury. The time of efflux is thus, for all practical purposes, a function of the viscosity only, the correction for kinetic energy being very small, as also is the correction for the viscosity and kinetic energy of the mercury, provided the lower tube, DE, be moderately wide in bore.

These viscosimeters can be very accurately calibrated on the lines indicated in the paper by G. Barr (J., 1924, 29 T). There is obviously a slight modification owing to the absence of any head of liquid, and we thus get for the exact equation

$$\eta = K\left\{t - m - (n + rd)/t\right\}$$

where, using Barr's notation, $m = b\eta_m/S$; $n = qd_m/S$; $r = p/S$; S being equal to $a\eta_o/t_o + b\eta_m/t_o + qd_m/t_o^2$.

Although, strictly speaking, all the constants used in the calibration of these viscosimeters are only true for the particular temperature at which the instrument is calibrated, it will readily be seen that the variations in the constants, m, n, and r, due to temperature do not materially affect the final result and may, therefore, be neglected.

The change in the main instrumental constant, K, is, however, of just sufficient magnitude to make a small correction necessary This is due to the change in density of the mercury only; the changes due to the expansion of the glass cancel out, since the effect due to the increase in capacity of the bulb and the length of the capillary is exactly compensated by that due to the alteration in the radius of the capillary. All that is necessary to take into account is, therefore, the change in the effective head of mercury. The coefficient of expansion (absolute) for mercury being 0·00018, K must be multiplied by (1−0·00018T) if the temperature is T degrees above and by (1+0·00018T) if below the temperature of calibration. As an example, the following results are quoted to illustrate the degree of precision obtainable with one of these instruments. The apparatus was of the dimensions suitable for use with thin liquids such as water.

Dimensions.—Radius of upper capillary, 0·0248 cm.; length of upper capillary, 46·4 cm.; radius of lower tube, 0·125 cm.; length of lower tube, 9·83 cm.; mean head of mercury, 10·50 cm.; volume of bulb, 6·744 c.c.

Instrumental constants.—$a = 21{,}065 \times 10^5$; $b = 6{\cdot}9 \times 10^5$; $q = 0{\cdot}21 \times 10^5$; $p = 136{\cdot}4 \times 10^5$; $S = 1{\cdot}26 \times 10^5$; whence $m = 2{\cdot}3$; $n = 0{\cdot}09$; $r = 108{\cdot}3$.

Calibration at 20° C.

Liquid	Viscosity as determined by absolute viscosimeter.	Efflux time (in seconds).	K.
Water ..	0·01005	171·7	0·00005876
Typewriter oil ..	0·2973	5062	0·00005873

Owing to the lateral displacement of the lower part of the tube, DE, the alteration in the effective head of mercury caused by a deviation of the apparatus from the vertical or standard position becomes appreciable. It is most convenient to plumb the long straight tube, AB, and let the corresponding position of the tube, DE, be the standard one at which the apparatus is calibrated and used.

In conclusion, the author wishes to acknowledge his indebtedness to Dr. Guy Barr for numerous helpful suggestions and criticisms.

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PLANT PIGMENTS.*

BY I. M. HEILBRON.

In the main, the pigments of nature may be divided into two classes, on the one hand the plastid pigments, chlorophyll and the carotinoids, which are common to all forms of land plants, and on the other the soluble sap pigments in which many well-defined groups are known, notably the yellow flavonols and the highly-coloured anthocyanins.

It is proposed in this paper to discuss briefly the general characteristics of these several groups and attempt, in so far as is possible, to follow their functions in the life process. As first in importance, the question of chlorophyll will be considered. The rôle played by this pigment is unique, and, without exaggeration, it may be claimed as the very essence of living matter, for the life and growth of plants are as dependent upon the presence of this substance as are human beings on the hæmoglobin of the blood. The pigment itself is contained within certain cells, the so-called chloroplasts, microscopic in dimensions but varying in size and form according to the species of plant. All chloroplasts so far examined appear to consist of two types of material—(*a*) A highly refractive colourless substance of proteinous nature which forms the basis of the chloroplast and bulks largely in its organisation; this substance appears to assume the form of an intricate sponge-work with innumerable and infinitely minute interstices. (*b*) An oily substance filling completely the interstices of the stroma and confined entirely within the limits of the plastid itself; in this oily substance the green pigment chlorophyll is contained in the form of an emulsion, and is apparently more concentrated towards the periphery of the plastid than elsewhere, even when fully developed. Its development and persistence appear to depend on the incidence of light upon the surface of the plastid, and, indeed, in the continued absence of light the chlorophyll disappears from the plastid altogether.

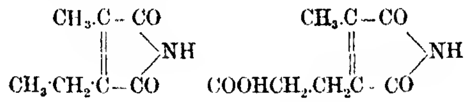
The story of its chemical investigation dates back to 1838, when Berzelius attempted to isolate the pigment from green leaves, but, being of the opinion that it was attacked neither by concentrated hydrochloric acid nor by alkalis, he treated the alcoholic extract of the leaves in such a violent manner that only decomposition products could actually have resulted. For many years following, other investigators attacked the problem in somewhat similar manner to that of Berzelius, without adding in any way much of importance. In 1879 Hoppe-Seyler attempted the isolation of chlorophyll, avoiding the use of chemical reagents, but his experiments produced negative results. Up till the year 1906 the main observations of value regarding chlorophyll are due not so much to chemists (although Schunck did much useful pioneer work) as to workers in other fields of science. On the one hand, the physicist, G. G. Stokes, in 1864 recognised from optical investigations the existence of two components in ordinary chlorophyll, and the Russian botanist, Borodin, observed in 1881 the formation of the so-called crystalline chlorophyll by the drying of leaf sections moistened with alcohol. This discovery, which is actually of enormous import, remained valueless until it was repeated for a second time in Willstätter's laboratory. When this latter investigator, to whom most of our knowledge regarding the constitution of the pigment is due, started his researches, chlorophyll in its solid state was unknown, as also any method of obtaining sufficiently pure solutions for a chemical investigation. Willstätter applied himself in the first place not directly to the examination of the pigment itself but rather to a study of its constitution through the derivatives obtained from it on treatment with acid and alkali. Chlorophyll itself is neither a base nor an acid, but when treated with alkali in alcoholic solution, it is converted into products—the so-called phyllins—which are acid in character, yielding soluble alkali salts. In this reaction, in addition to hydrolysis, a primary change occurs which can be directly observed owing to the alteration in colour which takes place, the green chlorophyll solution changing to brown and then back again to green. This phase phenomenon is termed "allomerisation," and occurs in alcoholic and other solutions, also extremely readily in presence of traces of alkali hydroxides. According to Willstätter, the reactions which occur are due to a rearrangement of a lactam group in one of two ways depending upon whether hydrolysis is brought about in cold or in hot solution. It has been ascertained that the first stage in the hydrolysis is the removal of an alcohol having the formula $C_{20}H_{39}OH$. This substance, known as phytol, is obtained as a colourless, thick oil and has the properties of an unsaturated primary alcohol containing a branched open chain of carbon atoms. It is probably closely connected with isoprene, which may also be looked upon as the progenitor of the terpenes and caoutchouc. In the leaf itself there is present an ester-splitting enzyme—chlorophyllase—which has the power of replacing the phytyl residue by the ethyl radical when allowed to act in alcoholic solution, and the ethyl chlorophyllide thus formed is identical with Borodin's crystalline chlorophyll. On the other hand, the enzyme acts in aqueous acetone solution producing a monocarboxylic acid, chlorophyllide, which still contains, however, a carbo-methoxy ester group which is hydrolysed by alcoholic potash to give dibasic acids—the so-called chlorophyllins. The reaction with alkali in the cold and in the heat leads to the production of different chlorophyllins, of which four

* Read at a joint meeting of the Liverpool and Manchester Sections on Feb. 22, 1924.

were definitely isolated. In these four substances it was found that magnesium was present, the metal being present as a co-ordinated complex not dissociated in solution. By treatment of the chlorophyllins with alcoholic potash under pressure, monocarboxylic acids are formed, and finally, on treatment of these with soda-lime, an oxygen-free compound, the so-called ætiophyllin, having the formula $C_{31}H_{34}N_4Mg$, results. With either the pigment itself or any of its derivatives, in every case treatment with acids brings about an immediate alteration in colour of the solution from green to olive-brown, which colour change is coincident with the removal of the magnesium atom and its replacement by two hydrogen atoms without otherwise altering the composition of the molecule. Thus from chlorophyll there results, on treatment with alcoholic oxalic acid, the magnesium-free compound known as phæophytin. In this compound the magnesium atom is quantitatively removed and replaced by two hydrogen atoms. Both ester groups, however, remain intact. Phæophytin is fairly readily obtained in a pure state free from fat, waxes, and other colourless or coloured impurities. On treatment with boiling methyl-alcoholic potash, it is hydrolysed just as chlorophyll itself is, and yields two extremely important products—a lactam dicarboxylic acid, phytochlorin "e" $(C_{31}H_{32}N_4)(CO)(CO_2H)_2$, and phytorhodin "g," which is obtained in dark reddish-black crystals and has the formula $(C_{30}H_{31}N_4)(CO)(COOH)_3$.

The production of these two acids so similar in constitution to each other and having approximately the same molecular weight as phæophytin, the inability of converting one into another, and the fact that they are invariably obtained in definite amounts, led Willstätter to conclude that phæophytin, and consequently chlorophyll, is actually a mixture of two components, phytochlorin "e" being a product of one and phytorhodin "g" a product of the other. This conclusion is in strict agreement with Stokes' observation and also harmonises with adsorption experiments carried out by the botanist, Tswett, in Warsaw. The complete experimental justification of these views was finally given in 1911 when the isolation of chlorophyll itself was achieved and its separation into its two components—chlorophyll "a" and chlorophyll "b"—accomplished. Chlorophyll "a" is obtained as a blue-black powder which dissolves in alcohol with a blue-green colour and deep red fluorescence. Chlorophyll "b" is a dark-green powder less soluble in light petroleum than the "a" component. In the phase changes, chlorophyll "a" passes into yellow, chlorophyll "b" into red, the original colours being obtained again more quickly with the "b" than with the "a" component. Analysis of the two compounds gives the following:—For chlorophyll "a": $C_{55}H_{72}O_5N_4Mg,\frac{1}{2}H_2O$. For chlorophyll "b": $C_{55}H_{70}O_6N_4Mg$.

The exact constitution of the pigment has not as yet been completely elucidated. According to Willstätter, ætioporphyrin, the magnesium-free crystalline base obtained from both chlorophyll "a" and "b" has the composition $C_{31}H_{36}N_4$. This substance has also been obtained from hæmoglobin and thus once again a direct continuity is revealed in living matter. The oxidation of chlorophyll derivatives leads to the imide of methylethylmaleic acid (I.) and hæmatinic acid (II.).



I. II.

By the reduction of chlorophyll hæmopyrrole is formed, a complicated mixture of pyrrole homologues.

The so-called carotinoids are red, orange or yellow pigments which can be extracted from tissues by fat solvents and are found abundantly in all forms of living matter both in the plant and animal kingdoms. Nothing definite regarding their structure is known. The first yellow plant pigment of this group to be isolated in crystalline form was carotin, the pigment of the root of the cultivated carrot. This chromolipoid is a hydrocarbon and all such substances whose constitution and properties are similar are designated carotins. On the other hand, there occur various oxyhydrocarbons which appear to be generically related to carotin. These are termed, according to Tswett's terminology, xanthophylls. Carotin itself was first described in 1826 by Wachenroder, who obtained it by ether extraction of dried macerated carrot roots and in this way isolated the pigment in ruby-red quadratic crystals. Various formulæ have been ascribed to this substance, but its composition was only definitely settled by Willstätter and Mieg in 1907, who showed it to be identical with the carotin which invariably accompanies chlorophyll "a" and "b" in the chloroplastid of the green leaf. The molecular formula of the substance is $C_{40}H_{56}$. The appearance of carotin together with chlorophyll was first noted by Stokes, but it was left to Willstätter to point out, by the study of innumerable species of land plants, its invariable existence in all green leaves. Stokes also mentions the existence of another yellow pigment now known as xanthophyll, and this has also been isolated in crystalline form by Willstätter and shown to have the molecular formula $C_{40}H_{56}O_2$. As regards the xanthophyll series, Tswett, by a study of the adsorption coefficients towards finely divided materials such as calcium carbonate, has been able to prove that the xanthophyll which accompanies carotin in the green leaf is a mixture of at least three and possibly four isomeric substances, designated as xanthophyll a, xanthophyll a′, xanthophyll a″, and xanthophyll b, the last named showing the greatest adsorption affinity for calcium carbonate and consequently existing in the largest colloidal aggregates. According to this investigator, crystalline xanthophyll is a mixture of two or three isomeric xanthophylls in which xanthophyll "a" predominates. These pigments are not alone common to green plants, but the vast majority of yellow to orange-red flowers and fruits owe their colour, at least in part, to chromoplastids containing carotin-

oids. Thus, the red tomato is characterised by the red carotinoid lycopin, which is isomeric with carotin, and crystallises in carmine-coloured aggregates. In the algæ, especially the brown sea-weeds, a carotinoid known as fucoxanthino has been definitely characterised. This carotinoid crystallises from concentrated ethyl alcohol in long amber-coloured prisms, and has the empirical formula $C_{40}H_{56}O_6$.

It will be seen from the foregoing that the carotinoid pigments are extraordinarily widely diffused in the vegetable kingdom, and consequently it is not surprising to find them equally widely distributed throughout the animal kingdom both among the vertebrates and invertebrates. The existence of a chromolipoid in the blood serum of certain mammals was known as early as 1835, but the relation of this pigment to the carotinoids was not established until the work of Palmer and Eckles in 1914. The chromolipoid of cattle and horse serum is carotin, but in man it may be either carotin or xanthophyll. The chromolipoid pigments of birds are of interest. The egg-yolk pigment was studied as early as 1867, and although its chemical relation to plant xanthophyll was suggested by Schunck in 1903, this was first definitely established by Willstätter and Esher in 1912. The yellow to red colours of feathers are also unquestionably due to carotinoid pigments, xanthophyll probably being most commonly present. Among the invertebrates, carotinoids are also abundantly present.

Recent investigations tend to show that all animal chromolipoids are derived from the carotinoids of the food, and, either unchanged or slightly modified, are the cause of the yellow to red colours of all species of animal. Their significance in the living organism has not been definitely fixed, but I shall endeavour to show immediately a probable function of carotinoids in plants. In animals our knowledge is not as yet far enough advanced to indicate any general physiological function, but the mere fact that they vary in amounts in animals fed on the same foods would seem to indicate that they play a definite rôle. It was at one time considered that a direct connexion existed between carotin and vitamin A, but this has not been substantiated by recent work of Coward and Drummond, whose experiments have proved that although the synthesis of this vitamin is undoubtedly associated with the formation of chlorophyll in the leaf, no correlation with the carotinoids can be detected.

Function of chlorophyll in plant assimilation.

As is well known, the term "photosynthesis" is applied to the process whereby the green plant in presence of sunlight and water is able to bring about the assimilation of carbon dioxide into sugars and other complex organic compounds. The photosynthetic process is still largely wrapt in mystery, but it is to-day generally recognised that chlorophyll is the active medium concerned in the operation. As to the function of this pigment in the assimilation process, Willstätter has definitely proved that formaldehyde must undoubtedly be the initial organic compound formed. According to this investigator, the process takes place in such a way, that under the influence of light, a chlorophyll-carbonic acid complex passes into a chlorophyll-formaldehyde peroxide, which in turn is deoxidised by means of an enzyme with liberation of formaldehyde and evolution of molecular oxygen. With experiments carried out *in vitro* it has been shown that actually, provided sufficient energy is given to the system, formaldehyde can be detected in a carbonic acid solution.[1] The minimum amount of energy required to activate the molecule of carbonic acid in this way is of the order of 150,000 calories. Moreover, when formaldehyde solutions are exposed to short-wave light, the formaldehyde molecules take up energy and are converted into "active" formaldehyde, and in this condition immediately undergo condensation to reducing sugars. From a consideration of the energy required to proceed from carbon dioxide to hexose sugars, it seems in the highest degree improbable that the energy which the chlorophyll complex alone is able to absorb would be sufficient to bring about the complete reaction. On the other hand, if the reaction takes place in stages in which both chlorophyll components, as well as the two carotinoid pigments, are involved, from theoretical considerations there would then be no difficulty in obtaining the necessary amount of energy. That the four pigments are actually employed would seem extremely probable when one considers that, to convert a molecule of chlorophyll "a" into chlorophyll "b" two atoms of oxygen are required, which is in exact agreement with the quantity of oxygen evolved during the transformation of a molecule of carbonic acid into formaldehyde and, finally, agrees absolutely with the oxygen ratio existing between carotin and xanthophyll. In support of this hypothesis, which at any rate it must be admitted is highly plausible, some very interesting experimental confirmation has recently been obtained.[2] By a close study of pure carotin solutions, very definite spectrographic evidence has been obtained that, under certain conditions, carotin does actually pass into xanthophyll. According to these views, each pigment definitely functions according to the following scheme.—

Chlorophyll "a," carbonic acid $\xrightarrow{\text{light}}$ chlorophyll "b"—hydrate + formaldehyde

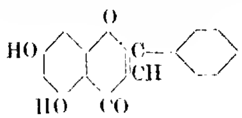
Chlorophyll "b" + carotin = chlorophyll "a" + xanthophyll.

Whether or no the xanthophyll in turn is deoxidised back to carotin by enzyme action, or whether purely chemical reduction occurs is at present being investigated, as also the problem regarding the transformation of the chlorophyll "a" into the "b" component.

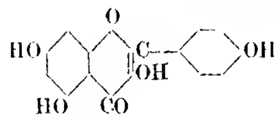
The pigments hitherto considered are all intimately connected with organised protoplasmic substance, and we may now turn to the consideration of colouring matters which exist in a state of solution in the cell sap. Such pigments are characterised generally by the presence of hydroxyl groups in the molecule, that is, they are for the most part phenolic compounds, the constitution of which has in the main been elucidated. Thus we find that several very important

[1] Baly, Heilbron, and Barker, Chem. Soc. Trans., 1921, 119, 105.
[2] Unpublished work in the Department of Inorganic Chemistry, Liverpool University.

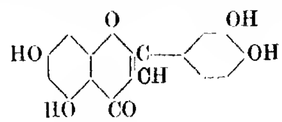
groups may all be regarded as derivatives of unsaturated hydroxyketones containing the linking Ph.C.C.C.Ph. The three important families under this heading are the flavones, flavonols, and anthocyanins. In the flavone group the parent substance is itself met with in nature as the characteristic dust present in many varieties of the primula. Other members of this family which may be mentioned are chrysin (I.), contained in the leaf buds of the poplar, apigenin (II.), met with in the form of its glucoside apiin in the leaf, stem and seeds of parsley, and luteolin (III.), the main colouring matter of weld, the oldest European dyestuff known :—



I.

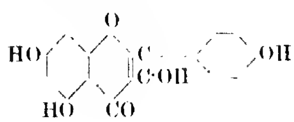


II.

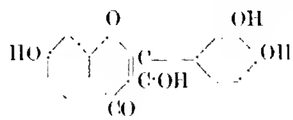


III.

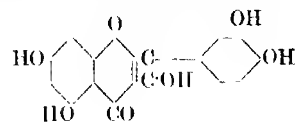
As examples of the widely distributed flavonol group, kaempferol (IV.) found in *Delphinium consolida* a member of the larkspur family, fisetin (V.) the colouring matter of young fustic, quercetin (VI.), the important yellow dyestuff extracted from quercitron bark, which is the inner bark of a species of oak native to the southern States of America, and in which the pigment is present in the form of a glucoside associated with rhamnose, and myricetin (VII.), the colouring matter of an evergreen tree met with in the tropics, may be quoted :-



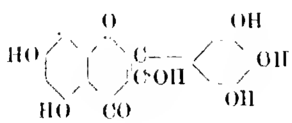
IV.



V.



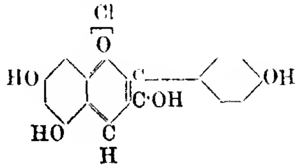
VI.



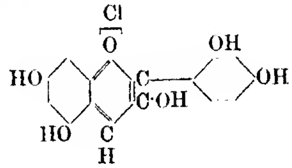
VII.

Closely associated with the flavones and flavonols there still exists a further group of pigments which are by far and away the most fascinating of the series. These are known as the anthocyanins, and it is to their presence in flowers that the red, blue and purple hues which nature so lavishly supplies, are due. Chemically, the anthocyanins are extraordinarily interesting, for although they are nitrogen-free and contain hydroxyl groups, at the same time they react as bases. It is remarkable how nature shuns the employment of nitrogen in her colour schemes, and probably views with indulgent disdain our feverish efforts to multiply azo, sulphur, and other complicated synthetic dyes from coal tar.

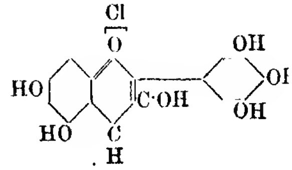
The term anthocyanin seems to have been coined by Marquart in 1835, although flower pigments had actually been investigated at a much earlier date. Thus directions concerning the extraction of the colour pigments of blossoms are found in the writings of Robert Boyle so early as 1664. Prior, however, to 1913, when Willstätter commenced his investigations on these substances, nothing very definite concerning their constitution was known. Willstätter and his collaborators were able to show that the diverse colours of flowers, whether the brilliant red deep violet or blue, were occasioned by quite minute changes of basal material. As present in nature, the anthocyanins are glucosides, yielding on hydrolysis a simple sugar—dextrose, galactose, or rhamnose—and the chromogen to which the distinguishing name anthocyanidin was applied. As regards the chemica constitution of these pigments, this was fairly readil arrived at, for on treatment with alkali all antl cyanidins break down to yield phloroglucinol a hydroxybenzoic acids such as *p*-hydroxybenzoic ac protocatechuic acid, and gallic acid, or their metl ethers. As similar products are obtainable from t flavonols, strong evidence is afforded of a structu connexion between the two groups, and the ant cyanidins are now recognised as oxonium salts ba on the following three formulæ :—



VIII.



IX.



X.

It will thus be observed that the anthocyanidins are actually reduction products of the flavonols, and the successful reduction of quercitin to cyanidin has been accomplished independently by both Everest and Willstätter. The three compounds, pelargonidin (VIII.), cyanidin (IX.), and delphinidin (X.), form the bases of all flower pigments, so far, at any rate, as has as yet been observed.

The different types which occur in nature are due either to the presence of different glucosides, on the one hand, or to methylation of the free hydroxyl groups on the other hand. As an example of this, cyanidin is met with as a monoglucoside in asterin, the pigment of the purple-red aster, and as chrysanthenin, which is isomeric, the pigment of the deep red chrysanthemum. On the other hand, idaein, the colouring matter of the cranberry is a galactoside of cyanidin. Cyanin, which is the pigment of the rose, dahlia, peony or cornflower, is a diglucoside, and isomeric with mekocyanin, the pigment of the purple-scarlet poppy. Again, keracyanin, isolated from the cherry, is a diglucoside containing both dextrose and rhamnose. According to Willstätter, the red coloration is due to oxonium salt formation, whereas the blue colour of flowers is to be ascribed to the formation of potassium salts of the oxonium base. The free base itself is purple in colour, but rapidly passes into the colourless carbinol. With these views, I myself am not wholly in agreement, for in the preparation of somewhat similarly constituted compounds in these laboratories, we have found that colour change from red to blue is only reached when a free hydroxyl group is present in the 4′-position of the 2-phenyl group, and according to our views, the change from red to blue is due to change of structure from the oxonium to a pyrone-quinonoid type.

The wonderful alterations in leaf colour observed in flowers are due to a variety of causes, notably the presence of different anthocyanins in the same plant or even in the same leaf. Colour variation depends also on the quantity of pigment present, as also on the acid or alkaline character of the cell juices. Frequently, moreover, flavonols, carotin, or xanthophyll are also associated with the anthocyanin pigment, producing in this way a variety of hues of unsurpassed beauty.

Although the constitution of the anthocyanin pigments has been conclusively proved by their direct synthesis in the laboratory and their relation to the flavonols equally definitely arrived at, the method by means of which they are synthesised within the living cell is still obscure. Fairly conclusive evidence seems to show that anthocyanin production is not directly photosynthetic, but that, indeed, the appearance of the pigment accompanies lessened photosynthetic activity such as is found in plants towards the end of their vegetative season. The same obscurity is met with when the physiological significance of the anthocyanins is considered. Here again, in contradistinction to the chlorophyll pigments, no satisfactory explanation has been arrived at. It has been suggested that they act as light screens shielding the chloroplastids from too intense insolation. Again, it has been advocated that their function is to bring about absorption of light rays and their conversion into heat, thus raising the temperature of the plant tissues. Against both these views many objections can be raised, and much further research is yet required to account satisfactorily for the formation of these wonderful and fascinating pigments. There can, however, be little doubt that they do actually play a very definite rôle in the life-mechanism of the plant.

In conclusion, the author desires to make grateful acknowledgement to the authors of the following books for the free use which has been made of their contents: R. Willstätter and A. Stoll, "Untersuchungen über Chlorophyll," A. G. Perkin and A. E. Everest, "The Natural Organic Colouring Matters," Leroy S. Palmer, "Carotinoids and Related Pigments."

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THE ANALYSIS OF LYSOL.

BY A. H. DODD, B.A., A.I.C.

The *Liquor cresolis saponatus* of the Pharmacopœia is required to contain 50% of cresols. Most Lysols on the market also claim to contain this quantity, but there are brands of lower strength. There appears to be no really accurate method for a rapid determination of the percentage of cresylic acid in these products (*cf.* Schmatolla, Chem.-Ztg., 1922, 46, 661).

In the examination of Lysols and similar compounds, the mixed tar, fatty, and rosin acids are separated from the oils, after demulsification, by extraction with sodium hydroxide solution and subsequent liberation with acids and extraction with ether or benzol.

This paper deals with the separation and measurement of the tar acids. In practice it is not usually required to know the composition of the tar acids; all that is necessary is that they should distil between the usual limits.

Separation of phenols from fatty acids etc.

Generally the cresols or tar acids are separated from the fatty or rosin acids by distillation with steam or by simple fractional distillation, it being assumed that the fatty or rosin acids are much less volatile.

There are special methods which can have only a limited application, *e.g.*, that of separating the barium or calcium salts of the soaps, which only succeeds with certain fatty acids such as oleic acid. Weyl's method of forming a soap in ethereal suspension with sodium carbonate (Ber., 1889, 139) seems never to have been developed, probably because emulsions are formed from which it is difficult to separate the cresols.

Separation of phenols by steam distillation.

In the "official method" of the German Pharmacopœia (Vol. 5) the acidified Lysol is distilled with

steam until the distillate is no longer turbid. The cooling water of the condenser is then turned off until steam issues from the condenser, after which steam distillation is continued for five minutes longer with cooling. The distillate is assumed to contain all the phenols. The U.S Dept. of Agriculture has issued a pamphlet* in which steam distillation is recommended to remove tar acids from the U.S.P. *Liquor cresolis compositus*.

Despite its obvious convenience, there is one serious objection to the method. The cresylic acids of commerce which are invariably used in Lysols contain varying percentages of higher-boiling phenols. These are present in the "water white 97–99% commercially pure cresylic acid." They are extremely difficult to volatilise in steam, especially in the presence of fatty acids, which lower the vapour pressure of the tar acids very considerably. Thus in one experiment 1 gram of pure xylenol was completely removed from a water suspension by 300 g. of steam; when excess of fatty acids and rosin were present 1200 g. of steam were required before the distillate gave a negative test for phenols. Edwards and Freak (J., 1920, 326 T) state that tar acids of b.p. above 250° (small quantities of which exist in ordinary cresylic acid) are not volatile in steam.

Hence, even if it be possible to distil the whole of the tar acids with steam, large volumes of distillate will be obtained. This is a great disadvantage when it is desired to extract the tar acids with ether or to concentrate with sodium hydroxide solution before acidification.

Jordan and Southerden (Pharm. J., 1921, 479) have suggested a very simple method for the examination of Lysol, in which it is distilled with steam until the distillate gives no coloration with ferric chloride. The distillate is allowed to settle and the volumes of oil and water are measured. It is assumed that the cresols are soluble to the extent of 1 part to 50 of water. Apart from the defect mentioned above, the assumption as to solubility is hardly warranted, since the solubilities of the *o*- and *p*-cresols are 2·5 and 1·8 parts per 100 respectively. In one instance using this method the aqueous distillate obtained was more than sufficient to dissolve all the cresol.

Martin (Analyst, 1921, **46**, 451) points out that certain fatty acids, being volatile in steam, may vitiate the method. With such fatty acids as the author has tried (oleic acid, and those of cotton seed, palm, and linseed oils) the error is negligible. Fischer (Arb. K. Gesundheitsamt, 1903, **19**, 577) made a detailed study of the separation of fatty acids from phenols by steam distillation, and came to the conclusion that with ordinary fatty acids met with in commerce the error was not appreciable.

Jordan and Southerden's method has the further disadvantage that the phenols will not separate in a definite layer, thus rendering the reading somewhat uncertain. The method is, however, useful for control purposes in works using a known cresylic acid.

* "The Analysis of Coal Tar Creosote and Cresylic Sheep Dips," Chapin, 1908.

The methods usually employed for determining the amount of tar acids in the steam distillate are as follows:—

(1) Extraction of the phenols by means of ether and subsequent drying at 100° C.†
(2) Formation and concentration of the phenates and subsequent acidification and measurement of volume of phenols.
(3) Noting the change of volume of caustic soda when the phenols are dissolved in it.

In the first method the water is not driven off from the cresols at 100°C., and at higher temperatures there is the possibility of loss of phenols. Schmatolla (*loc. cit.*) states that cresol holds back ether even on evaporation at 150°.

The process of concentrating the phenate solution and acidification has the merit of simplicity and is recommended by Schmatolla. Chapin points out, however, that the higher phenolates are hydrolysed by repeated boiling with water, and there is a danger of "cracking" under this somewhat drastic treatment, "pitching" undoubtedly taking place.

Chapin's method (*loc. cit.*) consists of extracting the tar acids with benzol, producing the phenate by adding 1 : 2 caustic soda to the benzol solution, evaporating off the bulk of the benzol, decomposing the phenates with acid, and extracting the phenols with benzol. Method 3 above is used for measuring the volume of tar acids (*cf.* Spalteholz, Chem.-Ztg., **22**, 58). The benzol extract is added to 1 : 3 caustic soda, and it is assumed that the volume increase in the soda is 1 c.c. for every gram of cresol.

Chapin gives (*loc. cit.*, p. 32) an analysis of a Lysol by this method in which the error is 0·02%, but with other samples containing 50% of cresylic acids the results varied between 38 and 45%, the average being 42%.

One undesirable feature of the process is that in order to get a sufficiently large volume increase of the soda, a large quantity of Lysol must be used. Also the separation of the tar acids from the acid must be absolute, since a reading error of 0·05 c.c. represents 1% on 5 g. of lysol. Further, 1 g. of cresols does not necessarily give an increase of 1 c.c. (Edwards and Freak, *loc. cit.*); the author has found that 1 g. of Kahlbaum's xylenol (b.p. 211° C.) gave an increase of 0·88 c.c. only (xylenol is found in cresylic acids of commerce from low-temperature tars).

Distillation method of separating tar acids from fatty acids etc.

This method is not generally recommended, since it is known to be impossible to separate accurately two oils of different boiling points by mere distillation. For example, the Swiss authority demands that *Liquor cresolis saponatus* should contain 50% of phenols and cresols boiling between 187° and 210°, and on distillation of 100 c.c. and salting out, 45 c.c. of cresols should separate.‡ This method is evidently

† Frank (Chem.-Ztg., 1922, **46**, 390) proposes to extract the untreated lysol with ether, evaporate the extract, and dry this for one hour at 100° C., the product being considered as tar acids. This method, however, would only be suitable for solutions of pure cresols in absolutely neutral soap made from strong fatty acids.

‡ Most Lysols contain 20-30 parts of fatty acid to 50 of cresylic acid

inapplicable when a considerable proportion of the cresylic acids consists of high-boiling constituents, but as such divergent results were obtained by other methods, it was resolved to test it, since its simplicity is one advantage over the methods described.

A dozen samples of the fatty acids used in commercial Lysols were examined and found to have distilling points well above 300° C. On distilling commercial water-white 97–99% cresylic acids, 95% distils below 210° C.; hence it should be possible to achieve a fairly sharp separation of mixtures of fatty acids and ordinary cresylic acid by fractionation. The ordinary counterbalancing effects of the lower-boiling constituent of the mixture carrying over with it a certain proportion of the higher-boiling constituent and *vice versa* can be allowed for. A study of mixtures of various fatty acids and cresols showed that under specified conditions, and in view of the fact that commercial Lysols are very uniform in composition, it is possible to apply a correction which gives satisfactory results.

There is a choice between two methods of procedure. The tar acids may be separated by fractionation, or a correction may be applied according to the nature and quantity of the fatty acid, which is found by weighing the residue after the tar acids have been removed.

The process decided upon after lengthy trials was as follows: the Lysol is measured into a suitable separating funnel—at least 100 g. should be taken—and shaken with a sufficient volume of 2% sulphuric acid to destroy the emulsion and decompose the fatty acids. About 50 c.c. of ether are added, and, after standing, the supernatant oil is separated. In most instances the dilute acid is again washed with 20 c.c. of ether, and the ether added to the ethereal solution of fatty acids and phenols, which is then allowed to dry over fused sodium sulphate. This is essential in order to get a sharp separation in distilling. The oils are then filtered through a folded paper into an ordinary 250-c.c. distilling flask with side arm, and washed in with more ether. During distillation the flask and gas burner are completely enclosed in a metal cylinder, and the thermometer projects from a sheet of asbestos used as a cover. The thermometer bulb should be at least 2 cm. below the exit of the arm.

Many attempts were made to modify this procedure to obtain more accurate results. For example, test mixtures were distilled in fractionating columns, but it was found that the amount of liquid left in the column detracted from the advantage of the fractionation. Distillation with successive portions of paraffin (generally used in America in distilling tar acids) presented no advantage, as the traces of fatty acid distilling over formed a soapy meniscus when the cresols were dissolved in soda.

After distilling off the ether on a water bath, the fraction which passes over from 100° to 160° C. is collected in a small measuring cylinder, and tested for ether by shaking with a few c.c. of strong caustic soda solution and measuring the volume of ether on the surface, or alternatively by dissolving the tar acids in 5 c.c. of 1 : 3 caustic soda solution and measuring the increase in volume.

The phenols are then allowed to distil over slowly at the rate of 1 to 2 drops per sec. If the flame is kept constant it will be found that the temperature will gradually rise to a maximum—somewhere about 215° C. according to the cresylic acid employed—but the rate of distillation will fall. The temperature will then drop. All the time, however, phenols will distil very slowly owing to a fractionation taking place. The flame is gently raised so that temperature rises about 5° above that reached before. After more drops have come over the thermometer again falls. It has been found that on the third time of heating the temperature can be raised to 230° C., impure cresylic acid coming over. After this an increase in the size of the flame sends the thermometer rapidly up to 300° C.

Although it is advisable to use 100 g. of the Lysol for each test, this is not always possible. In a sample of Lysol of unknown cresylic acid content examined by the author, 18·4 and 17·9% were found working with 50 g. each time. Actually 18·2% was present.

In order to determine the corrections necessary, curves were drawn up. As an alternative to these the following table gives the percentages of cresylic acid distilling at the various temperatures when mixtures of the usual quantities of oleic acid and cresylic acid were distilled. The first series (to 225°) shows the temperature and amount obtained on the first heating, and the second (to 220°) the amount obtained after allowing the temperature to fall and raising the flame. In the third series the mixture was slowly distilled to 230°. The amount of cresylic acid which can be obtained by distilling the usual mixture of fatty acid and cresylic acid appears to be about 98.5%:—

		% of cresylic acid distilled of that actually present			
	Mixture	1	2	3	4
	Oleic acid	80 g	70 g	65 g	60 g
Temperature.	Cresylic acid	20 g	30 g	35 g	40 g
°C		%	%	%	%
205		82.0	76.0	75.0	62.0
210		89.5	87.7	87.0	86.0
215		90.6	90.8	89.[illegible]	89.0
220		92.7	92.75	92.7	90.1
225		—		96.2(*a*)	94.3(*b*)
190		94.2	94.5	98.2	95·5
200		94.5	94.8	98.2	95.75
205		94.6	95.2	98.3	96.5
210		95.9	96.0	98.1	96·5
215		96.0	96.2	98.1	96·6
220		97.1	96.8	98.4	96·7
200		97.5	98.5	98.5	97.0
230		98.0	98.5	98.7	98·2

Although irregularities appear in this table, the final amount of cresylic acid obtained in each case is very much the same.

With mixture 3 it will be noted that a much higher percentage of cresylic acid was obtained at the second stage of the distillation than with mixture 4, although the reverse would be expected. The reason of this is that mixture 3 was distilled much more slowly. At (*a*) the rate was 10 secs. per drop as against 3 secs. per drop at (*b*).

Numerous tests on Lysols of known composition showed that an accuracy of 0·5% was possible, and results can be depended upon to 1%.

The following table gives the results of tests carried out on ten different brands of Lysols purchased haphazard from retail chemists. The first column gives the percentage of cresylic acid as found by the direct distillation method. For purposes of comparison the steam distillation method and the U.S. method were carried out in certain instances. In the last column is given the carbolic acid coefficient as found by the American Hygienic Laboratory method (U.S. Public Health Reports, July 8th, 1921). This method is more reliable than the Rideal-Walker method, since among other things the broth and organism are adjusted to a standard p_H value, and comparable results are obtainable by different workers. The original German Lysol appears to have a coefficient of 1—1·5 by this method:—

Sample no.	Direct distillation method	Jordan and Southerden's method	Chapin's method	A.H.L. coefficient.
1	47·5, 47·5, 48	46·1	41·0	1—1·5
2	48·0, 47·6	46	40·3	1·5—2·0
3	42·75, 43·0, 44·0	42·2	--	1·0—1·5
4	48·2, 50·0	51·5	40·8	2·5—3·0
5	50·0*	--	—	1·0—1·5
6	49·8	58·0	--	1·5—2·5
7	49·8, 50·0	42·0	45·3	3·75—4·0
8	47·5, 43·9†, 44·0†	49·6, 49·0	47·6	1·0—1·5
		42·5, 44·2	40·4	1·0—1·5
9	47·5, 48·0	44·6	36·0	2·0—2·5
10	Separation not possible	2·0	Less than 3·0	Less than 0·25

* American brand. Certified less than 10% water.
† The same brand, but from a different origin of manufacture.

An examination of this table shows that there is a pressing need for an "official method" for the determination of cresylic acid in Lysols. The method described depends for its accuracy on the fact that the Lysol contains approximately 40—50% of cresylic acid; its accuracy becomes less as the cresylic acid falls below this figure. The Lysols examined appear to be of higher quality than those studied by Jordan and Southerden, who found an average of 40% in 10 samples—one as low as 35%.

Apart from the cresylic acid content of Lysols, there are other considerations, viz.: (*a*) quality of cresylic acid or tar acids; (*b*) quality and quantity of soap present; (*c*) the carbolic acid coefficient.

The various substances which constitute commercial cresylic acid naturally have different germicidal effects. When tested in aqueous solution, for example, their differing solubilities cause differing results (*cf.* Lunge, "Coal Tar," 5th Ed., p. 77); apparently the Prussian Ministry which ruled in 1909 that Lysol should contain cresylic acid with no *o*-cresol* was guided by some such considerations. Experiments carried out by the author showed that when the isomeric cresols are made into Lysols with soap solution, their germicidal powers are approximately equal. Thus in one experiment, four Lysols were made up containing respectively 50% of pure *o*-cresol, *m*-cresol, *p*-cresol, and fractionated commercial cresylic acid, 35% of pure neutral soap being used in each. The American Hygienic Laboratory test was applied to each with the same culture (*B. typhosus* in 3% "Lemco broth" of p_H 6·7). In every instance results were positive at dilutions higher than 1 part of Lysol in 300 of water and negative at dilutions below 1 part in 200 for intervals of time from 5 to 15 minutes. In fact, the only differences found were at a dilution of 1 part in 250.

It may be mentioned that with six of the makes of Lysol examined, a Rideal-Walker carbolic acid coefficient was given on the label. There is no reason why a coefficient should not be stated in every case.

A large amount of work has been done in Germany on the influence of various soaps in Lysol (*cf.* Neufeld and Kahlbaum, Z. Hyg., 91, 21 for bibliography). Against a pure culture of any particular organism various soaps must have differing effects, as the physical properties of the colloidal cresol solutions are different. In practice no one is likely to contend that Lysol should be made of a particular soap.

The presence of soap in Lysol ensures that the cresol is brought to the part being disinfected, and is also of importance from the cleansing aspect. Consequently a stipulation might well be made that the "inert matter" in Lysol should not fall below a definite figure. This is the American custom, and it ensures that a product does not contain the maximum amount of water although complying with the requisite of 50% cresols.

In the method of analysis described above, it is easy to arrive at an approximate figure for the fatty acids present. If the distillation is carried out in a tared flask it is only necessary to weigh the residue after distilling off the cresols.

Arising out of the work described above, it is recommended that:—(1) An article described as "Lysol" should have a recognised composition; (2) the amount of water present should not exceed a certain figure (say 15%); (3) the product should be labelled with its "carbolic acid coefficient;" (4) an official method of analysis should be agreed upon.

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Sheffield.

* The formula given is linseed oil 120, potash 27, water 41, alcohol 12, raw cresol (*m*-*p* mixture) 200 pts.

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SILICA GEL AS AN INDUSTRIAL ADSORBENT.*

BY E. C. WILLIAMS, M.SC., F.I.C., M.I.CHEM.E.

A considerable amount of attention has been drawn in this country during the past year to the industrial use of silica gel as an adsorbent for condensable vapours from gases and as a refining agent for liquids, in particular for the refining of petroleum oils. It is proposed to deal mainly with the possibilities of its employment for the recovery of the benzene hydrocarbons from coal gas or coke-oven gas for use as a motor spirit. In view of the complex nature of coke-oven gas and the impurities which it contains, this is probably one of the most severe tests to which any solid adsorbent process can be subjected.

The work reported in this paper was carried out on behalf of the Joint Research Committee of the National Benzole Association and the University of Leeds, and it is by the permission and courtesy of that Committee and of the Executive of the Association that the results obtained are now made public. At the time when this work was commenced some two years ago, proposals had already been made in America for utilising the known adsorptive properties of silica gel for industrial purposes and patents for its manufacture and use had been taken out in the names of Patrick and others. We had no evidence, however, that any successful industrial process had been worked out or indeed that the problems of benzol recovery had been investigated at all. It was decided to investigate the problem from the beginning, and the conclusions arrived at are therefore independent of any claims put forward by the American Corporation, who are now developing the industrial applications of this substance.

As the use of inorganic gels is somewhat novel in industrial practice, a short review of their mode of preparation and properties may be desirable. It is well known that when certain hydroxides are precipitated, flocculent or gelatinous precipitates are obtained. Copper, iron, and aluminium hydroxides are typical examples, as also is silicic acid when precipitated from solutions of soluble silicates by mineral acid. Graham first showed in 1861 that by mixing with vigorous agitation a 10% solution of sodium silicate with a 10% solution of hydrochloric acid, the acid being in excess, it was possible to obtain a clear colloidal solution of silicic acid from which the dissolved electrolytes could be almost completely removed by dialysis. The silicic acid immediately after formation probably forms a true solution; it is able to diffuse through a parchment membrane and shows vapour pressure lowering and osmotic pressure. Within a few minutes, however, the molecules of silicic acid coalesce to form larger aggregates which exhibit the properties of a true hydrosol. Graham observed that such a solution, on standing, coagulated to a firm, elastic jelly which, on drying in a desiccator over sulphuric acid, gave a hard glassy mass of great lustre. Little further work was done until the years 1890 to 1900, when van Bemmelen, in a series of studies upon the vapour pressure relationships of various hydrated oxides, made an exhaustive examination of the vapour pressure phenomena displayed by silica gel and observed the physical changes which take place in the gel during the process of drying. He showed that, on drying, the hydrogel contracted to a hard glassy porous mass which was able to absorb water and other vapours. He investigated particularly the effect of the concentration of liquid from which the gel was prepared and the time taken for the drying of the gel, upon its porosity and adsorptive power (Z. anorg. Chem., 1897, **13**, 239; 1898, **18**, 117). Zsigmondy, Butschli, Bachmann, Anderson and Patrick have also investigated the structure of silica gel by ultra-microscopical methods or by the determination of vapour pressures of liquids adsorbed by the gel.

The fact that a jelly containing as many as 100 molecules of water to each molecule of SiO_2 is a moderately stiff elastic structure indicates some strong bond between the silica and water. Cases of two liquids forming an apparently solid structure, *e.g.*, butter; or a liquid and gas, *e.g.*, whipped cream or white of egg, are well known and may be explained on the basis of a cellular or honeycomb structure. Silica gel is unlike these in that the water in the gel can be completely replaced by other liquids or may be completely removed without affecting the characteristic structure of the gel. These properties preclude the possibility of a honeycomb or cell-like structure and direct ultra-microscopical examination has failed to establish definitely what the true structure is. It may conceivably consist of threads of silica particles intertwining indiscriminately and in all directions after the fashion of the threads in a ball of cotton wool; or may, as Zsigmondy represents it, be simply a formless collection of particles of silica held together by the adsorption of water at their surfaces. Either of these views would account for the open structure which, as will be seen, the gel must possess.

Van Bemmelen (Z. anorg. Chem., 1898, **18**, 140) investigated the physical changes which occur when silicic acid jelly is gradually deprived of water. Table I (reproduced from his paper) records the volume and specific gravity changes during dehydration. The last column shows the calculated specific gravity of a jelly containing the proportions of water and silica indicated in the first column, whilst the third column shows the specific gravities actually observed.

* Read at a meeting of the Chemical Engineering Group on March 7, 1924.

TABLE I.

Mols H_2O per mol. SiO_2	Volume of gel	Specific gravity Observed	Specific gravity Calculated
122	29	1·00	1·01
75·7	18	1·02	1·02
45·2	11	1·04	1·04
23·2	4	1·08	1·09
11·3	3	1·14	1·14
2·8	1	1·40	1·41
2·2	0·86	1·51	1·49
1·7	0·75	1·58	1·56
Transition point			
1·00	0·73	1·40	1·72
0·39	0·73	1·21	1·93
0·30	0·73	1·17	2·00

It will be seen from column 2 that the gel rapidly contracts as water is removed, until a point is reached at which the water content is some two molecules per molecule of SiO_2. Up to this point the decrease in volume of the gel exactly corresponds to the volume of water removed, as is shown by the agreement between the observed and calculated specific gravities. The particles of silica have, therefore, gradually closed together while the spaces between them have remained completely filled with water. After this point, however, dehydration does not cause further contraction. The silica particles have assumed a final rigid structure and further dehydration leads to the driving out of the water from between the silica particles, the spaces being filled with air as rapidly as the water is removed. With the first entry of air the gel loses its transparency and becomes chalky white in appearance, due to the refraction and reflection of light from the minute air bubbles, breaking the continuity of the water within the gel. As dehydration proceeds still further practically the whole of the water is removed and the interspaces become filled with air and the gel regains its transparency. The gel in this final form is a hard, clear, lustrous substance, to all appearances like fragments of broken glass, and it is in this form that it is employed as an adsorbent.

It is not necessary to enter more deeply into the fascinating studies which have been made upon the structure of silica and other gels. The essential point is that, by the formation of the hydrated gel, silica is obtained in a state of extreme subdivision widely dispersed in a water medium, the particles being held in a more or less rigid structure. On dehydration, either in a desiccator, or by heating, the gel contracts, the particles close together until finally they can contract no further. The interspacial water is then driven off, leaving a highly porous, but optically homogeneous, substance. The determination of the actual size of the pores is a matter of some difficulty. The fact that they are beyond the resolving power of the ultramicroscope indicates a diameter of the order of some $10 \mu\mu$, while determinations made by Anderson (Z. physik. Chem., 1914, **88**, 191) of the vapour pressures of liquids held in the pores lead to a value of 2·5 to 5·5 $\mu\mu$. Anderson's method is, however, open to some criticism in so far as his calculations are based on the assumption that the vapour pressure of liquids in such minute pores obeys the same laws as apply to liquids in bulk.

Van Bemmelen (Z. anorg. Chem., 1897, **13**, 239) further investigated the influence on the porosity and adsorbing power of silica gel, of variation of such conditions as the concentration of liquid from which the gel was coagulated, and the time taken for the drying of the gel. Either of these factors would tend to affect the size and nature of the silica aggregates formed, and therefore the structure and porosity of the dried gel.

The nature of adsorption by porous bodies.

Almost every solid surface, whether porous or otherwise, is able to adsorb small amounts of gas or vapour. The extraordinary difficulty, for example of removing the last traces of moisture from the surface of a glass vessel is well known. The amoun of vapour adsorbed by a given weight of substanc must clearly be greatly enhanced when the substanc exposes so vast a surface as does the silica in silic gel. (The surface of a cube of 1 cm. edge is 6 sq. cm. but if that cube were broken up into cubes of 10μ, edge, the surface exposed would be 600 sq. metre or some 6500 sq. ft.) This type of adsorption is purely surface effect, and is dependent upon definit forces of attraction between the molecules of th solid and the molecules of the gas or vapour. Thes forces are generally assumed to be of a chemical c polar origin and lead to a definite orientation of th adsorbed molecules at the surface of the soli It is therefore to be expected that adsorption of th type will be affected by the molecular arrangement the vapour molecules or of the molecules of th adsorbent, and that adsorption will be largel selective. Such adsorption is met with particular in the case of certain forms of active charcoal, ar is in many cases a very desirable property from th industrial standpoint.

A second type of adsorption, which may com into play when a highly porous adsorbent is use is purely physical in nature. When a capilla glass tube is dipped into water, or other liquid whi wets the surface of the glass, the water rises in t capillary to a height dependent upon the radius the tube and the surface tension of the liquid. T vapour pressure of the liquid over the meniscus the tube is less than that over the same liquid co tained in an open vessel and for any diameter of t tube, the vapour pressure of the liquid contained it may be calculated. (The reverse calculation is t basis of Anderson's determination of the pore diame already mentioned.) It is evident that if a su ciently fine capillary tube is brought into an atn sphere of condensable vapour in which the vapo pressure of the vapour is higher than that wh would be in equilibrium with the liquid contain in the capillary, then a partial condensation of vapour in the capillary will take place. Silica may be regarded as a mass of such fine capillar Since these capillaries are formed by the juxtaposit of silica particles they are not of the same diame throughout. The capillaries themselves are proba wedge-shaped and of different sizes. It is possi therefore, to consider the pore space of any fragm of gel as forming a single long wedge-shaped capill

ich in the presence of a condensable vapour will :ome filled with liquid from the apex of the wedge :wards, until a point is reached at which the .meter of the capillary is such that the vapour ssure at the liquid meniscus is equal to that the vapour in the surrounding atmosphere. The .ount of vapour adsorbed is therefore a function the vapour pressure. It is evident that it must o be a function of the temperature. Change in her vapour pressure or temperature alters what y be called the "ease of condensation" of the vapour, l it is more convenient, as pointed out by Patrick, express such case of condensation in terms of a gle condition of the vapour instead of in terms of o. This single condition, which determines the gree of adsorption, has been defined by Williams l Donnan (Trans. Faraday Soc., 1914, 167), who owed from a thermodynamic analysis, that if the io of the actual vapour pressure of a vapour the saturated vapour pressure is equal to unity, amount of vapour adsorbed is a finite maximum d is independent of temperature. Patrick has med this ratio of partial pressure to saturated ssure, the "corresponding pressure" of a vapour, d has shown that in the case of adsorption of phur dioxide by silica gel the same amount of is taken up whatever the temperature, provided that the corresponding pressure is equal to y. The amount of vapour adsorbed by a given s of gel is so great that it must be regarded as densed in the liquid state. It is therefore prefer-, in comparing the adsorption of different vapours consider adsorption in terms of liquid volume, ner than as weight or volume of vapour. Bach-an (Z. anorg. Chem., 1913, **79**, 202) showed that n silica gel is exposed to the saturated vapour of er, benzene, or chloroform, the same liquid volume each vapour is adsorbed, and furthermore that volume is equal to that taken up when the gel mmersed in the respective liquids. The finite ximum adsorption which takes place when silica is exposed to a vapour at a corresponding pressure al to unity represents therefore a complete filling the pore spaces of the gel, and the principle of lliams and Donnan can in this case be extended read: "that for corresponding pressures equal mity the same liquid volume is adsorbed, whatever vapour or whatever the temperature."

'he adsorption of vapours by silica gel is regarded many workers as a purely physical capillary nomenon of the type described above, but there several observations which do not agree with point of view. It is not intended in this paper, vever, to enter into the theory of the mechanism adsorption by silica gel, but rather to deal with e of its industrial applications. For this purpose capillary theory of adsorption presents a useful crete picture of the mechanism by which vapours adsorbed, and is sufficient to explain many of phenomena observed.

'he immediate problem before the National nzole Association was the possibility of using solid orbents in lieu of wash oil for the recovery of the densable hydrocarbons from coal gas and coke-oven gas. The use of active charcoal and various inorganic gels was considered, and silica gel was chosen for first investigation because of certain definite advantages which it appeared likely to possess. Coke-oven gas contains many impurities likely to affect or destroy the adsorptive power of solid adsorbents, chief amongst which are the presence of tar fog in the form of a fine suspension; the vapours of high-boiling hydrocarbons, or of compounds which tend to polymerise to high-boiling resinous substances in the body of the adsorbent, which would not be removed by the usual processes of distillation; and sulphur compounds, including hydrogen sulphide, which might act upon the material of the adsorbent. The possibility of contamination with resinous organic matter demands that the adsorbent should be able to withstand heating in an oxidising atmosphere to a temperature sufficient to burn off such organic compounds and the deposit of carbon which is formed from them in the pores of the adsorbent during the initial period of heating. Ferric hydroxide gel, a substance of similar structure to silica gel was found to be unable to resist the high temperatures involved; it broke up completely to a finely powdered oxide which showed no adsorption capacity; there is also the danger that such a metallic hydroxide gel, even if able to withstand high temperatures, would be acted upon by the hydrogen sulphide in the gas. Active charcoal is at a disadvantage when heating in an oxidising atmosphere to a temperature of about 600° C. is involved; this disadvantage might be obviated by carefully purifying the gas before passing it over the charcoal. Silica gel is commendable on account of its chemical inertness and its ability to withstand high temperatures. These two factors counteract to a great extent the undoubted superiorities which active charcoal possesses, particularly its greater adsorptive power for vapours at low concentrations and its selective adsorption of hydrocarbons in preference to water vapour.

In the investigations undertaken, adsorption efficiency and capacity were measured by the dynamic method rather than by the static method adopted by van Bemmelen, Anderson and Patrick, since this method is more closely allied to conditions which would obtain in large scale practice. After carrying out these investigations we became acquainted with a paper by E. B. Miller (Chem. and Met. Eng., 1920, **23**, 1155, 1219, 1251), in which the examination of mixtures of air with benzene, ether, acetone, and other solvents by the dynamic method is described and, in so far as our results cover the same ground, they are in complete agreement with Miller's.

The silica gel used was prepared by the method recommended by Patrick (J. Amer. Chem. Soc., 1920, **42**, 951) and preliminary experiments were made to determine the efficiency and capacity of the gel for the adsorption of benzene from mixtures of air and benzene.

The apparatus is shown in Fig. 1. A current of air was drawn through a calcium chloride drying tube, A, a calibrated flow-meter, B, a three-bulb saturator, C, containing benzene, the U-tube, D, contain-

ing the gel under examination, and two additional guard tubes (E, F) also containing gel and serving to determine the amount of benzene passing D. The release valve, G, ensures a steady suction through the apparatus.

It will be seen that benzene is adsorbed almost quantitatively for a period of three hours, during which time the gel takes up 40% of its own weight of benzene. After three hours the efficiency of adsorption falls off rapidly to zero, the gel becomin

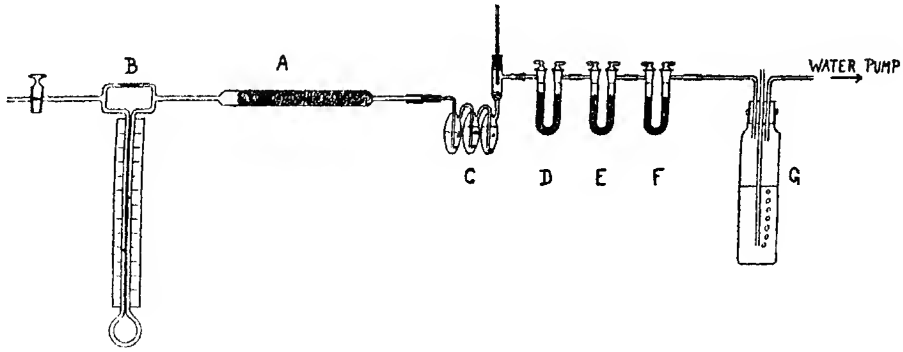
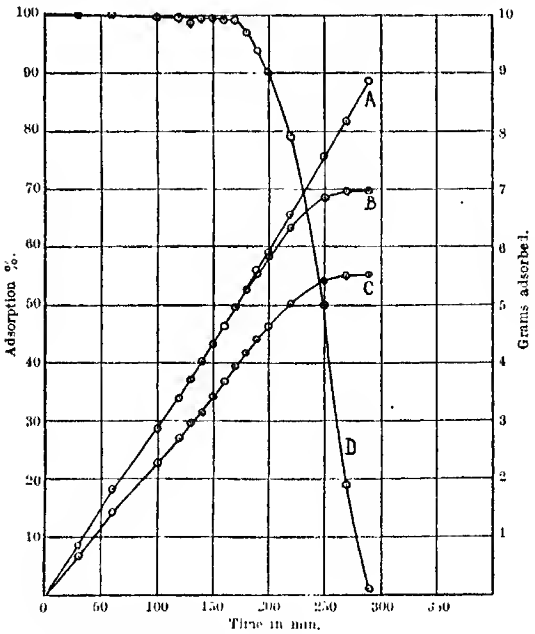


FIG. 1.

The gel tube, D, contained 12·606 grams of gel, and air was drawn through the apparatus at a rate of 100 c.c. per minute. The saturator, C, and the three U-tubes were weighed at frequent intervals, and it was found that the whole of the benzene lost from C



A. Weight of C_6H_6 passed.
B. „ „ adsorbed.
C. % C_6H_6 in gel
D. Efficiency of adsorption %.

FIG. 2.

was recovered in the three gel tubes. In Table II the adsorption by D only is shown. The data from this table are plotted in Fig. 2.

saturated at 55·4% benzene content. (It is interesting to note that the gel used in this experiment had been heated 30 times to 600° C. for a perioc of one hour, and its adsorptive capacity had no appreciably fallen from the value initially observed.

TABLE II.

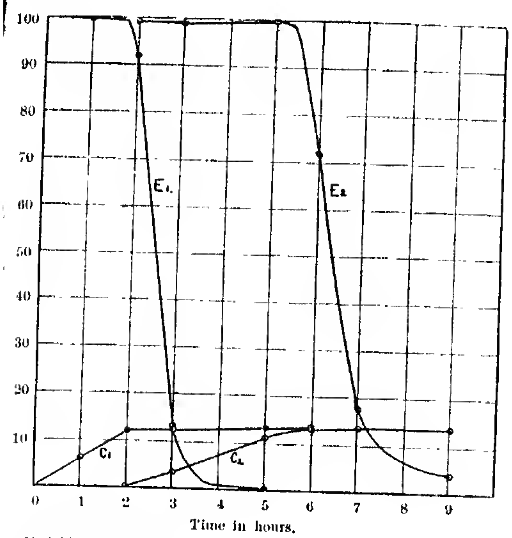
Benzene in gas, 9·5%

Time from start Mins.	Temperature during interval °C.	Total weight C_6H_6 passed Grms.	Total weight C_6H_6 adsorbed Grms.	Adsorption efficiency during interval %	Per cent. benzene in gel %
0	—	—	—	—	—
30	18 0	0·8600	0·8600	100·00	6·87
60	18·0	1 7980	1·8010	100·10	14·30
100	18·5	2·8675	2·8627	99·70	22·70
120	18·5	3·3960	3·3945	99·70	26·90
130	18·5	3·7110	3·7055	98·70	29·50
140	18·5	4·0200	4·0130	99·15	31·40
150	18·5	4·3435	4·3355	99·70	34·30
160	18·5	4·6480	4·6375	99·20	36·60
170	18·5	4 9865	4·9735	99·20	39·5
Stoppage overnight					
180	18·0	5·2775	5·2565	97·20	41·[illegible]
190	18·0	5·5880	5·5485	94·00	44·0
200	18·5	5·9020	5·8315	90·10	46·3
220	19·0	6·5605	5·3545	79·40	50·3
250	19·0	7·5533	6·8530	50·20	54·2
270	19·0	8·1715	6·9700	18·90	55·1
290	19·0	8·8585	6·9775	1·10	55·3

This adsorption of 55·4% of benzene was fr air saturated with benzene. The efficiency of adsor tion from a gas containing benzene at a concentrati corresponding to that actually present in coal gas coke-oven gas was next examined. The content benzene in coal gas may be taken as approximate 0·8% by volume, corresponding to about 8 saturation.

The apparatus was essentially as in Fig. 1, wit the exception that a second metered stream of dr air could be mixed, by means of a connexion, wit the stream of air saturated with benzene. adjusting the proportion of air added, any desire concentration of the mixed gas was obtainable.

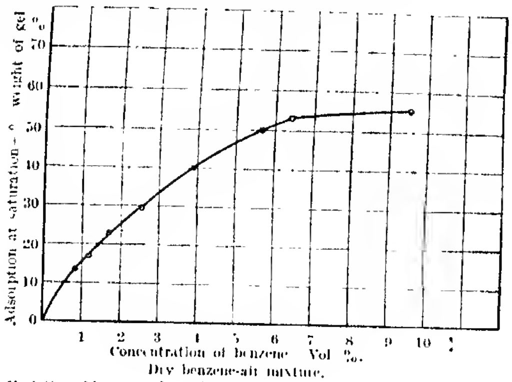
The figures of Table III and curves in Fig. 3 ow the efficiency and capacity of two gel tubes laced in series in a gas stream containing 0·84% of enzene. The first tube contained 5 grams and the cond 9·5865 g. of gel; the rate of gas stream was 82 c.c. per minute, giving a time of contact of 2 to 3 econds in the first tube and about twice that period n the second.



% C_6H_6 1st Adsorber.
" 2nd "
Efficiency 1st "
" 2nd "

FIG. 3.

Fig. 4 show the saturation capacities of the gel for different concentrations of benzene at 16° C. This is the usual form of adsorption isotherm.



Variation of benzene adsorption with its concentration Temp 16° C.

FIG. 4.

TABLE IV.

Saturation values for gel in equilibrium with benzene of different concentrations

Average temperature, 16° C.

Concentration benzene %	Partial pressure benzene mm. of Hg.	Per cent. weight adsorbed at saturation
0·84	6·40	13·65
1·19	9·05	16·85
1·69	12·8	22·96
2·55	19·4	29·50
3·90	29·7	40·00
5·65	43·0	50·20
6·41	48·9	53·40
9·50	72·2	55·40

TABLE III.

(See curves, Fig. 3)

Adsorption of benzene from a mixture of air and benzene containing 0·84% of benzene by volume.

[illegible]	Average temp. during interval	Total weight of benzene passed	Adsorption by first tube: Total	Efficiency during interval	Benzene % in gel	Adsorption by second tube: Total	Efficiency during interval	Benzene % in gel
..	—	—	—	—	—	—	—	—
..	16	0·3172	0·3165	99·70	6·30	—	—	—
..	17	0·6440	0·6170	92·00	12·34	0·265	99	0 028
..	18	0·9990	0 6615	12 60	13·23	0·3340	99	3·500
.	19	1·7250	0·6630	0·27	13·26	1·0600	100	11 100
				Stoppage overnight				
..	16	2·0327	0·6897	8 7	13·79	1·2622	72·0	13 200
..	17	2·3242	0·6770	Loss	13·50	1·3160	17·7	13·700
				Stoppage over week-end				
..	15	2·9012	0·6805	0·6	13 65	1·3380	3 85	13·900

'he results show a saturation value of the gel at C. of 13·7% by weight, while 11% is taken up 00% efficiency. These are the adsorption values ch would be expected when working on an rage coal gas, provided that the adsorption were affected by other factors.

'ables II and III show the adsorption obtain- from a gas containing 9·5% and 0·84% of zene. The adsorption capacity of gel in gases f intermediate concentration is not of immediate nterest from the standpoint of recovery from coal as, but it can readily be determined. Table IV and

The above experiments were made with simple benzene-air mixtures. The case of coal gas or coke-oven gas is not so straightforward. Apart from substances which may foul the gel and so reduce its activity, there are a number of different vapours, each with its own particular partial pressure and its own corresponding pressure, p/p_0 as defined by Williams and Donnan (see page 99 T).

The partial and corresponding pressures of some of the main condensable vapours in normal coal gas are found to be as follows :—

TABLE V.

	Partial pressure (p) mm. Hg.	Saturation pressure (p_0) mm. Hg.	Corresponding pressure p/p_0.
Pre-benzol	0·165	195	0·0009
Benzene	5·880	60	0·0980
Toluene	1·158	14	0·0825
Xylene	0·528	4	0·122
Naphthalene	0·019	0·03	0·65
Water	12·780	12·78	1·00

The figures for pre-benzol, benzene, toluene, and xylene are those given by T. F. E. Rhead (Gas J., 1917, **137**, 207) as representative of a normal coal gas at 15° C. The naphthalene figure corresponds to a content of 6 grains per 100 cubic feet; in practice even higher figures may be obtained. The water figure is based on the assumption that the gas is saturated. All the saturation pressures are for 15° C. It is clear from the principles of capillary adsorption discussed on p. 99 T, that if the adsorption of these constituents could be considered independently, the saturation capacity of the gel would be greatest in the case of water which is present at a corresponding pressure equal to unity, and would, therefore, be taken up by the gel to the extent of approximately 60% by weight (55% of benzene was taken up from a saturated benzene vapour, and the same volume of water would be adsorbed from a saturated water vapour). Naphthalene would come next as having the next highest corresponding pressure, then xylene, benzene, toluene, and pre-benzole in rapidly decreasing amounts. This is what would occur if a gas were passed containing each of these constituents singly at the concentrations mentioned, but obviously a vastly greater volume of gas would have to be passed in the case of naphthalene than, say, in the case of benzene or water, since the actual concentration of naphthalene in the gas is so small. What, then, will happen when a gas is passed containing all these constituents together? Examining the case where two only of the vapours are present, and choosing two which have widely different partial and corresponding pressures—benzene and naphthalene—it will be assumed for simplicity that the naphthalene is present to saturation in the gas, which is a possible condition. The corresponding pressure of naphthalene is then equal to unity, and if sufficient gas were passed, the naphthalene would be adsorbed by the gel to the extent of some 70% by weight (benzene at $p/p_0 = 1$ gave 55%: this multiplied by the ratio of specific weights of naphthalene and benzene, 1·15/0·88, gives the weight of naphthalene adsorbed at $p/p_0 = 1$). Thus, in order to saturate 10 g. of gel with naphthalene, it would be necessary to pass 7 g. of naphthalene, which at 9·4 grains per 100 cu. ft. corresponds to 1150 cu. ft., or 32,500 litres. In the meantime, however, the gel has long reached its saturation point with respect to benzene. This point, for a partial pressure of 6 mm. at 15° C., is approximately 14% of the weight of the gel, and is, therefore, reached when 1·4 g. of benzene, or 50 litres of gas, have been passed. At this point the naphthalene passed amounts only to 0·0108 g. There is a question now of what will take place if the gas continues to pass after the saturation poin to benzene is reached. Clearly, no more benzene wi be adsorbed by the gel, but will the naphthalen simply fill up the balance of pore space left to it b the benzene, or will it displace the benzene alread there? Where, as in this case, there is presumabl no question of preferential surface adsorption comin into play, the answer is not self-evident, and ther is no published work which gives a satisfactor reply.

In order to investigate this point, which appeare likely to be of importance in the recovery of benz from gases, it is necessary to consider adsorptio from a gas containing two condensable vapou whose separate distribution in the gel can be dete mined at frequent intervals. Working on a sma laboratory scale it was impossible to use, say, benzer and toluene, or benzene and xylene, as the adsorbe vapour would have to be distilled out of the gel the completion of each time interval before an analys could be made, and as only a fraction of a gram collected during each interval, this would be i possible.

As the adsorption by silica gel is supposedly purely physical phenomenon and not dependent the chemical nature of the vapour, it was n necessary to restrict attention to hydrocarbo Sulphur dioxide or ammonia might be used as second vapour in conjunction with benzene, as th would be easily distinguished from benzene a separately traceable in their adsorption relatio Actually, water vapour was chosen as being n only separately traceable, but also a material c stituent of coal gas, and one the action of whi will have to be considered. We have the followi data:—

Partial pressure of benzene in gas	6·0 m
Partial pressure of water in gas	12·8 m
Volume of liquid water from 22·4 litres vapour	18 c.c.
Volume of liquid benzene from 22·4 litres vapour	89 c.c.

The volume of water vapour in the gas is 2·13 tin that of benzene vapour; on the other hand, a gi volume of benzene vapour yields five times as m liquid volume as an equal volume of aqueous vap If, therefore, we express the ratio of benzene to w in the gas as volume of liquid condensates, whic the important point from the view of adsorpti we have benzene : water = 5 : 2·13 or 2·35 : 1.

This is a similar, though less extreme, case to t of benzene and naphthalene, discussed previou The benzene, although not capable, like water, of approaching the maximum saturat value (on account of its low corresponding pressu is yet present in considerably greater proportion, liquid volume, than the water, and is, theref able to enter the gel freely in the first stages adsorption before sufficient water has arrived exclude it—assuming for the moment that the vap of the higher corresponding pressure does tend exclude or drive out that of the lower. It is imposs to forecast what should occur in such a mixt and experiments were carried out to test the ab points.

Adsorption of mixed benzene and water vapours.

A gas containing both benzene and water vapour n known concentrations was prepared by mixing two netered streams, one having passed through a water aturator and the other through a benzene saturator, s shown in Fig. 5. Each stream was dried in a gel. The gas mixture contained 0·86% of benzene and 1·85% of water by volume with partial pressures 6·5 mm. and 14·2 mm. respectively. The temperature of the saturator and adsorption tubes was 18° C. The saturation pressure of water vapour at 18° C. is 15·46 mm. The gas was therefore not

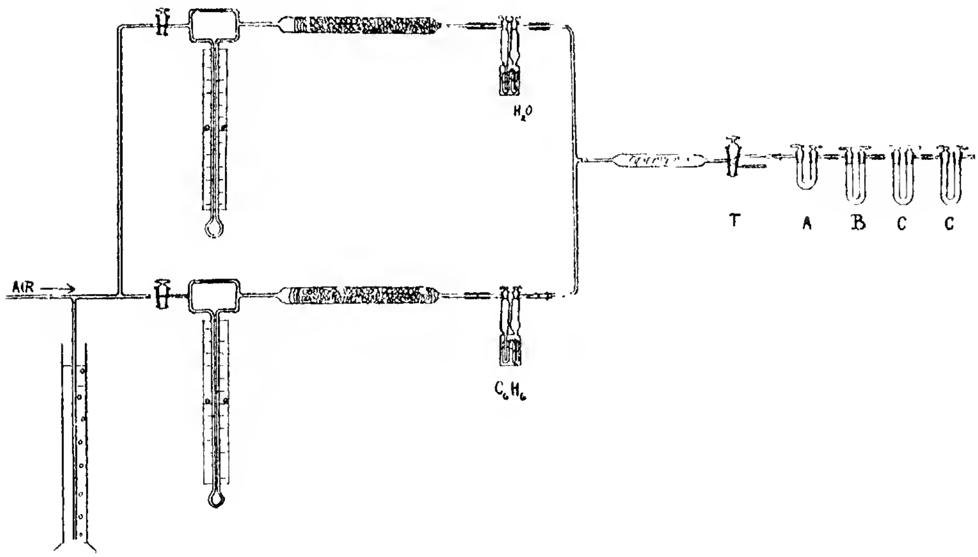


FIG. 5.

ng calcium chloride tube before passing through ie saturator. After mixing in an intermediate essel, the gas passed through: A, a small tube conaining 3·708 g. of gel; B, a tube containing granular alcium chloride; C, two guard tubes filled with silica fully saturated with water. The mixed gas was passed through the adsorption tubes for 21·7 hours at a rate of 135 c.c. per minute. By periodic weighings of the water and benzene saturators, the gel tube, A, containing the gel under examination,

TABLE VI

(See Curves, Fig. 6).

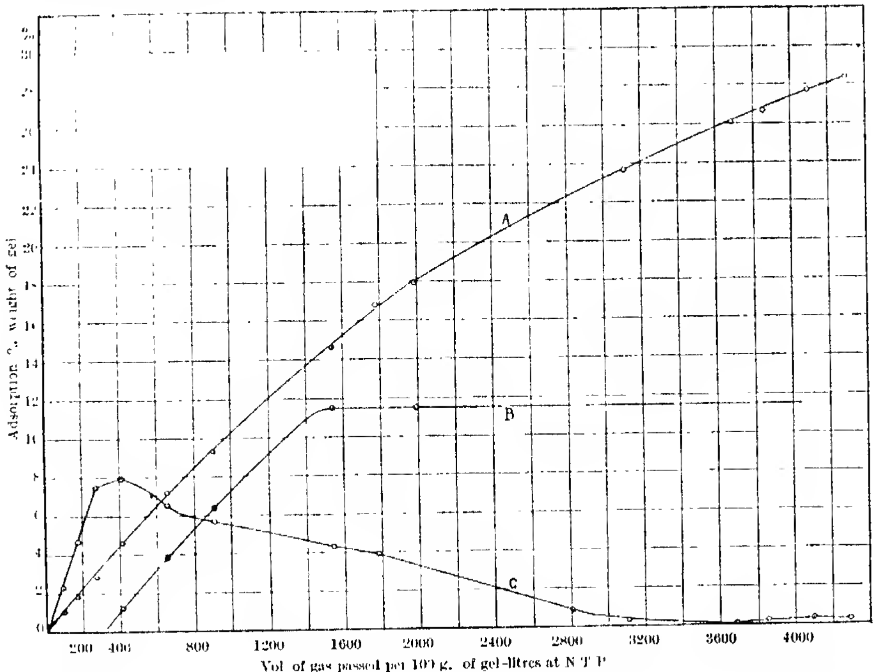
The adsorption of benzene from a mixture of benzene and air containing water vapour

Rate of gas stream . . . . 135 5 c c. per minute.
Benzene in gas . . . . . . 0·86 % by volume.
Water in gas . . . . . . 1·85 % by volume

Time Hrs.	Temp. °C.	Water distribution			Benzene distribution			Total vapours in gel		Per cent. vapours in gel		Per cent. of benzene passed adsorbed by guard tube in each period
		Passed Grms.	Adsorbed by		Passed Grms.	Adsorbed by						
			1st gel Grms.	$CaCl_2$ Grms.		1st gel Grms.	Guard Grms.	H_2O Grms.	C_6H_6 Grms.	H_2O Grms.	C_6H_6 Grms.	
0 0	—	—	—	—	—	—	—	—	—	—	—	—
2·0	18·0	0·1794	0·1726	0·0068	0 4395	+0 2945	0·1450	0 1726	0·2945	4·46	7·92	33
3 2	19 0	0·1128	0 0946	0 0812	0·2615	− 0 0515	0·3130	0 2672	0 2430	7·20	6·56	120
4·1	19·0	0·1162	0 0800	0 0362	0·2770	−0·0270	0 3040	0·3472	0·2160	9·35	5 82	110
7·4	20·0	0 3433	0 1949	0 1484	0 7885	−0 0557	0 8442	0·5421	0 1603	14·65	4 33	107
8·9	21·5	0 1703	0 0814	0·0889	0 4053	−0 0131	0 4187	0,6235	0 1469	16 80	3·95	103
9·7	21·5	0·0885	0 0418	0·0467	0·2247	− 0 0001	0·2248	0 6653	0 1468	17·98	3·95	100
13·7	20·0	0·4373	0·1853	0·2520	1·2183	− 0 1110	1·3323	0 8506	0 0328	20 30	0 88	110
15·2	17·5	0 1029	0·0294	0·0735	0 2796	0·0215	0 3011	0 8800	0 0113	23·70	0 30	108
17 7	18·5	0·2415	0 0900	0 1515	0·5361	− 0 0088	0·5449	0·9700	0 0025	26·10	0 06	102
18·7	17·5	0·0796	0 0222	0·0574	0·2120	+0 0077	0·2043	0·9220	0 0102	26·70	0 27	97
19·7	18·0	0·0854	0 0127	0·0576	0·2122	+0 0031	0·2091	1·0200	0·0133	27·50	0 35	99
20·7	18·5	0·1043	0.0343	0·0700	0·2413	−0 0024	0·2437	1·0543	0·0109	28·40	0 29	100
21·7	18·5	0·1053	0·1033	0·0740	0·2400	—0·0003	0·2403	1·0856	0·0106	29·40	0·28	100

the calcium chloride tube, and the final guard tubes, a determination of the amounts of water and benzene adsorbed by A at any moment was made. The results are given in Table VI and are plotted in Fig. 6. (The determinations for the first three points of the curves in Fig. 6 are not shown in Table VI; they were obtained from an independent experiment under exactly similar conditions.)

It is evident, therefore, that the F vapour is a factor to be seriously cons... ration point problem of recovering benzene from gas. ...zene will only prevents the benzene attaining the ne... saturation value corresponding to its vapour pressure, but also, in the event of the gas being passed over the gel in too great a volume, leads to a complete washing out of the benzene initially adsorbed, even though



Influence of water vapour on the absorption of benzene from a benzene-air mixture by silica-gel.

Curve A % H_2O in gel
,, B % C_6H_6 in guard tube (gel) after dehydrating gas.
,, C - % C_6H_6 in gel.
% Benzene in gas 0·86% Temp 18° C
% Water in gas 1·85%. Rate of gas - 7·6 litres per hr. N.T.P.

FIG. 6.

Curve A shows the adsorption of water, expressed as per cent. weight of the gel. Curve B shows the adsorption of benzene in the first gel guard tube, and is therefore a check upon the adsorption which would have been obtained had the gas not contained water vapour. Curve C shows the actual benzene adsorption from the wet gas. It will be observed that in the initial stages benzene was taken up to the extent of 7·92% of the weight of the gel, but as the passage of gas was continued, the benzene was gradually displaced by water, until finally no benzene remained in the gel. The water, on the other hand, gradually accumulated in the gel, and at the completion of the experiment was still being rapidly adsorbed. A further proof of the fact that the benzene is displaced is shown by the figures in the last column of Table VI, from which it is seen that during every interval after the first two hours, more benzene was recovered in the guard tubes than was lost from the benzene saturator.

the concentration of benzene in the gas remai constant. The explanation probably lies in t relative ease of wetting of the silica surface by wat and by benzene. If the silica surface is coat preferentially by a film of water, the benzene is n able to wet the surface, and therefore depends for i retention upon its power to wet, or be adsorbed b the water film. If benzene is adsorbed less strong at a water face than at a silica face, then as the wat film develops over the surface of the silica, benze must be driven out, whether the adsorption is regard as a molecular surface adsorption or as a pure capillary condensation.

The next step to be taken was the ex... stages of the adsorption of hydrocarbons from ... examination gas. A supply of purified town gas w... that actual coal the mains of the Leeds gas works at ... was drawn from ately after the iron oxide pur... a point immedi stream of this gas was pass... ifiers. A metered six adsorption tubes, carri... through a series of each containing 12 grams of

Adsorption of benzene just commenced to pass the A gas co... contents of each tube were distilled know... and collected in a graduated receiver ... to -10° C. The quantities obtained on such a le were too small to permit of an accurate analysis, ; were sufficient to show the selective adsorption he various constituents of the gas along a column dsorbent. The approximate analysis is expressed Table VII below, in terms of water, benzene, and iene. The small amounts of hydrocarbons with ling points higher than toluene and lower than zene have been neglected.

TABLE VII.

orption of water and hydrocarbons from coal gas in a six-section column

). of be in ries	Vol. water c.c.	Vol. hydro-carbons c.c.	% Composition of hydrocarbons C_6H_6 %	C_7H_8 %	Boiling point of hydro-carbons ° C.
I	1·15	1·90	25	75	98·9
[I	0·65	1·40	65·5	34·5	86·7
[I	0·15	1·15	100	0	80·1
V	0·05	1·20	100	0	80·0
V	0·0	1·45*	100	0	79·7
'I	0·0	1·10	100	0	79·5

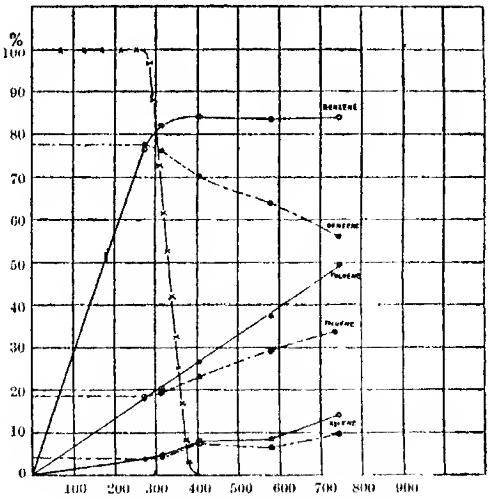
This volume includes a drop of the distillate from the vious tube.

t is evident from these figures that a considerable ;ree of fractional adsorption takes place, and that water and higher boiling hydrocarbons are con- trated at the entrance of the column of gel. leed, by using two adsorption chambers, the second taining twice as much gel as the first, it would be sible to recover 60% of the total hydrocarbon he gas (or 76-77% of the total benzene in the gas) practically pure benzene.

'he coal gas used in the above experiment con- ied 0·80% of benzene and 0·19% of toluene luding xylene and naphthalene).

Experiments were next carried out to determine, re accurately than was possible in the small six- tion column just described, the efficiency of orption and the composition of the recovered lrocarbons when varying amounts of gas were sed over a constant weight of silica gel. The ults of these experiments are summarised in ble VIII and are plotted in Fig. 7. The adsorption s carried out at a temperature of 14°, and the gas umes passed are expressed as litres at N.T.P. per) grams of gel.

'he first determination recorded, 273 litres of gas 100 grams of gel, is for an adsorption which was stopped exactly at the break point to benzene. For smaller quantities of gas it has been shown that all the benzene and all the other higher boiling hydro- carbons are quantitatively recovered. The important point therefore to be observed, where complete recovery of useful hydrocarbons is intended, is this break point to benzene. The still lower boiling constituents in coal gas, of which carbon bisulphide is the chief, are present at such small partial pres- sures and corresponding pressures (see Table V), that the amounts adsorbed are practically negligible. There is, therefore, in the hydrocarbon mixture recovered by silica gel none of the "pre-benzol" which must be so carefully fractionated from the spirit recovered by oil-washing processes.



Vol. of gas passed per 100 g. of gel.
Litres.
Recovery of hydrocarbons from coal gas by silica gel.
o—— o Adsorption as % weight of gel (× 10).
o - — - • Composition by vol. of recovered liquid.
x - x — x Efficiency of benzene adsorption.
FIG. 7.

The recovery figures corresponding to a passage of 273 litres of gas represent, therefore, a maximum recovery of the hydrocarbons valuable as motor spirit. Up to this point all such hydrocarbons are quantitatively adsorbed, and the proportions of the various hydrocarbons in the recovered mixture are therefore identical with the proportions in the original gas. If a greater volume of gas is passed over the

TABLE VIII.

orption of hydrocarbons from coal gas by silica gel, showing the effect of ratio of gas volume to weight of gel on the degree of adsorption, distribution of individual hydrocarbons, and composition of the recovered benzol.

Expt. no.	Volume of gas per 100 g. of gel Litres N.T.P.	Total hydro-carbons adsorbed as % weight of gel	Distribution of hydrocarbons as per cent. weight of gel: Benzene	Toluene	Xylene	Composition by volume of liquid hydrocarbons recovered: Benzene %	Toluene %	Xylene %
..	273	9·84	7·65	1·80	0·39	77·5	18·5	4 0
..	315	10·70	8·20	2·04	0·46	76 2	19·45	4 35
..	405	11·89	8·41	2·70	0·78	70·2	22·1	7·7
..	578	12·95	8·35	3·75	0·85	64·0	29·4	6·6
..	743	14·80	8·40	4·96	1·44	56·2	33·9	9·9

same amount of gel, benzene begins to escape at the exit of the adsorber. The higher-boiling hydrocarbons do not, however, reach their break points for some considerable period later, with the result that the composition of the mixture of hydrocarbons recovered from the gel gradually changes, the percentage of benzene becoming smaller and that of the constituents of higher boiling point less. This is shown clearly by the broken curves of Fig. 7. From this series of curves it is possible to determine what proportion of gel to gas must be employed in order to secure any desired composition of hydrocarbons from the adsorption units. In order to secure complete "stripping" it is not possible to pass more gas of the composition under consideration than 273 litres per 100 grams of gel, and at this point the adsorption expressed as per cent. weight of the gel is 7·65% of benzene, 1·80% of toluene, and 0·39% of xylene (including higher-boiling hydrocarbons). The total effective adsorption of hydrocarbons is, therefore, approximately 10% of the weight of the gel.

It will be observed, also, that over the range of these experiments, which more than covers the limits within which a commercial adsorption process would be operated, no evidence was found of actual displacement of benzene by water vapour. The benzene having attained its maximum saturation value of 8·4% remained at this value over the whole period considered.

It is therefore practicable to use silica gel for the adsorption of hydrocarbon vapours from coal gas saturated with water vapour. The adsorption capacity for the hydrocarbon is, however, lower than if no water vapour were present, and in the above experiments amounted to slightly less than 10% of the weight of the gel.

The whole of the water vapour must be removed concurrently with the hydrocarbon vapour. This is unavoidable since water vapour is, as has been shown above, preferentially adsorbed.

The actual saturation value for benzene when adsorbed from coal gas is slightly higher (8·4%) than that obtained from the pure mixture of benzene, water vapour, and air investigated in the laboratory and illustrated in Fig. 6. This is to be expected since the benzene in the gel is dissolved in a certain amount of higher boiling hydrocarbons, which tend to lower its vapour pressure.

A very interesting observation from the point of view of motor fuel production was that the mixture of hydrocarbons recovered from the gel by direct distillation was of considerably better quality as motor fuel than the corresponding mixture obtained by scrubbing the gas with wash oil. Apart from the fact that wash oil takes up, under normal working conditions, only some 3 to 4% of its volume of hydrocarbons from the gas, the product obtained on distilling benzolised wash oil with steam (known technically as "light oil") contains, at the low-boiling end of the scale, appreciable amounts of carbon bisulphide, and at the high-boiling end some 5 to 15% of creosote or high-boiling paraffin oils distilled from the wash oil itself. The product obtained from silica gel contains a negligible amoun[t] of carbon bisulphide, and clearly can derive [no] heavy oil from the distillation of the adsorben[t]. Furthermore, the light oil obtained by oil washing is almost invariably yellow in colour, and quickl[y] darkens to a light brown colour. The produc[t] obtained from silica gel, in the experiments described, was colourless, and remained colourless over severa[l] months. This is an important point for the moto[r] spirit producer. It is not proposed in this paper to g[o] into the causes of discoloration of motor spirit, but it is well known that there is frequently a close parallelism between discoloration of the spirit on storage and gum formation in the engine valves when the spirit is used. Drastic chemical treatment of the motor spirit, usually consisting in washing with concentrated sulphuric acid, is normally employed at the present time to remove these objectionable gum-forming constituents. Unfortunately such treatment destroys more than the objectionable constituents which it is intended to remove, and probably one-half to one million gallons of potentially valuable motor fue[l] are destroyed per annum in this country by moto[r] benzol producers alone. Petroleum oil refiners are, on the whole, more enlightened in this respect, an[d] by the development of less drastic refining process[es] have considerably reduced their refining losse[s]. Nevertheless, the loss of valuable petroleum mot[or] spirit by sulphuric acid washing probably great[ly] exceeds the figure given above for benzol.

The fact that the benzol recovered by means [of] silica gel appeared to show no signs of discoloration or resinification on storage was therefore an additional merit in the process, as it held out hopes tha[t] the product would need no further refining treatment. The other outstanding objectionable constituent in motor spirit is sulphur, whether free or combine[d]. In this respect the benzol recovered as describe[d] above did not show any marked superiority over th[e] unrefined benzol as normally produced by o[il] washing, except in so far as it was traceable to [its] freedom from carbon bisulphide. The average sulph[ur] content of the gel recovered spirit was 0·4–0·5[%]. This statement is not in opposition to the claim of t[he] Silica Gel Corporation that the sulphur content [of] many petroleum oils can be reduced to a very l[ow] figure indeed by treatment in the liquid phase wi[th] silica gel. The question of what types of sulph[ur] compounds are removable by silica gel is a compl[ex] one, and it is not proposed to deal with it in th[e] present paper.

The results already indicated warranted a tri[al] of silica gel as an adsorbent for motor benzol pr[o]duction on a larger scale. The main points in favour [of] such an adsorbent in place of wash oil appeared to be :

(1) Adsorption of 10% by weight or about 11·5[%] by volume of hydrocarbons as compared wi[th] 3–4% by volume usually obtained with wash o[il].
(2) Complete recovery of the useful hydrocarbon[s] very rarely obtained with wash oils.
(3) A crude oil free from low-boiling "pre-benzol" and uncontaminated with high-boiling creoso[te] oils, except for the small amount adsorb[ed] from the gas.

(4) The possibility of eliminating all chemical refining processes and particularly the sulphuric acid treatment.

(5) A saving, consequent on (4), of some 5-10% of the crude spirit.

(6) Avoidance of the nuisance and waste arising from the acid sludge produced by acid refining.

(7) A complete removal of naphthalene from coal gas is incidental to benzol recovery. This is of considerable importance to manufacturers of coal gas for town distribution. If desired a very small silica gel plant could be arranged to remove all naphthalene without stripping the gas of benzol.

It was at this stage that we were approached by Mr. J. A. Reavell of the Kestner Evaporating and Engineering Company, the concessionaires of the Silica Gel Corporation, Baltimore, who informed us that they were about to carry out semi-large scale trials on the recovery of motor spirit from coke-oven gases by silica gel adsorption. The National Benzole Association was invited to send representatives to investigate these trials and Mr. Basil Adler and the author were appointed for that purpose. Together with Mr. Reavell they visited America during June and July last, and the remaining portion of this paper is devoted to a description of the trials carried out during that period.

The Silica Gel Corporation had during the past four years been experimenting on the industrial application of silica gel to the recovery of vapours and for the treatment of liquids. For the adsorption of vapours a bed type absorber, consisting of static beds of granular gel, was originally proposed and is still recommended for certain purposes. Where large volumes of gas are to be handled, however, a continuous circulation plant is used. In this case the gel is finely pulverised to about 200-mesh, and is circulated with the gas, which, by means of a pump, is maintained at a velocity sufficient to carry the gel along with it.

Adsorption is carried out in vertical adsorbers consisting of nests of tubes in an outer cooling jacket similar in construction to a tubular condenser. The gas and gel are separated at the top of each adsorber by a cyclone separator. The gel is fed into the gas stream at the bottom of the adsorber by means of a small screw conveyor. In actual practice three such adsorbers are used in series, the gas and gel flowing counter current through the series. In this way most effective "stripping" of the gas and saturation of the gel are secured. After traversing the final adsorber, (the one nearest to the gas inlet) the saturated gel is taken from the cyclone separator by a screw conveyor to the top of the "primary activator." This is in effect a still in which the adsorbed vapours are driven off. It consists of a series of horizontal hearths placed vertically above one another and heated by the flue gases from a gas furnace. The hot gases pass through flues interspaced with the hearths but do not come in direct contact with the gel or distilled vapours. The gel entering at the top hearth is raked slowly downwards from hearth to hearth by means of revolving

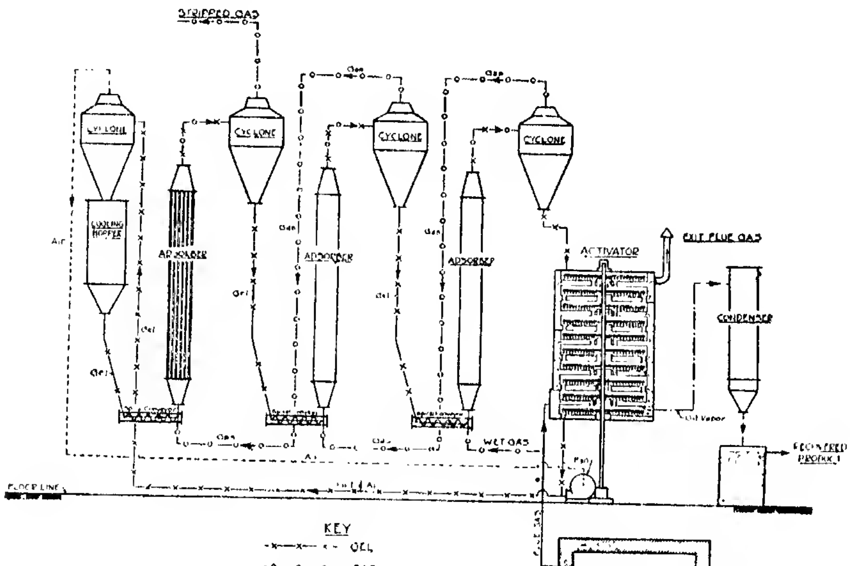


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FIG. 8.

rakes keyed to a vertical central shaft. The arrangement is very similar to the usual pyrites burner. The gel, completely freed from volatile vapours, is discharged from the bottom hearth into another screw conveyor which carries it to a "secondary activator." This activator consists of a slightly inclined revolving drum heated by means of an external jacket, through which hot flue gases pass. The purpose of this second activator, into which a small volume of air is drawn, is to burn off any non-volatile deposits from the gel. The temperature in the primary activator is maintained at 300°—350° C. and in the secondary activator at 550°—600°. The gel leaving the secondary activator is completely revivified and is returned by means of an air blast, provided by a fan working in a closed cycle, to the gel storage and cooling hopper from which it again enters the adsorption cycle. The coke-oven gas, which passes through the adsorption units in the opposite direction to the gel, is finally discharged from the last cyclone (the first from the point of view of gel flow) and passes through bag filters which remove any gel remaining in suspension and return it to the system.

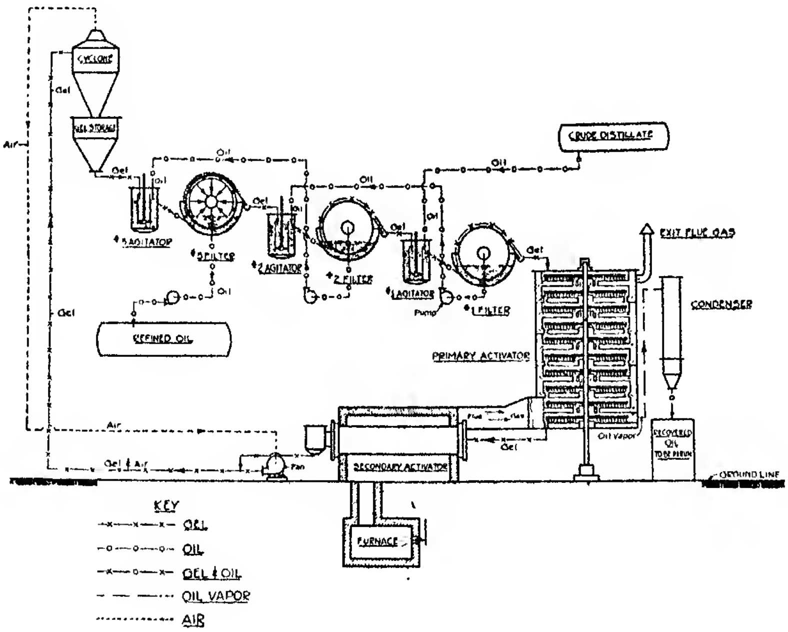

FIG. 9.

The general lay out of the plant is shown in Fig. 8, which is produced by the courtesy of the Silica Gel Corporation. This does not show the horizontal secondary activator, the arrangement of which is shown in Fig. 9.

The adsorption plant erected at the time of our visit was an experimental plant, designed to handle 80—100 cubic feet of gas per minute. This gas was drawn from the mains of the Bethlehem Steel Corporation's coke ovens at Baltimore at a point immediately following the ammonia scrubbers. The coke-oven plant was of the Koppers type and the gas had passed through the usual tar extractors, ammonia saturators, and water-spray coolers; it may therefore be taken as a fair average coke-oven gas.

The amount of recoverable hydrocarbons in the gas was determined by passing a metered volume of the gas through a calcium chloride drying tube and then through a silica gel adsorption tube containing 3 lb. of gel. The adsorbed hydrocarbons were distilled off with steam at 200° C. and measured. This test was shown to be more rigorous than a determination made by the usual method of bubbling the gas through ice-cold wash oil. The content of hydrocarbons in the gas issuing from the adsorption plant was determined in the same manner, and both inlet and outlet tests were made concurrently with a quantitative examination of the hydrocarbons actually recovered in the plant. The results of a typical test are shown below:—

I. Benzol in inlet gas (control)

Total volume passed .. .. = 54·53 c. ft. at 90° F.

Total benzol recovered on distillation .. .. .. = 51·5 c.c.

Benzol content (at 90° F.) .. = $\frac{51 \cdot 5 \times 0 \cdot 2200}{5 \cdot 463}$ Imp. gals. per 10,000 c. ft.

= 2·073 Imp. gals. per 10,000 c. ft.

[. Benzol in effluent gas from plant (control).

Volume gas passed ..	.. = 186·68 c. ft. at 90° F.
Benzol recovered ..	.. = 7·5 c.c.
Benzol content (at 90° F.) ..	$= \frac{7\cdot5 \times 0\cdot2269}{18\cdot668}$ Imp. gals. per 10,000 c. ft.
	= 0·0884 gal. per 10,000 c. ft.

[. Efficiency of adsorption in plant (calculated from control tests).

$$= \frac{(2\cdot073 - 0\cdot0884) \times 100}{2\cdot073} = \frac{1\cdot9846}{2\cdot073} = 95\cdot7\%$$

'. Recovery of crude benzol in plant.
Over the same period as that of the above tests.

Gas treated	.. = 103,505 c. ft. (at 90° F.)
Recovered crude benzol	.. = 10·55 Imp. gals.
Benzol	.. = 1·898 Imp. gals. per 10,000 c. ft.
Theoretical recoverable	.. = 1·9856 gals. per 10,000 c. ft.
Efficiency of recovery ..	.. = 95·6 per cent.

This figure of 95·6% is the average of three shifts ntinuous working; actually one of the shifts erated at 97% efficiency.

The hydrocarbons recovered from the effluent s had an unpleasant odour, and boiled at 76°–78° C. detailed examination of this product was not made, the quantity available was too small; it is almost rtain, however, from its general properties, that ly a small portion of this fraction could possibly considered useful as motor spirit. Estimating is proportion at a liberal figure of 50%, then total loss of motor spirit in the effluent is only 044 gallon per 10,000 cu. ft., and the efficiency adsorption of motor spirit in the plant becomes ·9% of the theoretical.

There is therefore an adsorption of motor spirit om the gas of 97·9% efficiency, followed by a covery of liquid benzol from the gel of 95·6% iciency, giving a total all-round efficiency of covery in the plant equal to 93·6–95% of the iount initially present in the gas.

These results entirely bear out the conclusions rived at in the laboratory as to the excellent covery of hydrocarbons attainable. The temrature conditions of the test were moreover not vourable, the temperature of the inlet gas being ° F. and that of the cooling water 80° F.

The recovered product was, however, not so isfactory. A colourless, non-gumming distillate d been expected from the gel, but the product tually obtained was yellow or yellowish-brown, d neither modifications in the method of working r redistillation of the crude spirit gave appreciable provement. It was evident that the crude spirit uld need further refining. The refining of a uid spirit with gel had already been worked out detail by the Silica Gel Corporation in connexion th the refining of petroleum oils and a continuous itation and filtration plant capable of dealing th 3000 gals. per day had been designed to operate is process. It had been found that a strongly loured gasoline, kerosene or lubricating oil when itated with successive quantities of gel and ered was rendered of excellent colour and pracally free from sulphur. The case of benzol, wever, proved to be somewhat different. Agitation with silica gel followed by filtration did not produce marked improvement in the appearance of the product; but there was this actual improvement in fact, that, if the liquid so treated were distilled, 88–89% came over below 130° C. as a colourless product, while the residual high-boiling 10% was only very slightly coloured. The higher-boiling fraction could also be rendered colourless by a further treatment with gel, and redistillation.

This refining action of the silica gel in the liquid phase appears to be due to the rapid polymerisation of those constituents in the crude benzol which are the cause of discoloration. It is already known that if a crude benzol is allowed to stand for a long period these constituents tend to polymerise spontaneously, and that if such a "matured" benzol is distilled, the high-boiling polymers remain as a gum-like residue in the distillation vessel. Silica gel by adsorbing such constituents increases their activity and accentuates the process of polymerisation, with the result that after a very short period of time the resin-like products can be completely separated by distillation.

The sulphur content of the spirit is not greatly reduced by this liquid phase refining process. The actual content of sulphur was 0·37% in the crude, and 0·28% in the refined spirit. There is therefore greater difficulty in removing the sulphur, whether free or combined, from benzol than from petroleum, for which the Silica Gel Corporation reports almost complete removal of sulphur by simple agitation with gel.

The plant designed by the American Corporation for carrying out the liquid phase refining treatment described consists in its simplest form of a tank fitted with an agitator for mixing the liquid and gel. The mixture from this tank runs to an Oliver continuous vacuum filter from which the treated liquid is withdrawn, while the gel is carried by screw conveyor to a primary and secondary activator of the type already described. In practice, in order to obtain the maximum duty from the gel, three agitating vessels and three Oliver filters are placed in series, the gel and liquid passing countercurrent through the system.

The cycle of storage tanks, agitating tanks, Oliver filters and activators is made gas tight so that losses by evaporation are reduced to a minimum. The actual loss of spirit during this process is confined to the very small amount of the resin forming constituents which are polymerised, the vapour which escapes through the vacuum pump operating the filters, and the vapour which escapes condensation after being distilled off in the activators. These losses amount to 2% as a maximum and probably less than 1% of the spirit treated. They are to be compared with the much greater loss which occurs when a sulphuric acid refining treatment is employed. The general arrangement of a continuous liquid refining plant is shown in Fig. 9.

The crude spirit after agitation with gel and filtration is distilled. This distillation is a necessary stage in the refining process, but it also serves for

The solution was boiled to remove the carbon dioxide and then cooled, a few drops of methyl orange were added, and the solution was titrated with $N/1$ sodium hydroxide until almost neutral, when a few drops of methyl red were added, and the titration with alkali continued until a purplish-red colour became just visible. This gave a very well-defined end-point compared with methyl orange.

The standardisation was also checked against pure dry ammonium chloride, as follows: 5 grams of the ammonium chloride were weighed out and distilled with caustic soda through an apparatus containing a bulb trap, into an excess of the standard acid. The distillate was cooled and the excess of acid titrated against $N/1$ soda first with methyl orange as indicator, the final end-point being determined with methyl red as previously explained.

Throughout the whole of the determinations the end-point was obtained in this way.

After the sulphuric acid had been standardised, the sodium hydroxide was standardised against the sulphuric acid.

Including the preliminary work, over 100 determinations were made, the final table being based on 62 determinations made after the best form of apparatus, and the best way of using it, had been decided. Specific gravities were determined as low as 0·875—a specific gravity very much lower than any previously determined with any degree of accuracy. Lunge's lowest gravity was 0·882 and Ferguson's was 0·886. Every precaution was taken to obviate errors due to wrongly calibrated weights or burettes, frequent standardising of all apparatus used being carried out. The water capacity of the special weighing pipette was found to be the same at the end of the experiments as at the beginning.

All calculations were worked out by two men independently, and were based on the 1923 atomic weights. The actual determinations are shown in Table I.

TABLE I.

Specific gravities of ammonia solutions at 60° F.

Sp. gr.	% NH_3.	Sp. gr.	% NH_3.
0·87510	36·81	0·92235	21·12
0·87636	36·47	0·92161	20·34
0·87653	36·36	0·92478	20·31
0·87836	35·72	0·92601	19·93
0·88000	35·20	0·92607	19·95
0·88052	35·07	0·92978	18·80
0·88061	34·98	0·93049	18·57
0·88083	34·99	0·93052	18·57
0·88204	34·47	0·93122	18·34
0·88325	34·10	0·93122	18·34
0·88410	33·77	0·93556	17·02
0·88465	33·69	0·93920	15·85
0·88468	33·66	0·93938	15·83
0·88721	32·78	0·94535	14·07
0·88861	32·35	0·94920	13·00
0·88973	31·95	0·94921	13·02
0·89037	31·71	0·95082	12·50
0·89055	31·66	0·95087	12·49
0·89394	30·55	0·95968	10·05
0·89812	29·15	0·96172	9·47
0·90341	27·37	0·96174	9·47
0·91016	25·06	0·96646	8·21
0·91018	25·05	0·96652	8·21
0·91145	24·67	0·97088	7·03
0·91622	23·08	0·97090	7·03
0·91625	23·07	0·97817	5·19
0·91658	22·95	0·97842	5·12
0·91661	22·95	0·97843	5·13
0·91945	22·08	0·98638	3·18
0·92113	21·45	0·98715	3·00
0·92232	21·12	0·98716	3·00

If these are plotted and the best smooth curve drawn through the points, it will be found that with specific gravities below 0·885 the maximum error is ± 0·05% of ammonia, corresponding to an error in the specific gravity of ± 0·00015; with determinations above 0·885 the maximum error is ± 0·02% of ammonia, corresponding to an error in the specific gravity of ± 0·00007.

Table II. was constructed by reading the percentage of ammonia corresponding to given specific gravities, from the curve obtained by plotting the actual determinations. For purposes of comparison Lunge's table is given side by side with the new table, but it should be pointed out that whereas Lunge's determinations were made at 15° C., the new determinations were carried out at 60° F., so that it was necessary to correct Lunge's figures; this was accordingly done, using Lunge's own temperature corrections.

TABLE II.

Sp. gr. at 60° F.	% NH_3 Price & Hawkins.	% NH_3 Lunge.	Sp. gr. at 60° F.	% NH_3 Price & Hawkins.	% NH_3 Lunge.
0·875	36·90	—	0·938	16·25	16·18
0·876	36·56	—	0·940	15·65	15·50
0·877	36·22	—	0·942	15·06	15·00
0·878	35·88	—	0·944	14·47	14·42
0·880	35·20	35·51	0·946	13·89	13·85
0·882	34·53	34·86	0·948	13·31	13·28
0·884	33·86	33·98	0·950	12·74	12·71
0·886	33·19	33·14	0·952	12·17	12·14
0·888	32·52	32·40	0·954	11·61	11·57
0·890	31·85	31·65	0·956	11·05	11·00
0·892	31·18	30·99	0·958	10·50	19·44
0·894	30·51	30·28	0·960	9·95	9·88
0·896	29·84	29·61	0·962	9·40	9·33
0·898	29·17	28·93	0·964	8·86	8·82
0·900	28·50	28·25	0·966	8·32	8·31
0·902	27·83	27·58	0·968	7·79	7·80
0·904	27·16	26·92	0·970	7·27	7·29
0·906	26·49	26·24	0·972	6·75	6·79
0·908	25·82	25·58	0·974	6·24	6·29
0·910	25·15	24·92	0·976	5·73	5·79
0·912	24·48	24·27	0·978	5·23	5·29
0·914	23·82	23·62	0·980	4·73	4·79
0·916	23·16	22·97	0·982	4·24	4·29
0·918	22·50	22·33	0·984	3·75	3·79
0·920	21·85	21·70	0·986	3·27	3·29
0·922	21·21	21·07	0·988	2·79	2·79
0·924	20·57	20·44	0·990	2·31	2·30
0·926	19·94	19·82	0·992	1·84	1·83
0·928	19·31	19·21	0·994	1·37	1·37
0·930	18·69	18·60	0·996	0·91	0·91
0·932	18·07	17·99	0·998	0·45	0·45
0·934	17·46	17·38	1·000	0·00	0·00
0·936	16·85	16·78			

A comparison of the two tables brings out the following points:—

(1) For specific gravities between 0·880 and 0·885, the new figures are lower than Lunge's, the maximum difference being 0·33% of ammonia.

(2) For specific gravities between 0·885 and 0·966, the new figures are higher than Lunge's, although the difference is very small.

Upon plotting the results it will be found that for specific gravities below 0·914 a straight line is obtained, whereas above 0·914 there is a slight, but distinct, curvature, the decrease in ammonia content for a given fixed increase in the specific gravity becoming gradually less and less. For example, an increase in the specific gravity of 0·002 at 0·920 corresponds to a decrease in the percentage of ammonia of 0·64%, whereas at 0·960 it is 0·55%, and at 0·990 it is 0·48%. This variation cannot be accounted for by any experimental error, for it is from 20 to 30 times greater than any possible experimental error. It is an interesting fact and one which it is hoped to investigate further at some future date, that this change from a straight line to a curve takes place between the points corresponding to 23·82% and

24·15%, when the composition of the solution may be expressed as $NH_3,3H_2O$, the theoretical ammonia content of which is 23·95%.

In conclusion, the authors desire to express their indebtedness to Messrs. Chance and Hunt, Ltd., Oldbury, in whose laboratories the work was carried out, for having given permission for this paper to be published.

THE USE OF DIPHENYLGUANIDINE AS AN ACCELERATOR OF VULCANISATION.

BY W. M. AMES, M.A., B.SC.

Diphenylguanidine appears to be used to a very considerable extent by rubber manufacturers as an accelerator of vulcanisation, and a study of its properties as such may therefore be of value. There is now a large volume of literature dealing with the numerous organic accelerators, but practically all of it is concerned with the mechanism of the phenomenon of acceleration, and there is little information to assist the manufacturer in the actual use of these materials. In this respect diphenylguanidine, or, as it will be hereafter denoted for the sake of brevity, D.P.G., is no exception.

Kratz, Flower, and Coolidge (J. Ind. Eng. Chem., 1920, **12**, 317) attempted to correlate chemical structure and accelerating effect for a number of substances, of which D.P.G. was one. They further gave data which showed it to be a very active material. Winfield Scott (India Rubber J., 1922, **64**, 605) investigated some of its reactions, and (Ind. Eng. Chem., 1923, **15**, 286) compared it with other guanidines in its behaviour towards sulphur. Regarding its technical use, Weber stated (India Rubber J., 1922, **63**, 795) that it did not produce any discoloration in the finished article, that it could be incorporated without danger of premature vulcanisation in the mixing machine, and that quantities up to ¾% on the rubber could be used with safety. It has been further stated (Le Caoutchouc et la Gutta Percha, 1923, 11816) that the most satisfactory quantity of sulphur to use along with it is from 3% to 5%, and that it produces very flat curing mixings. This rapid survey of the available literature on the subject indicates that the technical use of D.P.G. has perhaps not received the attention which has been given to such well-known organic accelerators as *p*-nitrosodimethylaniline, thiocarbanilide, and hexamethylenetetramine. In order to show how it compares in activity with some of the earlier discoverd accelerators, the first portion of this paper is devoted to a comparison between D.P.G. and *p*-nitrosodimethylaniline, or "accelerene," as it is generally, for convenience, called.

This comparison was carried out first by vulcanising straight test pieces until they reached a standard elongation under a standard load, as indicated in an earlier paper (Anderson and Ames, J., 1923, 136 T). Small equal quantities of D.P.G. and accelerene were incorporated into a control containing rubber and sulphur in the ratio 90:10. Another control containing, in addition, 5% of zinc oxide, had also small quantities of the accelerators added to it. In order to make the quantities of accelerator the same, allowance had to be made for the presence of 33% of water in the accelerene. The six mixings were thus made up as follows, figures denoting parts by weight: (1) Control: Plantation sheet 90, sulphur 10. (2) Control 98, D.P.G. 2. (3) Control 98, accelerene 3. (4) Zinc oxide control: Plantation sheet 45, sulphur 5, zinc oxide 50. (5) Control (ZnO) 100, D.P.G. 1. (6) Control (ZnO) 100, accelerene 1½. The length of time at a temperature of 142° C. necessary to vulcanise test pieces made up with these mixings, so that they reached a standard elongation under a standard load, is shown in Table I. The acceleration is calculated as a percentage of the time of vulcanisation of the appropriate control.

TABLE I.

Mixing.	Time of vulcanisation at 142° C. (287° F.)	Acceleration %.
1	3 hr.	
2	20 min.	89
3	15 „	92
4	2 hr.	—
5	15 min.	87
6	17 „	86

D.P.G. is seen to be an accelerator of practically the same power as accelerene. The presence of zinc oxide does not appear to have much effect on the activity of either, but that is really due to the defects of the method of investigation, which involves comparatively small extensions. Further, the mixings used are probably not suitable for the two accelerators concerned, though they are very useful generally for comparing different materials.

In order to provide a more reliable comparison between the two accelerators, they were incorporated into mixings of plantation sheet 100, sulphur 10, D.P.G. ½, and (A) zinc oxide 5 or (B) light magnesium carbonate 5. A¹ and B¹ are similar mixings containing accelerene, allowance again being made for the moisture present. The four mixings were vulcanised for various lengths of time in the form of slabs, from which ring test pieces were cut for testing on the Schopper machine. The results of these tests are shown in Table II.

TABLE II.

Time of vulc. at 142° C.	Breaking load kg./mm².	Final length, %.	Toughness 600% load, kg./mm².
Mixing A.			
½ hr.	1·44	817	0·41
¾ „	1·30	702	0·40
1 „	0·99	673	0·62
1¼ „	0·83	592	0·73
Mixing A¹.			
20 min.	1·33	875	0·31
30 „	1·03	804	0·35
50 „	0·24	465	—
1¼ hr.	0·25	403	—
Mixing B.			
20 min.	0·59	840	0·23
½ hr.	0·95	903	0·24
¾ „	0·83	808	0·30
Mixing B¹.			
15 min.	0·90	886	0·24
25 „	1·66	890	0·41
35 „	1·35	834	0·44

Comparison of the tensile figures for A and A¹ shows that, as far as strength is concerned, they are very similar. A¹ vulcanises slightly faster than A,

indicating that accelerene is the better accelerator of the two. It is noteworthy, however, that D.P.G. has a greater toughening effect than accelerene. The result of comparing B and B¹ is somewhat similar, except that the strength of the D.P.G. and magnesia mixing, B, is very poor.

From this preliminary investigation, then, it may be concluded that accelerene and the accelerator under consideration are not very different in activity; but it is also obvious that they are somewhat different in action.

In using such a substance the first necessity is to know the proportions of sulphur and accelerator which will give the most satisfactory results from the point of view of tensile properties, rate of cure, flatness of cure, toughness, and ageing. In the absence of any theoretical guidance, beyond very general statements, the only means of determining the optimum quantities of sulphur and accelerator is to adopt the method of trial and error, which was accordingly done.

To hard fine Para containing 5% of zinc oxide were added quantities of sulphur ranging from 1½% to 15% of the rubber. To these different batches were again added quantities of D.P.G. ranging from ⅛% to 1% on the rubber, so that practically all possible combinations of sulphur and accelerator were investigated. The results are indicated in Table III.

TABLE III.

% Sulphur.	% D.P.G.	Time of vulcanisation at 135° C. Hr.	Breaking load Kg./mm².	Final length, %	Toughness at 800% load, Kg./mm².
1½	¼	2	0·30	1062	0·09
		2½	0·42	1071	0·16
		3	0·45	1060	0·12
		3½	0·41	1063	0·11
		4	0·37	1038	0·13
1½	½	1¼	0·88	1026	0·27
		1½	0·81	1018	0·25
		2	0·87	994	0·20
		2¼	0·73	999	0·23
		3	0·74	1040	0·22
1½	1	1	1·10	994	0·40
		1¼	1·04	967	0·42
		1½	1·28	966	0·49
		2	1·21	985	0·41
		2½	1·01	1007	0·34
3	0	5	0·69	1083	0·16
		7	0·51	986	0·30
3	⅛	2	0·31	1006	0·13
		3½	0·58	1058	0·15
		5	0·64	1016	0·24
		8	0·66	990	0·26
		10	0·44	937	0·22
3	¼	2	0·72	1008	0·26
		3	0·89	984	0·33
		3½	0·99	980	0·34
		4	1·03	990	0·38
		4½	0·96	910	0·15
3	½	1	0·78	991	0·29
		1½	1·09	959	0·53
		2	1·22	933	0·55
		2¼	1·19	933	0·57
		2½	1·31	927	0·65
	1	½	0·93	961	0·40
		¾	1·27	927	0·62
		1	1·46	887	0·82
		1¼	1·76	922	0·91
		1½	1·72	897	1·04
5	0	4½	1·20	1036	0·34
		5	1·16	955	0·55
5	⅛	2	0·69	1034	0·22
		3	0·73	948	0·32
		4½	0·96	972	0·38
		5½	0·98	974	0·37
		6	0·84	914	0·47
5	¼	1½	0·69	961	0·42
		2½	1·16	939	0·58
		3	1·31	934	0·63
		3¼	1·18	890	0·66
		3½	1·25	923	0·64
5	½	1	1·32	969	0·58
		1¼	1·43	904	0·84
		1½	1·47	857	1·05
		2	1·43	865	0·98
		2½	1·78	893	1·08
5	1	½	1·40	946	0·70
		¾	1·63	901	0·99
		1	1·72	850	1·36
		1¼	1·72	821	1·56
		1½	1·80	815	1·69
7½	0	3½	1·31	978	0·50
		4	1·28	936	0·63
7½	⅛	1½	0·55	987	0·21
		2½	0·84	912	0·46
		3	1·06	922	0·56
		3½	1·02	909	0·54
		4½	0·91	963	0·68
7½	¼	1¼	1·08	982	0·43
		1½	1·05	922	0·68
		1¾	1·23	932	0·62
		2	1·49	927	0·76
		2½	1·07	843	0·83
		Min.			
7½	½	50	1·26	914	0·60
		Hr.			
		1¼	1·50	893	0·92
		1½	1·42	855	1·05
		1¾	1·53	794	1·51
		2	1·68	804	1·61
7½	1	½	1·40	925	0·73
		¾	1·68	870	1·16
		1	1·64	805	1·52
		1¼	1·79	788	1·89
		1½	2·13	787	2·24
10	0	2½	1·16	973	0·48
		2¾	1·16	955	0·52
		3	1·33	959	0·60
		3¼	1·36	950	0·57
		3½	1·42	927	0·71
10	⅛	1½	0·85	924	0·47
		1¾	0·89	923	0·45
		2¼	1·01	924	0·53
		2½	1·15	939	0·59
		2¾	0·80	849	0·61
10	¼	1	0·91	935	0·49
		1¼	1·21	893	0·77
		1½	1·18	856	0·87
		1¾	1·11	839	0·95
		2	1·02	813	0·90
10	½	¾	1·13	855	0·88
		1	1·41	878	0·97
		1¼	1·36	808	0·94
		1½	1·80	886	1·19
		2	0·93	713	1·54
10	1	¼	1·05	936	0·59
		½	1·36	884	0·89
		¾	1·76	870	1·24
		1	1·48	789	1·66
		1¼	1·81	799	1·89
15	0	1¾	0·99	925	0·51
		2¼	1·01	870	0·68
		2½	0·87	768	1·00
15	⅛	1	0·80	930	0·43
		1½	0·79	847	0·62
		2	0·85	832	0·70
		2½	0·81	823	0·70
		3	0·44	671	0·84
15	¼	¾	1·20	935	0·66
		1	1·18	885	0·78
		1¼	1·44	909	0·88
		1½	1·33	935	1·15
		2	0·84	720	1·31
15	½	¼	1·23	918	0·71
		½	1·15	881	1·00
		1	1·63	876	1·17
		1¼	1·35	791	1·45
		1½	0·76	690	1·74
15	1	¼	1·27	928	0·73
		½	1·30	853	1·03
		¾	1·83	815	1·47
		1	1·64	777	1·86
		1¼	1·54	735	2·34

Hard fine Para was used throughout, in order to be reasonably certain of dealing with a normal rubber. The mixings were made up in such a way as to eliminate errors arising from slight deviations in the proper quantity of sulphur, and the rubber was mixed so that the amount required for the experiment would be as nearly uniform as possible. After the mixings had been prepared, they were heated over a range of cures in a "daylight" press, in the form of slabs. The time necessary being in some instances short, the heating was carried out at 135° C., except for the controls and for mixings containing 1½% of sulphur, which were heated at 142°. When the

mixings had been vulcanised, ring test pieces were cut from the slabs and tested on the Schopper machine, giving the tensile data shown in Table III. Each observation of load and final length is the average of three readings. Before proceeding to general conclusions, the properties of each mixing are considered in detail.

No attempt was made to vulcanise a control mixing containing 1½% of sulphur. The addition of ¼% of D.P.G. to such a mixing enables it to be properly vulcanised, although the tensile strength is very poor. It appears to be fully cured in about 3 hours at 142° C. Increasing the D.P.G. to ½% improves the strength slightly, and reduces the time required to 2 hours. The third mixing of the series containing 1% of accelerator possesses quite good tensile strength, and is fully cured in 1½ hours. It is very noticeable that the addition of D.P.G. causes a marked increase in the toughness of the mixing, the increase becoming greater each time the accelerator is augmented. It appears probable that when these mixings are vulcanised beyond their maximum tensile point they become softer. This may be an indication of devulcanisation, due to prolonged heating in the presence of an active accelerator and a small quantity of sulphur.

In the case of the 3% sulphur mixings it was possible to compare the control with the accelerated mixings. The addition of ⅛% of D.P.G. to the stock makes practically no difference to its properties beyond reducing the time of vulcanisation, as indicated by the maximum strength, from 12 hours to 8 hours at 135° C. Further increase in the quantity of accelerator up to ¼% ensures an increase in both strength and toughness, and brings about a reduction in the time of vulcanisation to 4 hours. The ½% and 1% mixings show a very decided improvement in tensile properties. The toughness of each mixing increases with the addition of D.P.G., and in both cases flat curing properties are beginning to be evident. The strength attained by the last of the 3% sulphur series is noteworthy when considered alone, and is outstanding when contrasted with that of the control.

The same features may be noticed by referring to the tensile figures for the 5% and 7½% sulphur mixings. The various effects, however, are becoming very much intensified with increase in the quantity of sulphur. The only exception to this is that in the case of the two mixings containing only ⅛% of accelerator, the tensile strength is less than that of the control. The 7½% sulphur mixing with 1% of D.P.G. gives a strength of 2·13 kg. per sq. mm.

The 10% and 15% sulphur mixings represent a retrogression. They do not reach the same strength or toughness as the previous mixing, although there is a slight increase in acceleration. Reduction in strength with the addition of small quantities of D.P.G. is again noticeable. In spite of the retrograde movement with respect to tensile properties, both series of mixings are still satisfactory as regards strength, especially those containing larger quantities of accelerator.

In order to demonstrate the general features of D.P.G. as an accelerator, and to indicate clearly the type of mixing in which it should be used, a series of diagrams have been made. Fig. 1 shows how the maximum load obtained over the range of cures

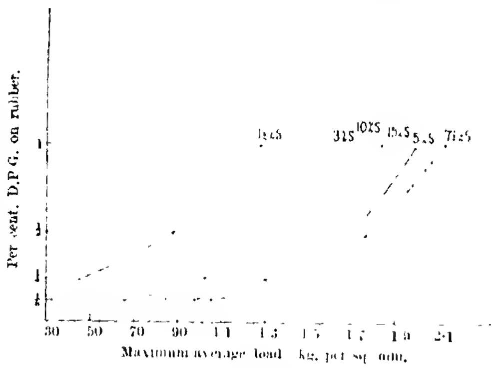

FIG. 1.

behaves with different quantities of accelerator in mixings containing different quantities of sulphur. After the points on this diagram had been plotted, it was found that they lay on a series of curves which corresponded to the different proportions of sulphur. This is the case, also, for the other diagrams, except for Fig. 4, which is an indication that the quantity of sulphur present is one of the main factors determining the properties of an accelerated mixing. Reverting to Fig. 1, it is clear that for every mixing, increase in the quantity of D.P.G. produces an increase in strength, the increment being greater when the quantity of accelerator present is small than when it is already large. As sulphur is added up to 7½%, the curves move further away from the D.P.G. axis and do not intersect, showing that the breaking load becomes greater as the proportion of sulphur is increased, no matter what quantity of accelerator is present. The 10% and 15% curves

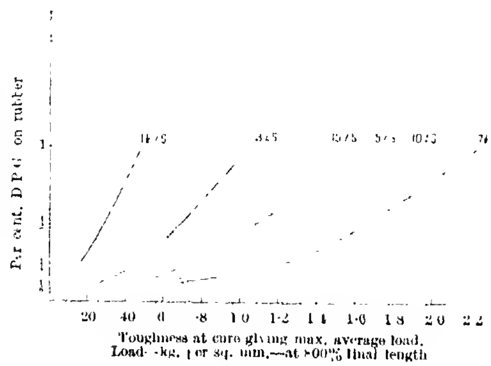

FIG. 2.

lie, however, nearer the vertical axis, which indicates that for all quantities of D.P.G., adding sulphur beyond 7½% causes the strength to decrease. This result cannot be due to the addition of sulphur alone, for a 10% sulphur mixing containing no accelerator possesses a better tensile strength than

one containing 7½%; it must therefore be due to the sulphur and D.P.G. together.

Fig. 2 shows the relation between the toughness (measured by the load required to produce a final length of 800%) of the mixings when they are at their maximum strength, and the quantity of accelerator present, for the different proportions of sulphur. This is thus a comparison of the toughness of the mixings under similar conditions of cure. As noted above, points when plotted lie on curves corresponding to the proportion of sulphur in the mixing. Further, however, for small quantities of sulphur the curves are straight lines, showing that the additional toughness due to the accelerator is practically proportional to the quantity of D.P.G. present. For all the curves the toughening effect increases with the addition of accelerator. When the amount of sulphur present is large, the increase is greatest when the proportion of D.P.G. is small. As regards their position relative to the D.P.G. axis, the curves on Fig. 2 are similar to those on Fig. 1, the toughening effect increasing for all quantities of D.P.G. up to 7½% sulphur and diminishing for quantities of sulphur greater than that. Toughness and strength thus vary similarly in mixings accelerated with D.P.G.

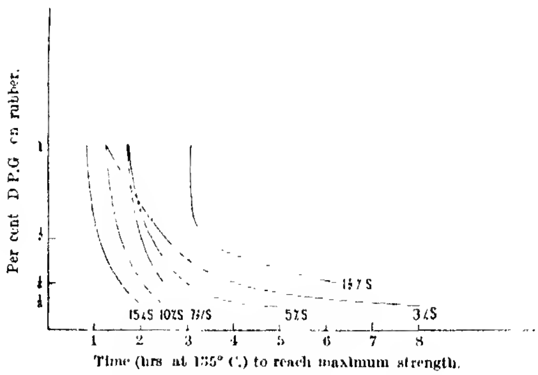

FIG. 3.

Fig. 3 shows the time (at 135° C.) required to reach the maximum strength, plotted against quantity of accelerator. Again, curves for the different proportions of sulphur can be drawn. Their position with respect to the D.P.G. axis indicates that as the quantity of sulphur is augmented, the time of cure is reduced, and there is no break in the continuity of this law at the 7½% curve. From 1½% to 15% sulphur the curves gradually approach the vertical axis. The portions of the curves above the ½% line are practically parallel to the D.P.G. axis, indicating that there is almost no increase in acceleration when more than ½% of D.P.G. is added. The acceleration is produced greatest with small quantities of sulphur, and the lower part of the curves being almost parallel to the time axis, the maximum increase in acceleration is obtained with proportions of accelerator less than ½%. The slope of the lower part of the curves gradually diminishes as sulphur is added, so that for large proportions of sulphur a small quantity of D.P.G. is almost as effective in reducing the time of cure as a large quantity.

An attempt has been made in Fig. 4 to show that when use is made of an accelerator, certain limitations are imposed in order that the good qualities imparted by such a material may be utilised to their fullest extent. The three properties which are most likely to require consideration in producing a new mixing are time of vulcanisation, strength, and toughness. Fig. 4 shows maximum strength plotted against the

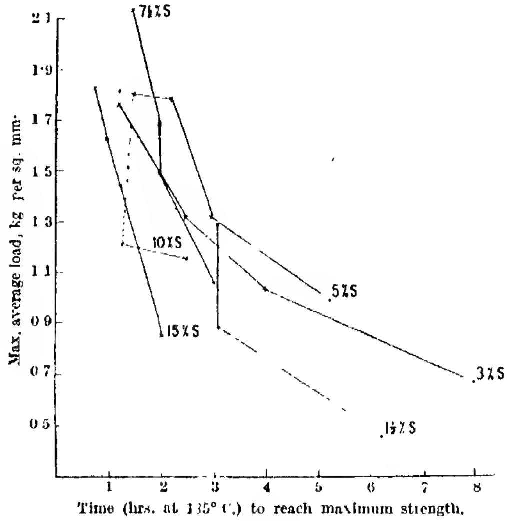

FIG. 4.

time (at 135° C.) required for its development. A similar diagram could be drawn for toughness. For convenience in identification purposes points representing mixings containing the same quantity of sulphur have been connected up. It will be observed that the majority of the mixings reach their best strength between 1 hour and 3 hours at 135° C. A few of very low strength take longer. This indicates that if a mixing is to be produced containing D.P.G. possessing good tensile properties, other circumstances must be such that it can be heated for about 1 hour at 135° C. subject to the influence of the compounding ingredients used. A similar diagram for toughness is not shown here, but it should be noted that satisfactory mixings containing D.P.G. will have certain definite limits of toughness between which they will lie, again subject to the effect of other ingredients. This is very important technically, as it indicates that radical alterations may have to be made in the compounding ingredients of a technical mixing when this accelerator is added in order that the accelerated mixing may possess exactly similar properties to the original, or conform to some specification. In some cases it is conceivable that the use of D.P.G. may be impossible.

Hitherto, in discussing the results, it has been assumed that the time taken to reach the maximum strength indicated when the mixings were fully

vulcanised. In Table IV. are given times of vulcanisation which are considered suitable for technical work, together with the strength developed.

TABLE IV.

% Sulphur.	% D.P.G.	Time of vulcanisation at 135° C. Hrs.	Strength, kg./mm².
1½	½	5	0·42
	¾	3	0·88
	1	3	1·28
3	¼	3½	0·58
	½	3	0·89
	¾	2	1·22
	1	1	1·46
5	¼	8	0·73
	½	2½	1·16
	¾	1½	1·43
	1	¾	1·40
7½	¼	2½	0·84
	½	1¾	1·23
	¾	1¼	1·50
	1	¾	1·40
10	¼	2½	1·01
	½	1½	1·18
	¾	1	1·41
	1	¾	1·36
15	¼	2	0·85
	½	1½	1·41
	¾	¾	1·15
	1	½	1·30

These have been arrived at by taking the first cure giving a reasonably good strength. In most cases the maximum strength is not reached until the mixing has been heated for a considerably longer period, and in all instances except for a few mixings containing a small quantity of sulphur or a small quantity of accelerator, there is a long range of time over which good tensile properties may be obtained. For technical work, therefore, most of the above mixings possess a very big margin of safety. Reference to Table III. shows that this accelerator produces mixings which are very much flatter curing than the controls. This must be reckoned as one of the most valuable properties of D.P.G.

From the above investigation it may be concluded that the best type of mixing to use with this accelerator is one in which the quantity of sulphur is in the neighbourhood of 7½% of the rubber, and the accelerator approximately ½% of the rubber. The quantity of sulphur necessary to bring out the full effect of D.P.G. is thus rather in excess of what might have been expected.

Hitherto, this work has dealt with mixings which are practically pure, containing only sufficient zinc oxide to activate the D.P.G. The possibility arises, however, that the conclusions may not be valid for compounded mixings particularly when active ingredients are present. As it is certain that the presence of active fillers does not invalidate the previous results, inactive fillers will not, it is sufficient to investigate how D.P.G. behaves in mixings containing large quantities of zinc oxide and light magnesium carbonate. Litharge is not considered, as it is such a good accelerator by itself, that it does not appear necessary or advisable that it should be used along with a powerful organic accelerator. Accordingly, the next portion of the experimental work dealt with mixings containing large quantities of zinc oxide and of light magnesium carbonate. In order to reduce the work necessary to a manageable amount, four representative mixings were chosen in such a way that the conclusions from their behaviour would be general for any combination of accelerator and sulphur. Two of the mixings contained a large quantity of sulphur with large and small quantities of D.P.G. respectively. The other two mixings contained a small quantity of sulphur with large and small quantities of D.P.G. respectively. Again, instead of adding different amounts of filler to these control mixings, the largest quantity of zinc oxide and of magnesia which can be efficiently used in rubber, was fixed upon as a suitable quantity to investigate. This procedure is justifiable in that addition of these substances up to that amount causes a progressive change in the physical characteristics of the rubber, and maximum effects were therefore being investigated. The actual quantity of filler which was added, namely 30% of zinc oxide, and 15% of light magnesium carbonate, had already been determined in previous experiments, and is in accordance with that indicated by Wiegand (India Rubber J., 1920, 60, 423).

Each mixing was cured over a range so as to exhibit the maximum tensile properties, and ring test pieces from each heat were tested on the Schopper machine. The resulting tensile figures are shown in Table V. For convenience the tensile figures for the controls have been abstracted from Table III., and are shown alongside those of the corresponding zinc and magnesia mixings. The figures given in the table are again average values obtained by breaking three rings.

TABLE V.

Cure at 275° F.	With 5% zinc oxide. Load kg./mm.²	Final length %	Toughness 700% load, kg./mm.²	With 30% zinc oxide. Load kg./mm.²	Final length %	Toughness 700% load kg./mm.²	With 5% zinc oxide and 15% light magnesium carbonate. Load kg./mm.²	Final length %	Toughness 700% load, kg./mm.²
				Rubber 100, sulphur 7½, D.P.G. 1.					
¼	—	—	—	—	—		1·22	807	0·76
½	1·40	925	0·41	—	—	—	1·81	793	1·26
¾	1·68	870	0·59	1·51	811	0·77	1·96	721	1·83
1	1·64	805	0·87	1·83	855	0·85	2·05	720	1·87
1¼	1·79	788	1·01	1·84	810	1·09	2·10	691	2·16
1½	2·13	787	1·31	1·86	785	1·26		—	—
1¾	—	—	—	1·90	777	1·38	1·70	699	1·63
2¼	—	—	—	1·48	674	1·68	—	—	—
				Rubber 100, sulphur 7½, D.P.G. ½%.					
1½	0·55	987	0·13	—			—	—	—
2½	0·84	912	0·27	0·81	874	0·35	1·39	828	0·82
3	1·06	923	0·36	0·71	829	0·40	1·51	867	0·71
3¼	—	—	—	—	—		1·60	862	0·81
3½	1·02	909	0·30	0·66	747	0·41	1·43	843	0·79
4	—	—	—	0·85	739	0·40	1·59	844	0·89
4½	0·91	863	0·38	0·97	861	0·44	1·51	832	0·90
5	—	—	—	0·72	739	0·52	—	—	—
				Rubber 100, sulphur 3, D.P.G. 1					
½	0·93	961	0·22	—	—	—	1·37	822	0·84
¾	1·27	934	0·33	—	—		1·64	784	1·12
1	1·40	887	0·45	1·23	870	0·52	1·81	764	1·41
1¼	1·70	922	0·48	—	—		1·75	780	1·35
1½	1·72	897	0·55	1·12	805	0·63	2·06	705	1·59
2	—	—	—	1·59	851	0·77	2·00	730	1·69
2¼	—	—	—	1·64	830	0·86		—	—
2½	—	—	—	1·75	835	0·95		—	—
3	—	—	—	1·70	791	0·91	—	—	—
				Rubber 100, sulphur 3, D.P.G. ½					
2	0·31	1006	0·09	—	—	—	—	—	—
3½	0·58	1058	0·10	—	—	—	—	—	—
5	0·64	1013	0·14	—	—	—	—	—	—
6	—	—	—	0·28	739	0·24	0·43	747	0·33
7	—	—	—	0·50	849	0·24	0·51	804	0·31
8	0·66	990	0·16	0·57	891	0·23	0·47	805	0·27
9	—	—	—	0·80	892	0·23	0·49	848	0·26
10	0·44	937	0·15	0·19	654	0·22	0·13	888	0·21

With mixings containing a large quantity of sulphur and 1% of accelerator, the addition of zinc oxide causes a reduction in strength, and also probably slows down the rate of vulcanisation. It produces, however, a slightly tougher rubber, this effect being

rather more marked at an advanced state of cure. The addition of magnesia to the mixing decidedly improves its qualities. Increased strength is obtained from a rubber already outstanding in this respect, coupled with a considerable increase in toughness, rendering the magnesia mixing superior to the zinc mixing. The addition of magnesia also appears to produce further acceleration in the rate of vulcanisation.

Similar effects are noticeable with mixings containing a large quantity of sulphur and a small quantity of D.P.G. The control mixing in this instance—not a particularly good one in respect of tensile properties—is not improved by the addition of zinc oxide. The strength shows a distinct tendency to drop. The maximum strength is not attained until 4½ hrs., as against 3 hrs. for the control. The only improvement effected by the addition is a slight increase in toughness. Very different is the action of the magnesia. The strength is very much increased, and the rate of cure of the control not only maintained, but probably slightly increased. Again, there is a great increase in toughness. Perhaps the most remarkable feature of this magnesia mixing is its flat-curing property. The strength remains good from 2½ to 4½ hrs., and though the mixing is gradually increasing in toughness the increase is not great. The other magnesia mixing possessed the same flat-curing properties as regards strength, but not as regards toughness.

The mixings containing a small quantity of sulphur with a large quantity of accelerator show the effects due to the addition of the two fillers better than any others. The addition of zinc oxide in this case produces practically no alteration in strength, and there is a slight increase in toughness. The rate of cure, however, is slowed down very considerably, the increase in the time required to reach the maximum strength being 1¼ hrs. on an original heat of 1¼ hrs., or 100%. The zinc oxide mixing shows rather a long range of cures which give good strength. The action of the magnesia is very marked. There is an increase in strength, coupled with a slight increase in the rate of cure. A very great toughening effect is produced. In respect of strength the mixing is very flat curing. In general qualities this magnesia mixing is very much superior to the corresponding zinc one.

The last lot of mixings containing a small quantity of sulphur along with a small quantity of D.P.G. is very disappointing. The control in this instance has poor tensile properties, and the addition of fillers does not improve matters. Both zinc oxide and magnesia seem to slow down the rate of vulcanisation of the already slow-curing control.

Considering these results generally, it is evident that the effects produced by the addition of zinc oxide to a mixing accelerated with D.P.G. are not very desirable. Firstly, no increase in strength is produced, there being in fact a slight diminution, which, however, is negligible, particularly as the accelerated mixings are usually very strong. The toughening effect is less than would have been expected. That is, the zinc oxide has a smaller effect on the accelerated mixing—which has already been toughened—than it has when no accelerator is present. The magnitude of the toughness induced by zinc oxide varies with different types of mixings, increasing as the sulphur decreases or with decrease in the quantity of accelerator. It is a well-known fact that the addition of an active filler to a mixing already containing another active filler produces less increase in toughness than if the second filler had been added to a pure stock. In the case under consideration, sulphur and accelerator behave as if they were equivalent to an active filler, so that the full benefit of the toughening powers of the zinc oxide is not obtained. Another disadvantage of using D.P.G. in zinc oxide mixings is the reduction in the rate of cure produced by so doing. This retarding effect of the zinc oxide is greatest when the quantities of accelerator and sulphur present are small. It can be shown that zinc oxide alone has no effect on the time of cure as measured by the time taken to reach maximum strength, so that the retardation noted above must be due to the zinc oxide and D.P.G. conjointly. It is, in fact, a reversal of the activation process. The activity of D.P.G. must be brought up to a maximum by the addition of zinc oxide and then slowly reduced. The magnitude of such an effect would obviously be influenced by the amount of sulphur and accelerator present, and, in particular, it would be greater with small amounts of accelerator. From the behaviour of the mixings investigated, it is concluded that D.P.G. should not be used in zinc oxide mixings unless it is permissible to have present as much as 1% of D.P.G. on the rubber along with a fairly high sulphur content.

The general effects of the addition of light magnesium carbonate to D.P.G. mixings are very different. For all mixings except when accelerator and sulphur are both present in small quantities, the addition of magnesia produces an increase in strength, an increase in the rate of cure, and a toughening effect very similar to what would be obtained if no accelerator had originally been present. The increased strength is most marked when a small quantity of accelerator is used along with a large quantity of sulphur. The augmented toughness is perhaps most marked with a small quantity of sulphur and a large quantity of accelerator. Although it fails to effect any improvement in mixings where both the sulphur and accelerator content are low, the mixings examined above are sufficient to show that in magnesia mixings the good properties of this accelerator are exhibited to their fullest degree.

Hitherto, nothing has been encountered which would indicate that as an accelerator D.P.G. behaves any less efficiently in compounded mixings than in mixings containing nothing but rubber, sulphur, and sufficient zinc oxide to activate it. However, in making experiments with accelerated mixings containing brown rubber substitute, considerable trouble was experienced due to porosity. It has since been noted (Lefebure, India Rubber J., 1923, 66, 932) that D.P.G. does not give good results with mixings containing white substitute. To investigate this

matter, a control (113½ pts.) consisting of hard fine Para 100, zinc oxide 5, sulphur 7½, and D.P.G. 1, was tested alone and with increasing quantities of brown substitute as shown in Table VI. The control and the first four mixings were heated in an autoclave press in the form of slabs for ¾ hr. at 135° C. The last mixing was heated in the same way for 1 hr. at 142° C. In none of the samples could any signs of porosity be detected.

TABLE VI.

Mixing.	Cure.	Load. kg mm²	Final length. %	Toughness 800% load kg mm².
Control	¾ hr.	1·80	818	1·47
1% Sub.	¾ ,,	1·71	816	1·36
5% ,,	¾ ,,	1·70	838	1·24
10% ,,	¾ ,,	1·62	891	1·06
40% ,,	¾ ,,	1·02	798	1·04
40% ,, *	1 ,,	0·60	671	--

* With additional 9% of light magnesium carbonate

As might have been expected, with increase in the quantity of substitute the strength diminishes. The mixings also become rapidly softer, and that may be taken as an indication of the rate of cure being slowed down as the substitute is increased. Magnesia was added to the last mixing in the hope that it would effect an improvement. The reverse is the case. The porosity encountered in mixings of this type is probably due to the slowing down of the rate of cure. From these results it would appear that D.P.G. should not be used along with mixings containing brown substitute. Although figures are not given, the same conclusion applies to white substitute. Probably the reason for this incompatibility of substitutes and accelerator is to be found in the traces of acid always present in these materials.

Another factor which requires consideration when an accelerator is added to a mixing is its influence, if any, upon the ageing properties of the rubber. There has, perhaps, always been some suspicion that rubber containing accelerators is liable to perish more rapidly than ordinary mixings. This point was investigated for D.P.G. by subjecting two of the mixings to an artificial ageing test in an oven. As there is a general similarity in behaviour amongst the mixings dealt with, the choice of two, as being sufficient to indicate the ageing qualities of D.P.G. mixings in general, seems legitimate. The mixings chosen contained large and small quantities of sulphur respectively, with enough D.P.G. in each case to ensure that the mixings would possess reasonably good strength when properly cured, and would also be fairly fast curing. Both mixings contained hard fine Para 100, and zinc oxide 5, whilst A contained in addition 7½ pts. of sulphur and ½ of D.P.G., and B 3 of sulphur 1 of D.P.G. Large batches of A and B were mixed, and sufficient of both vulcanised to provide 55 rings for testing on the Schopper machine. Each mixing was vulcanised for two different times, one of which was supposed to be below that giving the optimum tensile figures, while the other was supposed to be that giving the maximum strength. However, the heats for A turned out to be rather long, and both are actually over-cures. In order to eliminate errors in vulcanisation, as many slabs of each mixing were heated together as practical difficulties would allow. After curing, five rings of each heat were tested, and the remainder of the slabs put into a ventilated oven which was automatically kept at a temperature of 70° C. Each day after this slabs were removed, allowed to cool, and tested. Tensile figures for every second day are shown in Table VII., readings representing averages being obtained by breaking 5 rings.

With mixing A the loads obtained for both cures gradually diminish from the start, which shows that it has been over-cured. In spite of this the load shows no sudden decrease until the 10th day. This is better than the usual behaviour of rubber-sulphur mixings. The strength remains quite noteworthy for 6 days. As the rubber ages there is a gradual increase in toughness, but not as much as might have been expected. The longer cure represents a rather bad over-cure, and the strength breaks down after two days, as an unaccelerated mixing would do under similar circumstances. Considering that the short cure is an over-cure, mixing A possesses very good ageing properties.

Mixing B appears to be very outstanding in ageing qualities. In the case of the short cure the load slowly rises to a maximum which is reached in 5 days, and then gradually diminishes. The long cure reaches its maximum in two days. Both heats must, therefore, have been under-cures, although the longer heat is practically a correct cure. In neither case is there much increase in toughness, nor does either heat show signs of breaking up after 10 days in the oven. The strength of the longer heat is still at 1·41 kg per sq mm. after 10 days, which is quite outstanding.

TABLE VII.

Age in days	Load. kg mm².	Final length %	Toughness 700% load, kg mm²	Load kg mm²	Final length. %	Toughness 700% load, kg mm².
Mixing A.	Cure 1¼ hr at 135° C			Cure 1¾ hr. at 135° C		
0	1·83	879	0·66	1·30	777	0·86
2	1·70	884	0·61	0·52	574	0·81
4	1·56	834	0·73	1·00	639	0·98
6	1·39	806	0·71	0·23	436	
8	1·14	717	0·70	0·08	374	
10	0·48	578	0·71	0·16	340	—
Mixing B	Cure ¾ hr at 135° C			Cure 1¼ hr at 135° C		
0	1·55	945	0·40	1·66	903	0·51
2	1·53	952	0·40	1·70	910	0·54
4	1·65	936	0·42	1·41	845	0·66
6	1·68	939	0·42	1·44	854	0·65
8	1·57	944	0·41	1·45	850	0·64
10	1·34	953	0·32	1·41	856	0·62

From this it is evident that D.P.G. mixings show good ageing qualities when subjected to artificial ageing. On the whole, it is probable that mixings containing a small quantity of sulphur age better than those containing a large quantity, but there appears to be not the least danger in using a large quantity. The smallness of the increase in toughness as D.P.G. mixings age may prove a valuable property.

Besides the possibility of the use of an accelerator spoiling the ageing properties of rubber, another contingency which has to be guarded against is the possibility of the accelerator being sufficiently active to cause premature vulcanisation while mixing operations are being carried out, or during subsequent calendering or extruding of the mixing. This phenomenon is one which does not lend itself very

readily to strictly accurate investigation. However, an attempt has been made to deal with the problem in the following way. The mixing chosen contained rubber 100, zinc oxide 5, sulphur $7\frac{1}{2}$, and D.P.G. 1%, and was one of the fastest curing D.P.G. mixings obtainable. Small portions of the mixing were put into a mould similar to those used for the oil-bath method of heating (Comm Netherlands Govt. Inst., 1917, 139). After clamping up, this mould was placed in a water-bath which could be kept at any desired temperature up to boiling point, and allowed to remain for 5 hours. Samples were heated at 70°, 78°, 88°, 93°, and 97° C. After heating, each sample was carefully examined for signs of curing, a good test being to note the behaviour on passing through a hot mill. The samples heated at 70° and 78° showed no signs of vulcanisation. That heated at 88° was just set. In the case of the 93° and 97° samples, there was no doubt that some vulcanisation had taken place. The critical temperature of this accelerator is, therefore, somewhere about 88° C. That is to say, below that temperature there is either no vulcanisation, or the process is so slow as to escape detection. There is, however, another factor to be considered in connexion with premature vulcanisation, that is the rapidity with which the acceleration increases as the temperature rises above the critical value. The actual investigation of this at low temperatures would be laborious if not impossible, but from the known acceleration at 135° C. it appears that the acceleration will not increase sufficiently rapidly round about 100° to render premature vulcanisation a danger. This becomes more evident when the actual temperature reached on a mixing mill is considered. The temperature of several batches was taken immediately after removal from the mixing mill. As these batches were from 50 to 100 lb. in weight, and were in the form of compact rolls, the temperature of the centre of a roll will be a good indication of the temperature reached on a mixing mill. This was observed for a variety of technical mixings and found to vary from 81° to 85°, which is below the critical temperature for D.P.G. There should, therefore, be little danger of premature vulcanisation in the case of D.P.G. mixings, particularly when it is remembered they will only be at that temperature for a short time.

In considering the milling and mixing of accelerated mixings, another interesting point arises. It is well known that a number of organic accelerators have a marked depolymerising effect on rubber, and therefore they may be used to reduce the time of grinding necessary before solid materials can be incorporated. D.P.G. possess this property in no inconsiderable degree, as will be seen by the following experiment.

A batch of rubber was ground for 20 minutes and 1% D.P.G. added during the last two or three minutes. Another similar batch was ground for the same length of time, but the 1% D.P.G. was added at the start. When solution viscosities of the two rubbers had been determined by means of the Ostwald viscosimeter it was found that the first batch gave a viscosity number approximately twice that of the second batch. This indicates that by the addition of D.P.G. to rubber before grinding or at the start of grinding, less time will be required to reduce the rubber to a certain degree of plasticity than if no accelerator had been present.

Summary.

The conclusions reached in this paper may be summarised as follows :—

(1) Diphenylguanidine possesses accelerating powers of the same order as *p*-nitrosodimethylaniline.

(2) Diphenylguanidine improves the strength and toughness of mixings and imparts flat-curing properties.

(3) The optimum quantities of diphenylguanidine and sulphur are $\frac{1}{2}$ to $\frac{3}{4}$% of the former, and 5 to 7% of the latter.

(4) This accelerator gives similar results with mixings compounded with zinc oxide and light magnesium carbonate. It is more satisfactory, however, with large quantities of magnesia than with zinc oxide.

(5) Brown and white substitutes appear to h[illegible] retarding effect, and such mixings do not [illegible] good results.

(6) Diphenylguanidine mixings possess exc[illegible] ageing qualities when subjected to a[illegible] ageing tests, particularly if the sulphur is low.

(7) There appears to be little danger of pr[illegible] vulcanisation when this substance is pr[illegible] mixings.

(8) Diphenylguanidine possesses the property of softening rubber.

In conclusion, the author has to acknowledge his indebtedness to the management of the North British Rubber Co., in whose laboratories the above investigation was carried out, for permission to publish this paper.

Castle Mills, Edinburgh.

THE DISTRIBUTION OF THEOBROMINE DURING THE FERMENTATION OF CACAO.*

BY A. W. KNAPP AND R. V. WADSWORTH.

One of the effects of the fermentation of cacao is stated by Van Hall in his well-known book to be "the liberation of the theobromine, the substance which gives cocoa its peculiar tonic and stimulating properties."

Hilger and Lazarus[1] have shown the presence of a glucoside, Schweitzer[2] calls it "cacaonin"; which he gives its formula as $C_{60}H_{86}O_{15}N_4$, and affirms that by the action of an enzyme it is decomposed into theobromine, dextrose, and cacao-red. This Sack[3] expresses in the following equation :—

$$\underset{\text{Cacaonin}}{C_{60}H_{86}O_{15}N_4} + 8H_2O + 25O = \underset{\text{Theobromine}}{C_7H_8O_2N_4} + \underset{\text{Dextrose}}{6C_6H_{12}O_6} + \underset{\text{Cacao-red}}{C_{17}H_{12}(OH)_{10}}$$

*Read at a meeting of the Birmingham Sect on on March 18, 1924.
[1] Hilger, Apoth.-Ztg., 1892, 469.
[1] Lazarus, Botanisches Centr., 1893, 41, 296.
[2] Pharm. Ztg., 1898, 42, 389.
[3] Sack, J. Bull. No. 10, 1908, Dept. of Agriculture, Surinam.

On the other hand, A. Goris and G. Fluteaux[4], Ultée and van Dorssen,[9] failed to find cacaonin, or any analogous substance.

The above equation is difficult to accept for many reasons. If all the theobromine in unfermented Forastero cacao existed as cacaonin there must be at least 10·5% of the glucoside present, and considering that 50% of the bean consists of fat, it should be a very obvious constituent of the bean. Further, during drying the brown colour (?cacao-red) of the bean continues to develop, but the fermented bean does not contain any more reducing sugars than the unfermented bean. Whilst in the opinion of the present authors the presence of cacaonin requires further confirmation, it is admitted that there may be present in the unfermented bean a compound of theobromine and tannin[5], but if there is, it must be very easy to decompose. For example, a weak alkali like magnesia must completely decompose it.

Fermented and unfermented beans were finely [illegible]d. Part of each of these was heated for one [illegible] with 5% sulphuric acid. The theobromine being [illegible]en determined by the Dekker process, in which Magn[illegible]sia is used.

Theobromine by Dekker process.

	Original sample.		After hydrolysis.
[illegible], unfermented ..	1·58%	..	1·32%
[illegible], fermented ..	1·15%	..	1·03%

[illegible] results suggest that, allowing for the error [illegible] may occur in the Dekker process, if a glucoside or hydrolysable compound is present, the magnesium oxide is a sufficiently strong alkali to decompose it completely.

An attempt was made to settle this question of the presence of a glucoside by using Maupy's method of determination of the theobromine, because this method depends on its solubility in phenol-chloroform, without either acid or alkaline treatment. By this method 1·45% of theobromine was obtained from the fermented beans, and 1·35% from the unfermented. Even if it had not been evident that the theobromine from the fermented beans was the more contaminated with colouring matters etc., 0·1% would be a small amount of theobromine to have been liberated by fermentation. It was also attempted to extract the theobromine direct from the dry material by means of chloroform. The extract was washed with light petroleum to remove the fat, and the theobromine dissolved in water to separate it from insoluble material; 0·96% was obtained from the fermented, and 0·79% from the unfermented cacao. This result must be accepted with caution, as it is obvious that in neither case was the whole of the theobromine extracted. Finally the most accurate method of determination known to the authors[6] was tested on ground cacao nib from which the fat had been extracted. Part of this material was first treated with 10% hydrochloric acid for four hours at 95° C. The results obtained show that the acid treatment caused not the slightest increase in the amount of theobromine found.

[4] Bull. Sci. Pharmacol., 1910, 17, 599.
[5] Fritsch J. "Fabrication du Chocolat," 1910, Paris.
[6] Wadsworth, R. V., Analyst, 1921, 46, 32.

Cacao		Theobromine in dry fat-free nib. Without acid treatment.		With acid treatment.
Well fermented Jamaica	..	2·48%	..	2·44%
Lightly fermented Arriba	..	2·98%	..	3·00%
Totally unfermented Accra	..	3·80%	..	3·76%

On treating the residues from this method by other processes, no further theobromine has been obtained.

Instead of an increase in theobromine in fermented cacao, it has invariably been found in cacaos of the same kind that the fermented samples contain less theobromine than the unfermented. From our knowledge of the fermentation of cacao this is what would have been expected. The bean becomes full of an acid liquid during the fermentation, which results in some of the theobromine going into solution. A very little might thus escape in the "sweatings," *i.e.*, the juice which runs away. On drying the juicy bean, theobromine would tend to be concentrated on the outside, that is the shell, where the evaporation is taking place. Actually it is found that the shell of the bean fresh from the pod contains only a trace of theobromine, and it is probable that any theobromine found therein comes from the cotyledons, so that the cacao nib naturally contains less theobromine after fermentation. In order to determine accurately the distribution of the theobromine that occurs during fermentation, the authors arranged with Mr. Stanhope Lovell in Trinidad to supply samples of the same mixture of beans after various periods of fermentation. Amongst other analytical figures on these samples, the theobromine and the total nitrogen were determined.

Trinidad cacao (mainly Forastero).

Fermented	Shell (on dry shell).		Nib (on dry fat-free nib)					
	Theobromine	Gain	Theobromine.	Loss	N in theobromine	Loss	Total N.	Loss
Days	%		%		%		%	
0	0·28		2·96	—	0·92	—	5·28	—
2	0·28	—	3·05	—	0·95	—	5·39	—
4	2·35	2·07	2·57	0·43	0·80	0·11	5·05	0·29
6	2·35	2·07	2·36	0·64	0·73	0·20	4·97	0·37
8	2·33	2·05	2·23	0·77	0·69	0·24	4·84	0·50
10	2·23	1·95	2·22	0·78	0·69	0·24	4·71	0·63

The mean of the figures for 0 and 2 days is taken as a basis from which to calculate the loss or gain. The total nitrogen was determined by the Kjeldahl process.

In the above fermentation it is evident that at some period greater than two and less than four days, the distribution of the theobromine took place. From our experience this would be expected to commence somewhere about the sixtieth hour, that is, when the temperature has risen high enough to kill the bean, and the acid liquid has commenced to diffuse freely through the cotyledons. The distribution of theobromine appears to start at a fairly definite period, and an appreciable percentage of the theobromine appears to go almost immediately into solution. There is reason to believe that the theobromine found in shell after fermentation really exists as such, as it is completely removed from the dry shell by anhydrous solvents, such as chloroform. The theobromine in the nib cannot be completely extracted under these conditions, which may be because the solvent does not readily penetrate the cell wall, and

a certain observation points either to this, or to the presence of a very easily decomposable compound. It has been found to be impossible by any method to extract completely the theobromine from cacao nib, save in the presence of water. This corresponds to the observation of Gorter[7] concerning the caffeine in coffee, and certainly suggests either the presence of a compound which is decomposed by water, or that the cell walls are pervious to water but not to solvents like chloroform.

An attempt was made to balance the losses and gains of theobromine; thus after four days' fermentation:—

85·2 parts of nib lost 0·43% theobromine=0·36 pt.
14·8 parts of shell gained 2·07% theobromine =0·31 pt

This is a good agreement, but for longer periods the loss exceeds the gain appreciably. The "sweatings" contain about 0·03% of theobromine, and as roughly 100 lb of dry beans give 10—20 lb. of "sweatings," loss of theobromine from the beans in the "sweatings" might account for the difference in the figures obtained after four days' fermentation. After four days there are no "sweatings" running away, and if the theobromine has not been rubbed off the shell, it can only be suggested that it has been lost by decomposition. Other nitrogenous substances besides theobromine are lost in comparatively large quantities as the fermentation proceeds. It may be pointed out here that it is not usual in Trinidad to ferment for so long a period as ten days.

An attempt to find out more definitely just when the theobromine first went into the shell showed that it began within 24 hours, but there was a sudden increase between 48 and 60 hours.

Period of fermentation—Trinidad beans	½	1	1½	2	2½	3	3½	4	4½ days.
Theobromine in dry shell (%)	0·24	0·37	0·44	0·72	1·28	1·30	1·45	1·68	1·53

By the kindness of a cacao planter the authors were able to repeat the Trinidad experiments in Ceylon on Forastero cacao, and a large number of analyses were made. As the object of the methods as followed in this case was merely to remove th pulp and give the shell a beautiful appearance, an the total period of fermentation did not excee 36 hours, the temperature never rose high enough t produce those changes in the interior of the bea which are usually associated with fermentation Hence there is very little change in the theobromine content of the beans, or of the shell.

Period of fermentation.	Theobromine. In dry nib. %	Theobromine. In dry shell. %
0 days	1·52	0·03
,, (washed)	1·61	0·03
½ day	1·54	0·20
,, (washed)	1·53	0·17
1 day	1·58	0·18
,, (washed)	1·50	0·18
1½ days	1·53	0·46
,, (washed)	1·44	0·37

The washing of the beans did not appear to affect appreciably the theobromine content of shell or nib, a conclusion which in the case of cacao shell is contrary to the expectation expressed by one of us in a previous paper.[8]

Conclusion.—The figures which are included in this paper definitely prove a suggestion originally made by one of the authors[8] from an examination of the cacao beans of commerce, that theobromine passes into the shell during fermentation.

Theobromine, free and combined, exists only in the cotyledons of the fresh cacao bean. The skin of the fresh bean is practically free from theobromine As fermentation proceeds the temperature rises high enough to kill the bean, and at once the liquid which permeates the bean contains theobromine. Thus theobromine passes into the shell, so that it is usual in a well-fermented bean of the Forastero type to find from 0·8 to 2·98% of theobromine in the dry shell, practically all of which has come from the cotyledons. Hence the longer the fermentation, the less theobromine will be found in cacao "nibs."

The authors wish to thank Messrs. Cadbury Brothers, Ltd., for permission to publish this paper, the whole of the analytical work for which was done in their Research Laboratory at Bournville.

[7] Allen "Coml. Org. Anal." 4B, Vol. VI., 1912, 616 See Annalen, 1908 to 1911.

[8] Wadsworth, R. V., Analyst, 1922, 47, 152.
[9] Van Hall's "Cocoa," p. 31.

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THE CORROSION OF COPPER AND COPPER ALLOYS.

BY ULICK R. EVANS.

It has been pointed out in previous papers[1] that the corrosion of metals like zinc, iron, and lead is caused by electric currents set up through unequal access of oxygen to different parts of the surface; the attack tends to become concentrated at any part of the surface which happens to be relatively inaccessible to oxygen, since that part will form the anode of the cell. It is true that the accumulation of metallic salts at the anodic area may sometimes tend to diminish slightly the strength of the current after a time; but, unless the primary anodic corrosion-product is insoluble, the current will not usually drop to zero. In the corrosion of a noble metal such as copper, the E.M.F. set up through "differential aeration" will always be small, and, if copper salts accumulate to any extent at the anodic places, current may finally cease to flow; in that case, corrosion will come to an end.

The essential difference between the behaviour of copper and that of the more reactive metals is shown by the following simple experiment. If two electrodes of iron are placed in a divided cell containing potassium or sodium chloride solution in each compartment, and if air, free from carbon dioxide, is bubbled through one compartment, a current is produced, the aerated electrode being the positive pole; the same effect is obtained if the electrodes consist of zinc, cadmium, or lead. If, however, the experiment is repeated, using copper electrodes, the current produced flows in the opposite direction, unless special precautions are taken to eliminate oxygen from the side over which no bubbles are passing; if a certain amount of oxygen is present on both sides, the pole over which bubbles are made to pass becomes the negative pole. Investigations have shown that this abnormal current is not the effect of aeration, but of stirring. If the liquid in one compartment has previously been rendered moderately free from oxygen by heating, and if it is covered with a layer of paraffin to prevent access of the gas, then when air is bubbled through the other compartment, the electrode in the "aerated" compartment becomes the positive pole, notwithstanding the stirring which is produced. Thus, under appropriate conditions, copper obeys the same law as the other metals.

If, on the other hand, dissolved oxygen is present in both compartments, and one side is stirred mechanically, the electrode on that side immediately becomes negative, owing to the removal of copper ions from the surface of that electrode, with the production of a concentration cell. In fact, the cell

Copper | Potassium chloride solution (stirred) | Potassium chloride solution (stagnant) | Copper

is precisely analogous to the cell

Copper | Potassium cyanide solution | Potassium chloride solution. | Copper

In both cells the copper on the left-hand side acts as negative pole (anode), owing to the smaller concentration of copper cations around it; in the second case the copper cations are removed through chemical destruction by the cyanide, whilst in the first case they are removed mechanically by the stirring.

The practical consequences of the difference in the behaviour of copper and iron are important. Imagine an iron article immersed in a stream of running water. The corrosion is likely to be concentrated at the recesses or crannies in the surface, since these are the parts least accessible to oxygen; as the total area suffering corrosion is small, the linear rate of penetration downwards will be comparatively large. If, on the other hand, the article is of copper, corrosion is unlikely to occur at these comparatively stagnant places, unless they are kept completely free from oxygen (*e.g.*, if they are shielded by a layer of a substance like cuprous chloride, which absorbs oxygen); otherwise the attack is likely to be distributed over the whole surface of the article—a much more desirable state of affairs. Where, however, there exist certain limited areas from which the copper salts are likely to be removed more quickly than from other points, these points may be expected to be anodic and to suffer specially rapid corrosion; as will be shown, this local removal may take place in more than one way.

Thus localised corrosion of copper and copper alloys may be set up: (*a*) through the preferential removal of copper salts from certain areas; (*b*) through the shielding of certain areas from aeration, giving a "differential aeration cell" similar to those operative in zinc and iron. These causes have been investigated by means of observations conducted upon copper and various kinds of brass; the experiments specifically described below were carried out with electrolytic copper, and a brass containing 63·80% of copper, which was practically free from lead. The metals were cleaned with emery immediately before the experiments.

(*A*) *Localised corrosion caused through preferential removal of copper salts from certain areas.*

(1) *Corrosion due to inequalities in the velocity of the liquid.*—An example of localised corrosion has recently been observed in the copper tube of the central condenser installed at the Cambridge University Chemical Laboratory for the production of distilled water. The condenser, which is of the form shown in Fig. 1, was furnished with a pinched copper tube, originally tinned externally; the steam passed

[1] U. R. Evans, J. Inst. Metals, 1923, **30**, 239; J. Oil & Colour Chem. Assoc., 1923, **6**, 150. Proc. Camb. Phil. Soc., 1924, **22**, 54; Chem. and Ind., 1924, **43**, 222.

through the tube, and cooling water drawn from the town water supply passed outside it. After some years the tube failed, and on inspection it was found that a very deeply corroded area, with actual perforation at one point, had appeared near the bottom, at the level where the cooling-water was introduced.

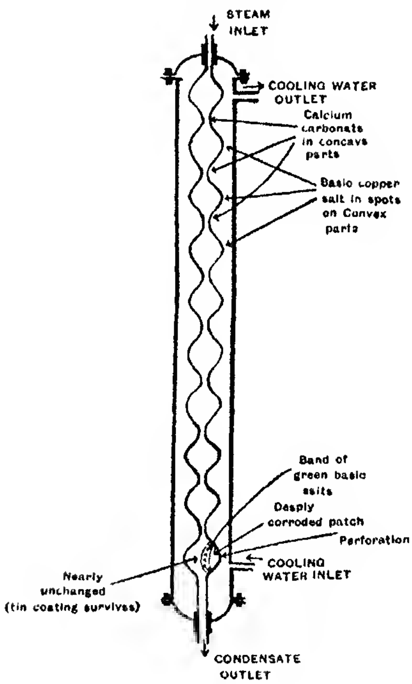

FIG. 1.

This was confined to one side of the tube (presumably that opposite the inlet pipe); the corroded area was surrounded by a deep green adherent deposit, mainly basic copper carbonate, with some chloride. The lower part of the tube was remarkably free from scale, but in the upper part, an adherent scale of calcium carbonate had been produced at the concave portions of the tube; the convex projections were free from scale, and were covered with spots of the green corrosion-product.

The production of the scale of calcium carbonate indicates that alkali must have been produced at the concave portions in the upper part of the tube, and suggests that these places were cathodic; it is noteworthy that these are just the places where the velocity of the water must have been least. On the level of the entry pipe, where the velocity of the water was certainly greatest, the copper was evidently anodic, and suffered serious local corrosion. The green basic salt was presumably produced where the anodic product (copper salts), and the cathodic product (alkali) met and interacted. It is unfortunate that absence of information regarding the original annealing of the tubes, and uncertainties introduced by the fact that the tube was originally covered with tin (which covering survived intact over a large part of the surface of the lower part of the tube, on the opposite side to the corroded patch) make it impossible to say that this is the only factor involved; but the description given almost certainly conveys a truthful account of the essential mechanism of the process.

(2) *Water-line attack in dilute acids.*[1]—The local removal of copper salts from certain points may also be produced by gravity or by capillary forces. The well-known water-line attack, which is so characteristic of copper and its alloys, affords an interesting example. If a sheet of copper (Fig. 2) is half

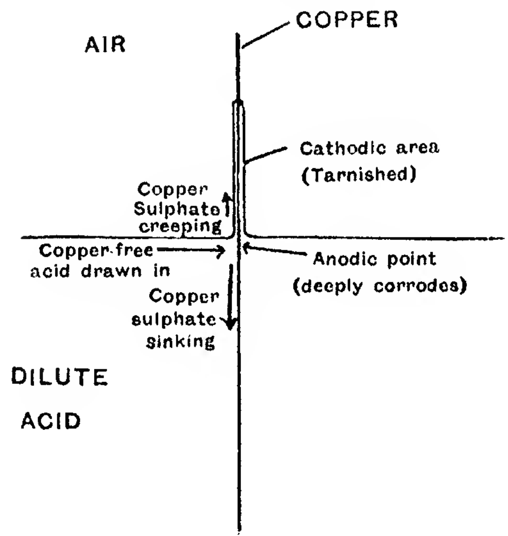

FIG. 2.

immersed in dilute sulphuric acid, the surface being wetted with the acid above the water-line, very rapid attack occurs just below the water-line, and the metal may be eaten through within a few days; the attack is comparatively slow if the copper is not wetted above the water-line. The explanation appears to be as follows. The aerated part above the water-line becomes cathodic, and the part immediately below the water-line is anodic, since it is just from this part that the copper sulphate will be removed most readily; the heavy solution containing that salt will sink downwards through gravity along the surface of the copper, whilst part of the salt will be sucked through capillary forces into the liquid film extending upwards over the copper surface; fresh acid free from copper salts will flow in laterally to replace the liquid which is sinking downwards, and thus the copper salt concentration just below the water-line is always kept low, and anodic attack will be concentrated on this part.

The explanation of water-line attack in dilute sulphuric acid just suggested is based on that given

[1] Water-line attack in neutral salt solutions often follows a course similar to that described in the section on "Corrosion due to drops resting on the surface."

y the author in a previous paper[1], but embodies so certain parts of the views put forward by E. A. Bolton[2] and K. M. Watson[3]; it attributes the special anodic attack just below the water-line to the preferential removal of copper salts from that point, but it also introduces the notion of selective aeration, and leads naturally to the consideration of differential aeration cells.

(B) Localised corrosion set up by differential aeration cells, analogous to those operative in the corrosion of iron and zinc.

(1) *Corrosion caused by contact with a non-conducting substance.*—The general analogy between the corrosion of copper and that of zinc, iron, or lead is clearly shown by experiments carried out under stagnant conditions, which exclude complications due to stirring. It has been demonstrated in previous papers that zinc, iron, and lead suffer special corrosion where they are in contact with non-conducting substances, such as glass, porcelain, or thread, which will tend to screen the metallic surface from diffusing oxygen. More recently the same effect was produced on copper, in the following way. A sheet of copper, cleaned with emery, was half immersed in a 3% solution of sodium chloride at an angle of 65°, being supported in this position by resting on a glass rod. The surface of the copper was wetted above the water-line, and solution naturally crept up between the rod and the sheet. The whole was placed in a large closed vessel to prevent evaporation. After two weeks the sheet was found to be very deeply attacked where it had rested on the glass rod, especially at the bottom portion of the rod, the place least accessible to diffusing oxygen. The other parts of the copper surface, both beneath the liquid surface and the wetted area above the water-line, although tarnished, were not sensibly corroded.

Analogous results have been obtained with brass. A piece of brass sheet, half immersed in 3% sodium chloride and supported against a glass rod in the manner just described, was found, after two weeks, to be deeply eaten away, where it had leant against the glass. Other pieces of brass, placed horizontally in 3% sodium chloride in porcelain dishes, with weighted watch-glasses resting on them at certain points, were found to be attacked locally around the points where the glasses had rested on the brass surface. In all experiments the (anodic) areas which had suffered attack were covered and surrounded by heaps of a loose green-blue salt, which was found to be mainly basic cupric chloride. It appears probable that the immediate anodic product was cuprous chloride, which shielded the surface on which it rested from oxygen, and thus promoted anodic attack on the brass below; any oxygen which commenced to diffuse through the salt was consumed in oxidising the cuprous chloride to basic cupric chloride.

The fact that corrosion through differential aeration can be set up in brass by contact with non-conductors is of great practical importance in connexion with brass condenser-tubes. It has long been known[1] that the entry of foreign bodies into the tubes of marine condensers is a most important cause of the initiation of corrosion; such foreign bodies include sand, coke, wood, cotton-fibre, shells, sea-weed, flakes of iron oxide, metallic sulphides or hydroxides. It is probable that the trouble usually arises when the vessels are in port; stagnant conditions then prevail in the tubes, and any foreign fragments which may have entered will rest on the bottom of the tubes and produce corrosion of the type described above. When once a considerable deposit of basic salts of copper or zinc has been produced, it is likely that the corrosion will continue at this point in preference to others, even if stagnant conditions cease to prevail. In practice it is often found that the trouble, once initiated, continues to increase long after the vessel has put to sea, in spite of the rapid passage of water through the tubes.

(2) *Corrosion due to drops resting on the metallic surface.*—A partial analogy between the corrosion of copper and that of iron is also observed on comparing the action of drops of sodium chloride solution placed on the surfaces of the two metals. In the case of iron (Fig. 3), as explained elsewhere,[2]

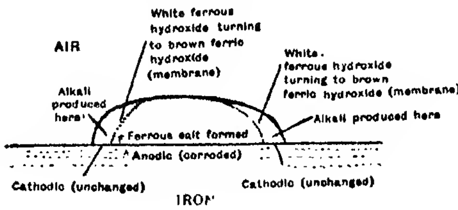

FIG. 3.

alkali is formed at the cathodic (aerated) margin of each drop, and ferrous salts at the anodic (unaerated) interior; where the alkali and ferrous salts meet, a membrane of white ferrous hydroxide, gradually oxidising to brown ferric hydroxide, appears; the corrosion is confined to the central portions within the membrane. This effect develops within a few hours. If a drop of sodium chloride solution is placed on a copper surface (Fig. 4), the action is much slower, and for some hours no change is observed, apart from the appearance of a fine series of "tarnish-colours" on the metal below the liquid. After a time, however, a cloudy white patch appears in the interior of the drop, and when once this white substance is observed on the surface of the metal,[3] the change proceeds comparatively rapidly. After a few days, there is a loose heap consisting of a pale blue-green precipitate in the centre of the drop, whilst the liquid around the heap is clear and contains alkali. If the precipitate is washed away, it is seen

[1]J. Inst. Metals, 1923, **30**, 272, 293.
[2]*Ibid.*, 1923, **30**, 289.
[3]Trans. Amer. Electrochem. Soc., 1924.

[1]W. A. Tilden, J., 1886, **5**, 84. A Philip, J. Inst. Metals, 1912, **1**, 56. G. D. Bengough, R. M. Jones, and R. Pirret, *ibid* 1920, **23**, 65. G. D. Bengough, *ibid*., 1921, **26**, 433.
[2]U. R. Evans, J. Oil & Colour Chem. Assoc., 1923, **6**, 154.
[3]Frequently a very thin film or membrane appears on the upper surface of the drop before the precipitate appears on the metal itself; this film does not promote subsequent corrosion. The superficial membrane, which invariably appears sooner or later on the surface, is too thin to be analysed, but resembles a hydroxide-membrane.

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that the copper below it is distinctly corroded, whilst in the parts not covered by the precipitate the copper, although tarnished, has not been eaten away. The precipitate consists of a mixture of cuprous chloride and basic cupric chloride; in the early stages it is usually quite white, but darkens when exposed to the light; in the later stages, it is bluish or green.

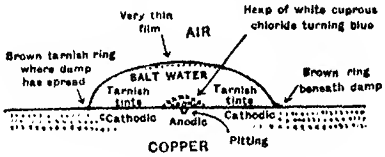

FIG. 4.

The explanation of these phenomena appears to be as follows. At first only a very minute current is set up between the margin of the drop and the interior, where the oxygen concentration is slightly lower than at the margin. But as soon as the anodic product, loose cuprous chloride, begins to accumulate, it will commence to shield the copper below it from oxygen, not merely by interfering mechanically with the diffusion of the oxygen, but also by absorbing it chemically with the production of the basic cupric chloride. Thus when once the precipitate has begun to form the action goes on at an increased rate.

If the interpretation just offered is correct, it would be expected that salts which will not yield a sparingly soluble cuprous compound as the anodic product will not produce serious localised corrosion of this kind. To test this matter, drops of $N/2$ solutions of potassium chloride, potassium sulphate, potassium nitrate, and sodium carbonate were placed on copper. After two days, the potassium chloride solution had produced marked local corrosion at the centre of the drop in the manner described above; but the other liquids had produced no real corrosion, although the copper was darkened below the sulphate and nitrate solutions. This observation supports von Wurstemberger's statement[1] that localised corrosion of copper and brass occurs most readily if the conditions are such as to produce deposits of sparingly soluble salts; he considers, for instance, that an alkaline reaction in the liquid, being favourable to the production of basic salts, is likely to promote the localisation of corrosion.

The nature of the tarnish-film produced within a drop of sodium chloride on the parts of the copper surface to which oxygen has access is of interest. A sequence of brightly-coloured concentric zones, rose, green, yellow, and blue, were produced, indicating, probably, that the film thickened as the edge of the drop was approached; the colours were due, no doubt, to interference or diffraction. After the precipitate had been washed away, the parts of the surface where the drops had rested were tested with different reagents. It was found that dilute sulphuric acid blackened the whole of the coloured region, hydrochloric acid removed the colours with slight blackening, whilst ammonia had no marked effect These three reagents behave in exactly the sam way towards the films produced by heating coppe in air—films which also show a fine series of col ours. Since the work of Pilling and Bedworth[1] has indicated that the film produced on heating copper in air is mainly cuprous oxide, it is legitimate to regard the behaviour of the tarnish-films towards the three reagents as indicating that the tarnish-films also consist of cuprous oxide.[2] At the extreme margin of the drop, where the moisture had crept outwards from the original position of the boundary, there was observed a narrow zone of a brownish colour, which was dissolved away by dilute sulphuric acid without blackening, and which was therefore presumably cupric oxide.

Results analogous to those observed on copper were obtained when drops of 3% sodium chloride were placed on a brass surface; a blue-green precipitate appeared in the centre of the drop, and below it the brass was found to have suffered distinct alteration, giving rise to a light brown adherent layer. The fact that the placing of drops on brass may initiate corrosion is of some importance, in view of the fact that some marine engineers advocate the draining of condenser tubes when ships are in port. If the tubes are dried quickly, this is no doubt a good plan; but if the tubes are left for any considerable time with wet and dry patches on the internal surface, the practice may initiate just the type of corrosion whicl it is desired to avoid.

(3) *Corrosion due to an uneven surface.*—Pieces of brass rubbed with coarse emery paper and immersed in 3% sodium chloride solution contained ir a shallow dish, were found to be corroded in a manne dictated by the direction of the grooves left by th emery. The blue-green corrosion product was seen t run largely in straight lines following the grooves and on rubbing off this layer of salt the underlying brass was itself found to be darkened within the grooves and almost unchanged between them. This i precisely analogous to the observation previousl made on iron,[3] on which metal the rusting alway tends to follow the grooves left by emery-treatment The reason in both cases is, of course, that th interiors of the grooves are less accessible to th diffusion of oxygen than other parts of the surfac and therefore become anodic. The observation has certain practical importance, because Maass an Liebreich[4] consider that internal unevenness i condenser tubes is a serious cause of corrosion, an state that one of the most important advantages tinning the tubes is that the unevennesses are filled u

Effect of the corrosion-product in promoting corrosio

Several examples have already been given of th way in which, when once the formation of cupro chloride has commenced at a place, corrosion procee there apace. The explanation offered is analogo

[1] Z. Metallk., 1922, **14**, 23, 59.

[1] N. B. Pilling and R. E. Bedworth, J. Inst. Metals, 1923, **29**, 529.
[2] Many text-books say that cuprous oxide dissolves quickly in ammoni this statement would not appear to apply to the oxide in the form an adherent film.
[3] U. R. Evans, Proc. Camb. Phil. Soc., 1924, **22**, 54.
[4] Z. Metallk., 1923, **15**, 245.

› that put forward previously to account for the ‹fect of wet rust in promoting further rusting; the ›rrosion-product in each case tends to prevent the ›cess of oxygen to the unchanged metal below, and ›us allows anodic attack to proceed. The shielding › the metal from oxygen is probably not merely a ›se of mechanical hindrance to diffusion; it is ›kely that the oxygen is absorbed chemically by the ›uprous chloride or by the ferrous hydroxide.

The effect of the corrosion-product in promoting ›ibsequent corrosion of copper, brass, and bronze ›as been noticed under many different circumstances. › has long been known that copper or bronze exposed › the atmosphere sometimes develops at certain ›laces a greenish deposit, which gradually spreads ›om these points until it covers the whole surface; ›iis spreading of the area under attack has often been ›escribed as a disease. Rathgen[1] has examined ›veral hundred specimens of the greenish deposit, ›nd has found chloride present in every case; the ›istence of chlorides in the deposit found on ancient ›onze articles at the British Museum has also been ›tablished by recent investigators, who regard the ›loride as the active agent in corrosion.[2] The ›esent author[3] has observed that when specimens › copper are exposed to moist air containing hydrogen ›loride, serious corrosion occurs at certain points ›hich become covered with a thick green deposit, ›hilst other parts are only superficially attacked. ›any years ago Tilden,[4] after lengthy examination › the action of warm sea-water on copper, brass, ›d bronze, came to the conclusion that the basic ›loride of copper was the main corroding influence. Bengough and his colleagues,[5] as the result of ex›nded and careful study of the corrosion of condenser ›ibes, have come to the conclusion that some of the most important types of localised corrosion are to be attributed to the presence of basic salts adhering to the surface of the tube.

Other influences causing localisation of corrosion.

Since the total rate of attack upon copper and brass articles by most liquids (as measured by loss of weight) is very small, corrosion will only become of serious import if it is localised upon a limited area of the article in question. Certain causes of localisation have already been enumerated, but for the sake of completeness, two other influences, which have been urged by other writers, may be mentioned.

Philip[6] and also Lasche[7] have pointed out that particles of carbonaceous substances (coke, coal, graphite flakes, etc.) settling on the bottom of a brass condenser tube have a particularly disastrous effect, and have attributed this to the production of corrosion couples, the carbonaceous substance acting as cathode. Furthermore, the local removal of the oxide or other scale which should exist all over the surface of a healthy condenser tube is likely to lead to the concentration of corrosion at the exposed place; this removal may occur by mechanical means (erosion) as suggested by Bengough, or by stray electric currents, or by the presence of an unduly acid water, as suggested by Lasche; the presence of a *weakly* acid reaction is, however, probably favourable to the life of the tube, as has been indicated by von Wurstemberger.

The author desires to thank Mr. C. T. Heycock, F.R.S., for information regarding the condenser at Cambridge, and Dr. Bengough and Mr. Stuart for information regarding marine condensers.

Summary.

Localised corrosion of copper and brass articles may occur :—

(A) By *preferential removal* of copper salts from certain points, thus producing a concentration cell; the points of low concentration are the anodes of the cell, and suffer attack. This removal may occur:

(1) by *high local velocity of water* (an example is described of the corrosion of an externally cooled condenser-tube, just opposite to the cooling-water inlet);
(2) by *gravity* or *capillary forces* (*e.g.*, in water-line attack by acids).

(B) By *differential aeration*, the points shielded from oxygen become anodic and suffer attack. Differential aeration cells may be set up:

(1) where *foreign bodies* rest on the metallic surface (*e.g.*, sand, shells, etc., in marine condenser-tubes);
(2) where *drops* of liquid rest on a dry metallic surface;
(3) where the *surface is uneven* (*e.g.*, corrosion in scratches left by emery treatment).

Cuprous chloride, the corrosion product, when once formed, serves to screen the underlying metal from oxygen, and thus to promote further corrosion.

Other probable causes of localised corrosion include :—

(C) *Contact with conducting bodies* (*e.g.*, effect of carbonaceous fragments in condenser tubes).

(D) *Local removal of a protective skin.*

[1]Dingler's Polyt. J., 1896, **301**, 44.
[2]"Cleaning and restoration of Museum specimens," (Dept. Sci. Ind. Res.) 2nd Report (1923), pp. 7, 8.
[3]Trans. Faraday Soc., 1923, **19**, 205.
[4]J., 1886, 84.
[5]G. D. Bengough, R. M. Jones, and R. Pirret, J. Inst. Metals, 1920, **23**, 65.
[6]J. Inst. Metals, 1914, **12**, 133.
[7]Z. Metallk., 1920, **12**, 161.

SEPARATION OF COBALT FROM NICKELIFEROUS ORES BY THE PURPUREO-COBALT CHLORIDE PROCESS.*

BY GILBERT T. MORGAN AND J. D. MAIN SMITH.

Metallic cobalt and its salts are obtained commercially from arsenical cobalt ores containing considerable amounts of nickel and iron together with smaller quantities of other metals such as copper and bismuth. After preliminary treatment to remove part of the arsenic, a calcined speiss is obtained, consisting largely of arsenides and oxides. This speiss is dissolved in hot concentrated hydro-

* Read at a meeting of the Birmingham Section on April 4, 1924.

chloric acid, iron and arsenic are removed as ferric arsenate by hot milk of lime, the metals of analytical group II. removed as sulphides with hydrogen sulphide, and the remaining iron as ferric hydroxide by milk of lime. From the final liquid the peroxides of cobalt and nickel are fractionally precipitated with bleach-liquor, cobalt being separated nearly quantitatively before nickel.

A description of this process appears in Tilden's "Manual of Chemistry" (1889) as being the oldest and most efficient in use at that time, but the process is not mentioned as being in commercial use in later text-books. A very similar process has been worked on a large scale for over half a century and is still in use by Messrs. Henry Wiggin and Co., Ltd., of Birmingham, to whose courtesy we are indebted for the gift of the cobalt speiss used in the following investigation.

In the course of our researches on residual affinity and co-ordination, in which cobalt has played an important part in the elucidation of the constitution of mordant dyes (see Chem. Soc. Trans., 1921, **119**, 704; 1922, **121**, 160, 2857, 2866), considerable quantities of various cobaltammines have been prepared and a large-scale process has been devised for the rapid and economical preparation of purpureo-cobalt chloride (chloropentamminocobaltic chloride), $[CoCl,5NH_3]Cl_2$. This carmine-red complex salt, originally discovered in 1851 almost simultaneously by Genth in America, Fremy in France, and Claudet in England, was utilised by the last of these for the separation of cobalt from its ores. This method is frequently referred to in the literature relating to cobalt, although the process does not appear ever to have been in commercial use, due doubtless, not to the incompleteness of the separation, but to the costly nature of the process, excess of hydrochloric acid, ammonia, ammonium carbonate and chloride being necessary.

The improved process described below can be worked at a small fraction of the cost of existing methods for the preparation of purpureo-cobalt chloride, and this could be further greatly lessened by the recovery of the ammonia, calcium chloride becoming the sole waste product. A comparison with Biltz's process, probably the best known and most efficient (see "Laboratory Methods," p. 173), is subjoined

Reagents	Biltz's process.	New process.
Cobalt as chloride	1 g.-atom	1 g.-atom
Ammonium carbonate	3 mols.	nil.
Ammonium chloride	17 mols	3 mols
Ammonia	11 to 14 mols.	8½ mols.
Hydrochloric acid	20 to 35 mols	nil
Hydrogen peroxide	nil.	0·6 mol. or nil.
Water, including that in reagents (approx.)	600 mols.	60 mols

Biltz's process thus involves an excessive use of reagents and large volumes of liquid. These solutions have successively to be oxidised by prolonged aeration, evaporated to dryness, made up to the original volume, and boiled repeatedly. The yield of purpureo-cobalt chloride varies considerably; 70 to 80% of the theoretical is usual, although much smaller proportions are often obtained owing to incomplete oxidation and loss of ammonia during aeration. By the new process a yield of over 90% is invariably obtained, and 94–95% is usual. For the preparation of about 50 grams, Biltz's process requires about seven hours, and much larger quantities cannot be conveniently made in the laboratory owing to the bulk of solution. By the new method, the same amount can be made in less than an hour, and 500 grams are obtainable with ordinary laboratory vessels in about four hours.

The new process is well adapted for large-scale operation, and is under complete control at all stages. The free ammonia and the combined ammonia in the cobaltammine salt and ammonium chloride are readily recoverable. On boiling with the calculated amount of chalk or milk of lime, the purpureo cobalt chloride readily yields ammonia, hydrated cobaltic oxide being precipitated and calcium chloride passing into solution. Apart from normal wastages, the only reagents, other than hydrochloric acid necessary for solution of the ore, are hydrogen peroxide and chalk or lime. On a works scale the use of hydrogen peroxide, which, however, is now cheaply available, could be dispensed with in favour of aerial oxidation, under pressure if necessary for rapid working. The presence of metals yielding hydroxides soluble in ammonia, such as nickel and copper, affects neither the amounts of reagents nor the yield and purity of the product. Metals yielding hydroxides insoluble in ammonia, may be removed by filtration after oxidation, or may be dissolved out of the product by dilute hydrochloric acid, in which the product is almost insoluble. The only metals which could be present in the final product are rhodium and iridium, which form similar ammines. If present in the ores, these metals could be isolated by this precipitation, as both are readily separable from cobalt.

Cobalt-nickel ores containing a high percentage of nickel are usually worked for nickel by the Mond carbonyl process, cobalt accumulating in the residues, whereas ores containing a high percentage of cobalt are worked mainly for cobalt by the Wiggin process. The crude cobalt oxide thus produced invariably contains a considerable amount of nickel, which is largely removed by extraction with dilute hydrochloric acid, but analytically nickel-free cobalt oxide is never obtained. We have found, however, that analytically pure cobalt oxide is obtainable practically quantitatively by the purpureo-cobalt chloride process, and that the presence of nickel in the original ore or mixture, in amounts varying from 5 to 50% of nickel, does not affect the yield or purity of the cobalt product. The residual liquors from precipitated purpureo salt contain 5 to 6% of the original cobalt content and the whole of the nickel, together with ammonium chloride. After recovery of the ammonia by boiling with milk of lime, the mixed oxides of cobalt and nickel accumulated from several batches may be separately treated for recovery of the bulk of the cobalt, or returned to the ore solutions for repeated treatment, depending on the

relative proportions of cobalt and nickel. With ores very low in nickel, the mixed oxides would advantageously be returned to the ores for subsequent treatment until the proportion of nickel in the residues was approximately equal to that of cobalt. The mixed oxides are then separately treated for recovery of the cobalt, and the final mixed oxides, containing over 90% of nickel oxide, used metallurgically as nickel, since few nickel alloys require to be entirely free from cobalt.

Four chemical operations are involved in the process:—solution of the ore, removal of arsenic, formation of the insoluble cobalt compound, and its decomposition to yield cobalt oxide. On boiling the calcined ore (speiss) with concentrated hydrochloric acid, the cobalt and nickel peroxides are converted into the lower chlorides, the chlorine liberated oxidising the ferric arsenide to ferric arsenate, which remains in solution in the acid liquor, and is precipitated therefrom after nearly neutralising and boiling. A deficiency of chlorine may be corrected by employing bleach-liquor as part of the neutralising reagent, since it is essential that no arsenite be present. A deficiency of iron necessary for complete precipitation of the arsenic as ferric arsenate is corrected by the addition of a slight excess of ferric chloride. A satisfactory speiss should contain sufficient available oxygen to convert all the arsenic to arsenate and enough iron to combine therewith. The formation of the cobalt compound consists in the addition of six molecules of ammonia to each molecule of cobaltous chloride, the simultaneous oxidation and hydrolysis of the hexamminocobaltous salt to the aquopentamminocobaltic salt, and the conversion of the latter by hot ammonium chloride into insoluble chloropentammino- or purpureo-salt $[CoCl,5NH_3]Cl_2$. This salt is readily decomposed by alkalis or calcium carbonate on boiling, with precipitation of cobaltic hydroxide.

Separation of cobalt from mixtures of cobalt and nickel.

1. *Mixture containing 50% of nickel.* To a solution of 23·8 g. of hexa-aquocobaltous chloride and 23·8 g. of hexa-aquonickel chloride in 50 c.c. of water were added 16 g. (=3 mols. per atom of Co) of ammonium chloride, forming after boiling a bluish-green liquid, which was cooled to room temperature before the addition of 17 c.c. of 6*N* hydrogen peroxide solution (=1·7 g. H_2O_2=½ mol.). The mixture was immediately poured into 39 c.c. of 18*N* ammonia solution (=11·9 g. =7 mols.), the liquid turning dark brown, becoming hot and effervescent. On boiling vigorously the solution turned dark red and a carmine-red crystalline precipitate of purpureo-cobalt chloride separated. When nearly all the free ammonia had been removed by boiling, the hot liquid was filtered and the precipitate washed with a few c.c. of 2*N* hydrochloric acid solution to remove the adherent mother-liquor, and the filtrate and washings were allowed to cool. The precipitate was well drained at the pump and then dried at 160° C.; the yield was 20·8 g. (=83%). The required 17% of the original quantities of the ammonia (=7 c.c.) and hydrogen peroxide (=3 c.c.) solutions was added to the still ammoniacal cold filtrate, and the mixture again boiled till nearly all the free ammonia was removed, purpureo-cobalt chloride again separating. After washing with a few c.c. of 2*N* hydrochloric acid solution and drying at 100°, the precipitate weighed 2·7 g. (11% yield), the total yield of the cobalt compound thus being 94%, or precisely the same as if the original solution had contained no nickel.

2. *Mixture containing only 5% of nickel.*—The foregoing process was repeated with the same quantities of all the reagents, except that only 2·4 g. of the nickel salt were used, the yield of cobalt compound being again 94%.

3. *Separation of cobalt from cobalt speiss.*—To 53 g. of finely powdered cobalt speiss (calcined arsenical ore) containing 12·5% of cobalt (=22·5 g. Co) were added 160 c.c. of concentrated hydrochloric acid solution (=10*N*), and the mixture was boiled vigorously and stirred till the green liquid became pasty. It was then boiled with 50 c.c. of water and filtered. The residue was boiled with a further 40 c.c. of the acid till again pasty, then with 20 c.c. of water, and filtered. The combined filtrates were nearly neutralised with powdered limestone, boiled to precipitate ferric arsenate, and filtered. The liquid on testing still contained both iron and arsenic, and further small amounts of limestone were added and the liquid was boiled till the final filtrate was free from arsenic, a slight deficiency of iron necessary for the removal of all the arsenic as ferric arsenate being corrected by the addition of a slight excess of ferric chloride solution. The filtrate was diluted to 300 c.c. and 61 g. of ammonium chloride (=3 mols. per atom of Co) dissolved in it by boiling. After cooling, 65 c.c. of 6*N* hydrogen peroxide solution (=½ mol.) were added, and the mixture was immediately poured into 170 c.c. of 18*N* ammonia solution, *d.* 0·880 (=8 mols.), the mixture becoming hot, dark brown, and effervescent. It was then boiled and stirred vigorously till nearly all the free ammonia was removed, and the purpureo-cobalt chloride which separated removed by filtration, washed with 50 c.c. of 5*N* hydrochloric acid solution to remove ferric hydroxide, and dried at 100°, 79·5 g. (84% yield) being obtained. The filtrate when cold was re-oxidised with 12 c.c. of the hydrogen peroxide solution after the addition of 34 c.c. of the ammonia solution, boiled till the free ammonia was nearly removed, and filtered. The precipitate was washed with a few c.c. of 2*N* hydrochloric acid solution to remove mother liquor and dried at 100°, 10·3 g. (11% yield) being obtained. The total yield of purpureo-cobalt chloride was 95% calculated on the cobalt content of the speiss, the separation of cobalt being practically quantitative.

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THE VOLATILE MATTER AND ASH CONTENTS OF SAMPLES OF COAL FROM THE SAME SEAM.

BY T. J. DRAKELEY AND J. R. I. HEPBURN.

The calculation of the percentage of volatile matter (V) in a sample of coal, on an ash- and moisture-free basis, has usually been made by means of the formula :—

$$V_1 = 100(v_c - w)/(100 - a_c - w), \ldots\ldots\ldots\ldots (1)$$

where v_c is the percentage of volatile matter including water in the crude coal, a_c the percentage of ash, and w the percentage of moisture.

In view of the fact that the volatile matter content on an ash- and moisture-free basis is one of the factors which may be used in the classification of coals (see, for example, Parr, J. Ind. Eng. Chem., 1922, **14**, 919), it is of importance that the accuracy of this formula should be examined.

The effect of moisture in the coal is apparently precisely expressed by the equation ; and in the following investigation dry coal samples have been used, so that the formula under examination becomes :—

$$V_2 = 100\,v/(100 - a) \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where v is the percentage of volatile matter and a the percentage of ash in the crude dry coal.

Equation (2) takes no consideration of the fact that incombustible volatile products are usually evolved from the incorporated mineral matters (such as hydrated silicates of aluminium) when they are heated to incandescence in the absence of air. In such cases, the yield of volatile matter from the coal naturally appears to increase as the ash content rises, since increasing quantities of water of hydration of mineral matter are accepted as volatile constituents of the coal substance. Reference may be made to column six of Table III. which illustrates the application of equation (2) and the consequent apparent abnormal increase in the volatile content of the coal.

Furthermore, the ash constituents, whether introduced as mineral matter inherently present in the plant residues from which the coal was formed or as extraneous inorganic compounds incorporated with the coal substance, are regarded as identical compounds. The former quantity is, however, so small that only a very minute error is made in classing all the mineral matter together.

For an average sample of mined coal little variation is observed in the volatile content of the pure coal substance throughout the seam, but if the sample is separated into fractions differing only slightly in specific gravity, a considerable divergence results. This has been shown to be due to a variation in the proportion of the different banded constituents of the coal in the samples.

Volatile matter and ash contents of coal yielding a small ash.

The coal studied was a Notts. hard (steam) coal. A large block was cut into pieces of about 2 cm. size, which were separated by flotation in a series of mixtures of alcohol and chloroform into fractions of increasing specific gravity (*cf.* Blyth and O'Shea, Trans. Inst. Min. Eng., 1919, **57**, 261).

Ten samples having specific gravities ranging from 1·250 to 1·300 and increasing by regular intervals of 0·005 were secured. These ten samples constituted 85% of the original coal, and it was found that no visibly clean coal remained having a specific gravity higher than 1·300. The samples were dried in the steam oven to remove chloroform and alcohol, and powdered to pass a 30-mesh sieve.

The volatile matter and ash contents and the true specific gravity were determined for each of the ten samples after drying in a steam oven for 3 hours, and cooling in a desiccator over sulphuric acid. This method of drying was found by preliminary experiments to yield, in the case of the particular coal studied, results identical with those obtained by drying for a considerable time over sulphuric acid at the ordinary temperature.

True specific gravity.—The true specific gravity of each coal sample was determined in an ordinary specific gravity bottle, using air-free distilled water. The work of Drakeley and Jones (J., 1923, 163T) indicates that, for pieces of coal of moderate size, saturation is most easily effected by immersing in boiling water for a minimum period of one hour and a quarter. In the case of coal powdered to pass a sieve of 30 meshes to the inch, it was found sufficient to treat the coal for half an hour with boiling water, before determining its true specific gravity.

Determination of the volatile matter.—The method employed was that of Bone and Silver (Chem. Soc. Trans., 1921, **119**, 1145), which had been shown to yield results of high accuracy. It was found necessary to raise the temperature very gradually to prevent explosive evolution of the volatile matter from the coal. The temperature was maintained at 900° C. for about 7 hours to ensure complete elimination of the volatile matter.

Ash content.—The coke samples obtained in the previous determination were powdered to pass a 30-mesh sieve, dried for a short time in the steam oven, and incinerated in open porcelain dishes in a gas-muffle furnace for 3 hours, at the maximum temperature of the furnace (910° C.).

The results of the above determinations are given in Table I.

Throughout the paper the significance attached to each of the following symbols is :—

p = percentage of volatile matter yielded by dry shale.

v = percentage of volatile matter in dry crude coal.

a = percentage of ash yielded by dry crude coal.

V = percentage of volatile matter on ash- and moisture-free basis (calculated).

The number affixed to V (*e.g.*, V_2) indicates the equation used in the calculation.

TABLE I.

No.	Specific gravity. Apparent.	Specific gravity. True.	Volatile matter in dry coal. v%.	Ash on dry coal. a%.	Ash and moisture free basis. V_2.
1	1·255	1·322	34 43	1·30	34 89
2	1·260	1·325	34 82	1·02	35 18
3	1·265	1 335	31·37	1·32	31 79
4	1·270	1·332	30·68	0 97	30 98
5	1 275	1·348	31 17	1·09	31 52
6	1·280	1·343	27·43	1·83	27·94
7	1·285	1·348	28·62	2 92	29·48
8	1·295	1·347	31·82	2·41	32 96
9	1 300	1·347	30 67	2 01	31 30

The volatile matter content, V_2, of the ash-free ry coal shows a considerable variation, to an xtent which cannot be accounted for even by any rror in the accuracy of the equation.

Samples 1 and 2 were characterised by low specific ravity, low ash content, and high volatile matter. 'hey yielded good cokes. The colour of the ash 'as red-brown in each case, but a few white particles 'ere present. On the other hand, samples 6, 7, 8, nd 9 possessed relatively low volatile matter and igh ash contents and high specific gravity (nearly onstant at 1·348). They yielded poor cokes and he ash was almost white in colour.

It was thought that the anomalous results given ı Table I. might be attributed to the varying uantities in each sample of the four ingredients f banded bituminous coal (see Stopes, Proc. oy. Soc., 1919, **B 90**, 470).

Tideswell and Wheeler have shown (Chem. Soc. rans., 1919, **115**, 619) that the bright constituents f bituminous coal (clarain and vitrain), isolated y Stopes from the thick seam (Hamstead Colliery), ssess specific gravities markedly lower than that the dull variety (durain). In addition, the bright oal has lower ash and higher volatile matter contents han the dull coal.

Accordingly, the Notts. hard coal was examined, nd samples of the four ingredients separated from ;, following the procedure prescribed by Stopes *loc. cit.*). The chief constituents were durain and larain, a small proportion of vitrain being interanded with the clarain in layers about 5 mm. in hickness. Very little friable fusain was found ut a quantity of the hard variety of fusain recently escribed by Sinnatt (Trans. Inst. Min. Eng., 1922, **2**, 156) was separated and analysed. The amount this fusain, chiefly associated with durain, was tremely difficult to determine.

In Table II. the properties of these constituents e given. There is a marked parallelism with deswell and Wheeler's figures (*loc. cit.*, p. 630). ıe clarain yielded a brownish-red ash, vitrain own, durain pure white, and fusain (friable riety) pale grey.

TABLE II.

	Specific gravity Apparent.	Specific gravity True	Moisture. %	V. %	a %	V_2. %
rain	1 291	1·343	7 02	29 30	0 80	29 57
raln	1 248	1 301	4 06	34 14	0 79	34 42
rain	1·257	1 345	2 50	32 00	2 78	33 00
saln	—	1 558	1·54	13 32	11 3	15 00
saln (hard)	—	1 452	2 06	13 67	5 38	14 45

A comparison of the results given in Tables I. nd II. shows that samples 1 and 2 of Table I. consted mainly of clarain, samples 6, 7, 8, and 9 of ırain with varying amounts of fusain. A fairly good separation of this particular coal into its two most important constituents, clarain and durain, may thus be readily effected in the laboratory by a carefully regulated flotation process.

This conclusion agrees with Lessing's work (Trans. Inst. Min. Eng., 1921, **60**, 288) on the separation of a coking slack from South Yorkshire into two fractions, by flotation in mixtures of carbon tetrachloride and petroleum spirit of d 1·35 and 1·50 respectively (*cf.* also Beet and Findley, *ibid.*, 1921, **60**, 213; Küppers, Glückauf, 1916, **52**, 599).

Conclusions.

As a result of the examination of samples of clean coal from the same seam of increasing specific gravity, it has been shown that the volatile matter content on an ash- and moisture-free basis does not admit of mathematical treatment. The difficulty is due to the separation of the coal sample into fractions containing varying proportions of the four different banded ingredients of the coal substance.

Relation between volatile matter and ash contents of coal yielding a high percentage of ash.

An examination of a large bulk sample (2 tons) of the same coal (Notts. hard steam coal) as used in the earlier part of the work, showed that it

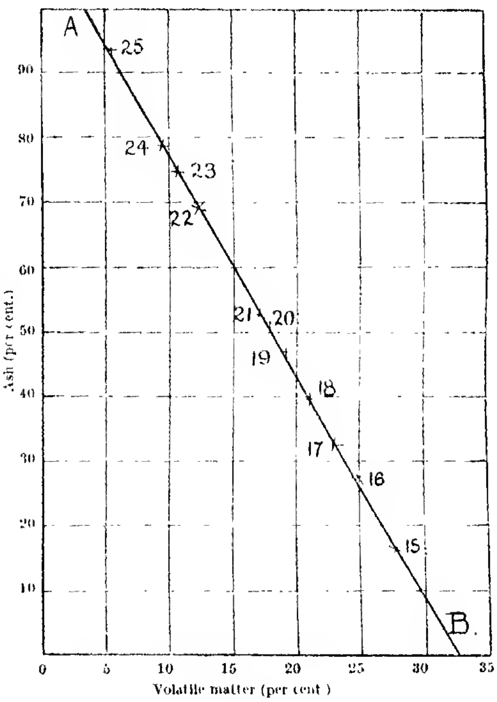

FIG. 1.

contained so small a proportion of inorganic partings, consisting chiefly of calcium carbonate (*cf.* Sinnatt, J., 1921, 1 T) with a mere trace of iron pyrites, as to render their determination impossible. The ash-

producing impurity consisted almost entirely of shale, apparently from the roof and floor of the seam. The iron pyrites was kept for the final experiments.

A sample selected for examination was considerably interbanded with shale. It was cut into roughly cubical pieces of about 2 cm. size, and experimental data for 10 fractions of specific gravity ranging from 1·35 to 2·25 were compiled (see Table III.). The colour of the ash from the 10 samples was a uniform very pale brown, indicating the absence of appreciable quantities of iron.

TABLE III.

No.	Specific gravity Apparent.	True.	v %	a %	V_1 %	V_2 %
15	1·387	1·410	27·87	16·12	33·23	32·54
16	1·481	1·543	24·60	27·52	34·08	32·74
17	1·515	[illegible]	23·06	32·83	34·33	32·62
18	1·610	1·671	21·17	39·54	34·90	32·70
19	1·701	1·782	19·10	46·97	36·02	32·94
20	1·758	1·817	17·81	51·60	36·80	33·09
21	1·770	1·877	17·05	62·90	36·20	32·91
22	2·015	2·121	12·36	69·08	39·96	32·11
23	2·117	2·264	10·10	75·81	42·99	31·93
24	2·216	2·315	9·59	78·97	45·60	32·45
25	—	2·764	5·12	93·96	—	—
					Average	32·60

The figures for the volatile matter of the "pure coal" (V_2) contained in the samples steadily increased in an unaccountable manner.

The exact relation between volatile matter content (v) and ash content (a) is shown in Fig. 1. The points in the graph which are numbered to agree with the reference numbers of Table III. lie on or close to the straight line AB. The volatile matter content of the pure coal of zero ash content is found by extrapolation from the graph to be 32·6%. This value is close to that previously obtained for durain (Table II.).

A sample of almost pure shale was obtained, and is represented on the figure by the point numbered 25. It appears from the regularity of the graph that the samples consisted of mixtures of shale and pure average coal, and consequently a formula may be developed to express the relation between the volatile matter and ash contents of the coal.

Thus if x is the percentage of pure coal and p the percentage yield of incombustible volatile matter from the shale, the following equation may be deduced :—

$$V_2 = [v - ap\,(100-p)]/[100 - a - ap/(100-p)] \quad \ldots\ldots\ldots (3)$$

The pure coal substance is assumed to possess a negligible ash content. For vitrain and clarain (see Table II.) this statement is true, whilst Lessing (Chem. Soc. Trans., 1920, 117, 256) has shown that the mineral ingredient of durain and fusain is of similar constitution to shale, and therefore it is correct to regard durain and fusain as mixtures of a pure organic substance with shale.

Equation (3) represents a straight line graph and can therefore be made to apply to the line AB (Fig. 1) by suitable adjustment of the constant p. From the position of the line AB, the value of p is 4·93%. This value agrees fairly well with the direct determination of the volatile matter of the purest sample of shale discovered in the mined coal (5·18%). Even this sample must have contained a little carbonaceous matter which, however, was invisible. Tests proved the absence of a mineral carbonate in the sample of shale, so the difference in the two values cannot be ascribed to this impurity.

By substitution of the result 4·93 for p in equation (3), the volatile matter content of the pure coal in each sample (V_2) was calculated, and the values are given in Table III. The results for the percentage of volatile matter in the pure coal are now constant and therefore formula (3) is suitable for calculating the volatile matter content on an ash-free basis.

To correct the results for moisture it is necessary to subtract w from the numerator and from the denominator in equation (3).

The volatile matter content of shale.

The percentage loss of weight (p) when shale is heated appears to be subject to greater variation than was at first anticipated. Parr (*loc. cit.*) accepts a constant value of 7·4% for p. Drakeley (Trans. Inst. Min. Eng., 1918, **56**, 52) found that for Lancashire shales, the loss on heating air-dried samples averaged about 9·5%, and subsequent experiments show that, after more complete drying such as was resorted to in this investigation, the loss was reduced to about 7·2%. Küppers (*loc. cit.*) calculated the value of p as 6·8% for Westphalian shales.

In the present investigation, however, the incombustible volatile constituents of the shale only amounted to 4·93%. The results may be exceptional, but sufficient evidence has not been obtained for definite statements to be made.

Relation between volatile matter and ash content in the presence of pyrites.

For a mineral impurity which loses weight on further open ignition after all the volatile matter has been evolved by heating in the absence of air (*e.g.*, pyrites), a modification in equation (3) becomes necessary.

The amount of pyrites present in a coal sample is usually not large, but it is not regularly distributed throughout the coal.

The following values (averages of six determinations) for the volatile matter and ash contents were obtained by igniting a sample of pyrites in the absence and presence, respectively, of air; "volatile matter" content, 16·70%; ash content, 67·42%; from which it was calculated that the percentage of pure iron pyrites (FeS_2) in the original sample was 89·3%. The sample contained 42·61% of iron, corresponding to 91·3% of FeS_2.

The impurity present in the pyrites amounted to 8·7%, and assuming that the "volatile matter content" of pure iron pyrites is 17·78% and of the original sample 16·70% the volatile matter content of the impurity is 5·4%, that is, its ash yield is 94·6%.

Since the ash yield of dry shale from this seam amounted to 95·07%, it would appear that the impurity in the sample of pyrites was shale. Hence the experimental data for mixtures of coal and iron pyrites will require correction for the shale present in the iron pyrites.

Formula (3) may be modified to include iron yrites as well as shale as a possible impurity in ie coal by subtracting $f\{0{\cdot}38\text{–}1{\cdot}38\ p/(100\text{-}p)\}$ from e numerator and $f[0{\cdot}76\text{–}1{\cdot}38\ p/(100\text{-}p)]$ from the nominator, where f is the percentage of iron in e original coal.

The use of this modified equation gave a value f 32·69% for the volatile matter content of the coal, hich agrees well with the value of (32·60) given Table III.

The equation may be expressed in terms of the ercentage of sulphur (s) in the coal, although this alue will now include the "organic" sulphur. t will then be necessary to replace f by s, 0·38 by ·44, 0·76 by 0·87, and 1·38 by 1·58.

For ordinary industrial purposes it will probably e sufficiently accurate to use the value 0·075 for $p/(100\text{-}p)$. In each case, the validity of the equation ests on the assumption that the iron pyrites burns ompletely to iron oxide, and that no sulphate emains in the ash. A slight retention of the sulphur n the ash would not appreciably affect the equation. ncidental experiments seemed to show that at 10° C. little sulphate remains in the ash and, furthernore, a high percentage of silica in the ash appaently tended to prevent the formation of sulphate ven when calcium carbonate was one of the subtances in the original mineral matter.

Summary.

(1) The volatile matter contents of samples of lean coal do not admit of mathematical treatment wing to the fact that the sample may be composed f any one, or any mixture, of the four different anded constituents of the coal.

(2) An equation is given for calculating, on verage samples of dry coal containing no iron yrites, the volatile matter content of the coal on n ash-free basis.

(3) The percentage of volatile matter yielded by lry shale appears to vary considerably. The variaions may be due to the different methods employed n the initial drying of the shale.

(4) For crude coal samples, containing iron pyrites and other impurities such as shale, modified equations are given for calculating the volatile matter content of the coal on an ash-free basis.

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TRAVANCORE ESSENTIAL OILS.—I. OIL FROM THE SEEDS OF *ELATTARIA CARDAMOMUM* (CARDAMOMS).

BY K. L. MOUDGILL, B.A., B.SC., A.I.C.

Three varieties of cardamoms, viz., the "wild," the "Malabar," and the "Mysore," are available in Travancore. The plant occurs in its wild state at high elevations, in almost all the interior and evergreen forests. The other two varieties are cultivated. Most of the plantations containing the Malabar variety were started originally with the cuttings taken from the wild plants and, therefore, these varieties resemble each other.

A fourth variety, called the "Hybrid," has recently been noticed on plantations where the "Mysore" and "Malabar" grow side by side. No attempt has, so far, been made to cultivate this variety.

A sample of cardamom oil of unknown origin received by the author in August, 1922, from the Director of Industries, was a light yellow, viscous liquid, with an odour of cardamoms, but its constants were outside the limits recorded for normal oils (Table II., column 6). With a view to ascertain the variety from which the oil had been distilled, a comparative study of the oil from the seeds of the three varieties was made, and has shown that the constants of this oil agree with those of the oil from wild cardamoms. Analysis has further shown that, besides the known constituents, the Malabar and Mysore oils contain in the combined state, a small quantity of an acid (mol. wt. 182) having a strong odour of cumic aldehyde.

The fruits (about 5 lb. each of Mysore and Malabar cardamons, and ½ lb. of wild cardamoms) were received two months after plucking, and the oil from these was obtained within a week after their arrival. The fruits were husked, the seeds crushed in a coffee-mill and distilled with steam. The use of an oil bath and of superheated steam (170°–180°) was helpful. Table I. gives the characters of the fruits and the seeds of the different varieties of cardamons, and Table II. gives the constants of the oils immediately after distillation and on keeping.

TABLE I.

	Malabar.	Mysore.	Wild.
Average length of fruit	1·87 cm.	2·1 cm.	1·91 cm.
Weight of seeds	78·9%	72·3%	73·3%
Weight of husk	21·1%	27·7%	26·7%
Volatile matter in crushed seeds	19·0%	18·3%	20·0%
Ash	3·9%	6·05%	4·3%
Yield of oil on dry seeds	8·1%†	7·3%†	6·1%*

† On 400 g. (average of several distillations).
* On 200 g. (one distillation only.)

TABLE II.

	Malabar.		Mysore.		Wild	Industries Department sample		Parry.	Simmons.*
	Fresh	After 10 months	Fresh	After 10 months	Fresh	After 12 months	After 18 months.		
d^{30}_4	0·9213	0·9550	0·9210	0·9300	0·9320	0·9459	0·9820	0·923 to 0·947	0·9352
α_D^{30}	+20·3°	+15·8°	+28·8°	+26·6°	+35·0°	+32·71°	+24·2°	+24° to +48°	+28° 21'
n_D^{30}	1·4580	1·4660	1·4575	1·4665	1·4620	1·4650	1·4672	1·462 to 1·467	1·4617
Acid value	6	12·0	—	3·2	1·3		16	1 to 4	
Ester value	121	132	144	149	180	188	192	90 to 150	144·2
Ester value after acetylation		—	163	—	—	216·3	210		—
Solubility in 70% alcohol	2·2 (†) vols. 4·4 ,,	incomplete	3 vols.	2 vols.	1·1 vol.	1·2 vols.	1·2 vols.	2 to 5 vols.	incomplete
76% ,,	1·3 vols. 2·4 ,,	1 vol.	in all proportions	—	—	—	—	—	1 vol.

* These figures are taken from a certificate by W. H. Simmons to Essenflour Products, Ltd., and published in the *Perfumery and Essential Oil Record*.
† The oil dissolves in alcohol but turbidity reappears on adding more alcohol. The lower figures give the volumes at which turbidity reappears.

The Mysore and Malabar cardamom oils thus fall within the limits of known oils, but the oil from wild cardamoms is abnormal. The constants of the fresh oil from the latter agree very closely with those of the sample received from the Industries Department, and it is, therefore, concluded that the sample under examination had been obtained from the wild seeds. Further, the constants of the oils from Mysore cardamoms grown in Travancore, and those grown in Mysore (compare Simmons, Table II.) agree very closely. The Malabar oil was more penetrating in odour than the Mysore oil.

Aqueous distillates.—The chloroform extract of the aqueous distillate from Malabar oil yielded a small quantity of an oil ($n_D^{28} = 1{\cdot}4620$) which deposited crystals of borneol, m.p. 198°. The aqueous distillate from Mysore oil yielded traces of an oil but no borneol.

Combined acids.—The Malabar oil was saponified with alcoholic caustic potash, the alcohol evaporated off, and the residue extracted with water; the aqueous extract was washed with ether to remove adherent oil, acidified with excess of dilute sulphuric acid and distilled with steam. An oil, with a very strong odour of cumic aldehyde, was recovered along with the aqueous distillate. The latter did not give a positive test for formic acid (*cf.* Parry "The Chemistry of Essential Oils," Vol. I., p. 104), and was shown to consist entirely of acetic acid.

The oily acid which possessed the odour of cumic aldehyde could not be purified easily, and has not yet been identified. It yielded a silver salt containing 37·3% Ag (mol. wt. = 182 if the acid is monobasic). The Mysore cardamoms also gave a very small quantity of the same oil.

Examination of the oil.—The residual oil after saponification had a very strong odour of the lily of the valley. Distillation under atmospheric pressure yielded the following fractions :—

No.	B p.	Yield. %	n_D^{28}	a_D^{28}	d_4^{28}
1	Up to 180° ..	37	1·4640	+25·2°	0 8609
2	180°–230° ..	52	1 4730	+46·5°	0·9325
3	Above 230° ..	3	1·4830	—	—
4	Residue by difference ..	8	—	—	—

Fraction 1 was suspected to contain cineol. On shaking with a 50% aqueous solution of resorcinol the absorption was 15–16%. The resulting oil had

$$a_D^{28} = 28{\cdot}25°, \quad n_D^{28} = 1{\cdot}4650, \quad d_4^{30}\ 0{\cdot}8532.$$

These constants agree to some extent with those of sabinene, but an attempt to prepare the solid glycol $C_{10}H_{16}(OH)_2$ was not successful.

Fraction 2 consists almost entirely of terpineol, as shown by the constants, by the odour, and the melting point of the compound with hydriodic acid prepared in the usual manner.

The composition of the oil from the Malabar cardamoms of Travancore, indicated by this work, does not differ from that described by other authors. Mysore cardamom oil also gives similar results. Unfortunately, the wild cardamoms were not available in sufficient quantity for complete analysis of the oil.

Summary.

1. The oil from wild cardamoms gives an abnormally high ester value.
2. The Malabar cardamom oil contains borneol, terpineol, cineol, and sabinene (?), together with esters of acetic acid and another acid (mol. wt. = 182?) having an odour of cumic aldehyde.
3. The Malabar and Mysore oils contain the same constituents.
4. The constants of the Malabar and Mysore oils, most noticeably the refractive indices, alter appreciably on storage.

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THE TECHNOLOGY OF CANNING.*

BY OSMAN JONES, F.I.C.

In the year 1810 M. Appert succeeded in nning a prize of 12,000f. offered by the French vernment for the invention of the best method of eserving fruits, vegetables, and the like. In 09 an English tin-plate worker took out a patent a vessel of tin-plate for the preservation of foods. America the canning industry was started in 0 by Underwood and Mitchell, who packed certain its, and also by Daggett and Kensit of New York, o canned salmon and other fish. The canning lustry proper may be said to have started in gland about 1900; prior to this time it had been ried on in a small way. A great impetus was given the industry by the war. America has always the way, and many of her methods and much of ingenious machinery have been adopted in this ntry.

In a factory with a considerable turnover the tin can is usually manufactured on the premises. The -plate must be carefully selected and should possess uniform coating of tin, the thickness of which, thin reasonable limits, is not of undue importance far as meat products are concerned; a suitable ecification for preserving containers in 0·75 gram r sq. dm. A research by the technical staff of National Canners' Assoc. (U.S.A.) has shown that the case of acid fruits the thickness of the tin ating on the plate has a considerable bearing on perforation of the plate; in general, the thicker coating the less liable is the container to perfora- n. Further research is being carried out to ertain what bearing, if any, the method of manu- ture of the steel plate has upon the quality of tin.

It is not possible to obtain tin-plate with an solutely uniform coating of tin. So far as meat oducts are concerned, the quality of the tin-plate as an important bearing upon the appearance and quality of the finished article. It should be free rom pinholes, and entirely covered with tin, because f the meaty matter comes into contact with iron luring the process of cooking, discoloration will ake place. A suitable test for the plate is as follows: A few sheets of tin-plate are selected at random rom each consignment, and are flooded with an lmost cold 3% solution of potassium ferricyanide ontaining about 10% of gelatin. If blue spots of errous ferricyanide develop in the gelatin, the onsignment is rejected as unsuitable. The size of he spots gives no true indication of the dimensions f the surface of the iron which has been improperly oated with tin.

Cans are usually of two kinds: (1) the "sanitary" or solderless can; (2) the hole-and-cap can. The former kind is coming into almost universal use where possible; it possesses the advantage that it is not soldered on the inside joints, and therefore no solder or flux can come into contact with the food material, and also it is more economical to handle in the factory. The hole-and-cap can is usually soldered in most of its joints, the lid being soldered on after the can has received its contents. A small hole is left in the centre of the lid for the escape of gases during the preliminary process of cooking. On the underside of the lid, immediately beneath the hole, a small disc of metal is soldered; this acts as a screen to prevent, as far as possible, any solder coming in contact with the food by dropping through the hole during the final process of sealing. Some manufacturers prefer this variety or can, since the food is partially cooked before the can is finally sealed, some of the gaseous products produced by cooking escape, and it is possible to obtain a more perfect exhaust. The author has experience of both kinds of container, and, in his opinion, the sanitary can is more suitable in the majority of cases

In making the sanitary can, the body is cut out to size and the piece of plate passes to the body maker, where it is turned into shape, and a single flange stamped upon it. It then passes through the soldering bath, where a thin film of solder is run on the outside of the joint. This is the only place where solder is used in the manufacture of this type of can, and then only on the outside. The lids and bottoms are stamped out on a separate machine, and a very small quantity of sealing fluid is auto- matically run into the outer flange; the bottoms and lids then pass to the drying stove, where all the solvent of the sealing fluid is driven off. The bottoms are attached to the body by means of a double seam, the edge of the body resting on the small cushion of rubber formed by the evaporation of the sealing fluid. In this way a perfectly airtight joint is pro- duced. Special attention must be given to this joint; if satisfactorily made it should be U-shaped. In order to test whether the can is sound, it is mechanically filled with compressed air and passed under water; if it be a "leaker," air bubbles are seen to escape, in which event the can is rejected. The lid is, of course, not placed upon the can until it has been filled.

Great care is necessary in the selection of the sealing fluid. It should consist of a solution of rubber in a light solvent such as benzene, b.p. 70°–90° C. If the solvent used has a boiling point above 100° it may not be entirely volatilised in the drying oven, and as a consequence is liable to contaminate the contents of the can. Even a minute trace of this solvent imparts a most disagreeable flavour to the

* Read at a meeting of the Bristol Section on Jan. 3, 1924.

food, and the unpleasant "tinny" flavour of some tinned goods may occasionally be traced to this cause. The cans should be passed through a washing machine before being filled.

The lay-out of a canning factory must depend to a large extent upon the kind of articles to be handled, but in all cases the factory should be so constructed that it can be kept scrupulously clean, and that raw material can be dealt with rapidly after its receipt.

For the production of tinned meats the following departments are required :—

(1) Slaughter department.
(2) Cooling room and curing cellars.
(3) Kitchen where the blanching and preparation of the meats is carried out.
(4) Exhausting, retorting, and cooling.
(5) Lacquering, labelling, packing, and despatching.
(6) The laboratory.
(7) Can-making department, in some factories.

In the kitchen preparation of soup stocks, boning and cutting of meats, and the filling of the cans are the chief processes conducted. The importance of the use of fresh and clean material cannot be too strongly emphasised. Many of the difficulties of the manufacturer are brought about through the lack of sanitary methods in the handling of the articles that are to be turned into food. The greater the bacterial contamination of the article, the more difficult it becomes to put up from it a satisfactory and sterile product.

The filled tin is conveyed by automatic means from the kitchen. Its contents are hot, the temperature depending to some extent upon the nature of the article, but as a rule the nearer to boiling point the better. In order that the space between the contents and the lid shall contain as little air as possible, the can is passed through a machine which gives a single turn to the flange on the body and the flange on the lid ; the lid is now held fast to the can, but an air-tight joint has not been made. The can then proceeds through the exhaust chamber, which consists of a slowly-moving endless belt passing through a steam-heated area. By this means the contents of the can are brought to as near the boiling point as possible. At this stage the can has the lid finally sealed by means of machinery, and is now ready for the cooking or processing, whereby sterilisation is effected. A hole-and-cap can is filled in the kitchen and the lid soldered on. It is then exhausted by a partial cooking in the retorts, taken out, sealed, and again retorted for its final process. In some canneries the exhaust is brought about by passing the cans into a vacuum plant, the lid being sealed on the can during the time that it is under reduced pressure. Such a method is applicable to sanitary cans only.

The operation of exhausting is of considerable importance ; an imperfect exhaust will tend to produce discoloration, and will materially assist decomposition by enabling aerobic bacteria to multiply. Finally, a faulty exhaust will prevent the tin showing a good collapse when cool so that it might be mistaken for a blown tin.

It is now the custom in the trade to mark the lid of every can with a private code, which shows the date of manufacture, and the nature of the contents of the can, so that every separate lot put up can be traced and identified.

Retorting.—This is one of the most important steps in the manufacture, and upon it depends to a large extent the quality of the finished article, and also its keeping properties.

The retort consists of a direct-steam-heated vessel, the steam entering at the bottom. It is usually circular in form, but may be rectangular. In either case the tins are loaded on to trays which fit the retort. It is then filled, the lid screwed down, and the steam turned on. Each retort is fitted with at least one thermometer and a steam-pressure gauge. The temperature is raised to the required point, and maintained for the necessary length of time to bring about the desired result. The regulation of the temperature is usually effected by means of an automatic pressure control on the steam supply pipe.

In some American canneries continuous cookers are used. In this type of machine the cans pass through a steam-heated chamber and receive gentle agitation during their passage. It is claimed by the makers that the use of the continuous cooker reduces the time of cooking. The length of time of cooking can be regulated by altering the rate of the travelling belt with which the retort is fitted.

Immediately the process is completed the tins are cooled below the cooking point, to about 60° C. A lower temperature than this is not desirable, as the tins should be warm for lacquering. The cooling is brought about in one of the following ways : either the retort is flooded with cold water, or the trays of tins are removed and placed under a cold water spray, or immersed in a tank of cold water. The tin is then lacquered—an operation which, in large factories, is carried out mechanically—and labelled and packed for despatch.

The laboratory.—Here are carried out the usual routine examinations of all the raw food materials, and also the tin-plate, solder, flux, sealing fluid, etc., used in the manufacture of the can. To ascertain that the finished article is in a sterile condition before release to the public, sample cans drawn from each batch manufactured are treated as follows : A fair proportion, say 10% of the batch, is placed in a chamber, the temperature of which is maintained at 37°—40° C. for at least 14 days, and the number of "blowers," if any, is noted. Further sample cans are tested for sterility by incubating for at least 8 days at 37° C., by which time any spores which may be present will have probably germinated. No hard and fast rule can, however, be laid down, as it has recently been shown that the spores of *B. botulinus* can remain dormant for a period of 400 days, and probably longer. After incubation the top of the tin is sterilised by burning upon it some methylated spirit or by heating it with a Bunsen flame, the lid is pierced with a sterile awl through the flame, and the awl quickly withdrawn before the flame is removed, thus preventing a rush of unsterile air into the tin. A sterile platinum needle is then inserted

into the contents of the can, and a loopful of the material placed in a tube of sterile culture medium, such as nutrient broth, which is incubated for 48 hours at 37° C., and its appearance noted. If the familiar turbidity indicating non-sterility is noted, it is sometimes desirable to make a bacteriological examination with a view to trace the cause of the trouble.

Heat penetration.—One of the difficulties that the ner has to overcome is to render his products rile without overcooking them. The length of cooking process depends largely upon two factors he period required for the heat to penetrate to centre of the contents of the can, and the thermal th point of the bacteria with which the food erial is likely to be contaminated. The shorter time and the lower the temperature at which possible to process, the better will be the quality the finished article, always bearing in mind the important factors mentioned above. To deter- e the rate of heat penetration, a thermo-couple y be fixed in the centre of the can and connected h a recording instrument through the lid of an oclave. The temperature of the autoclave is d as quickly as possible to the agreed point and time required for the centre of the contents of can to reach this temperature carefully recorded. result is then plotted in the form of a curve. ther method is to fix the bulb of an accurate rmometer in the centre of the contents of the n, make an air-tight joint through the lid of the n and also through the lid of the autoclave, raise e temperature of the latter as rapidly as possible, d again record the readings. The second method ntioned is more troublesome to manipulate but es equally reliable results.

The determination of heat penetration becomes re difficult when the contents consist of a mixture large particles of solid matter in a liquid, such as at and vegetable rations. Under these circum- nces it is best to fix the thermo-couple in the ntre of the largest portion of solids present, and arrange the contents of the can that this large ece of solid is itself in the centre of the can. The eat penetration can then be determined in the sual manner.

The type of bacteria likely to be encountered aries considerably, and the different classes possess lifferent thermal death points. The thermal death oint depends upon the nature of the organism itself nd on the kind of material in which it is existing. s a general rule sporulating species are the most esistant to heat; the spores require either a higher emperature or the same temperature for a con- iderably greater period than do the living organisms n order to reach their thermal death point.

Meyer has shown that the spores of *B. botulinus* ossess thermal death points as follows :—4 minutes t 120°, 10 minutes at 115°, 33 minutes at 110°, 00 minutes at 105°, 330 minutes at 100° C. Bigelow as stated that sporulating organisms will not grow n acid media, such as tinned tomatoes, and that a emperature of 100° for a short period is sufficient o destroy spores in tomatoes and acid fruits. It is, therefore, unnecessary to process these articles at such a high temperature, or for such an extended period as that employed for meat products which are not highly acid in reaction.

Provided the exhaust has been properly carried out, the presence of true aerobes in the finished article is not of such importance, as they will not readily develop in the absence of atmospheric oxygen.

Among the organisms which are sometimes the cause of spoilage unless removed by sterilisation, are the thermophilic bacteria which grow at a temperature of about 33°–55° C. If present in a can which is stored in a hot place they will ultimately develop.

It is quite possible for a can to remain in a fresh condition although not sterile, conditions such as acidity prevent development of the organisms, or the can may be stored at a low temperature which will not favour the growth of thermophilic bacteria. A canner should, of course, endeavour to render all his pack sterile, and in any case must make certain that the articles does not contain spores of any anaerobic bacteria.

It is not practicable to make a bacteriological examination of every consignment and variety of raw material, and as some sporulating organisms possess a heat resistance at least equal to that of *B. botulinus*, the meat canner has perforce to work to high temperatures, or use a prolonged process to ensure producing an article that will keep for an indefinite period.

For example, suppose in working with a temperature of 100° C. that it required 60 minutes for the heat to penetrate to the centre of the can so that it reached boiling point, then to ensure sterility the can would have to be maintained at this temperature for an additional 330 minutes. With higher temperatures the length of time required decreases. The temperature at which sterilisation is effected depends on the nature of the article and on the species of the organisms present, but it is seldom practicable to work with such a low temperature as 100° C., although in some cases it may be necessary. The author's own experience is that in arriving at the necessary process for any particular material, it is always desirable to maintain the temperature for at least an extra 10 minutes beyond the time found for the heat penetration. This extra period may be regarded as a margin of safety.

It is sometimes necessary to determine the amount of vacuum in a can. For this purpose an instrument, the invention of which is due to Young, is employed, consisting of a small vacuum gauge fitted with a perforated pin and a heavy rubber gasket. The can is punctured by forcing the pin through the end, and the vacuum registered on the gauge is noted.

To examine a can which is proved to be unsterile for anaerobic bacteria the method of Novy may be used. This depends upon the cultivation of bacteria in a vessel containing alkaline pyrogallol.

The absence of a blown appearance of the tin does not necessarily indicate sterility; certain kinds of

bacteria do not generate sufficient gas to cause the tin to bulge, and sometimes the tin may contain a small hole which will allow the gas generated to escape. The fact, therefore, that a batch of tins may pass an incubation test satisfactorily does not necessarily mean that they are fit for shipment, and a laboratory examination is essential.

Discoloration.—Meat products which contain spices are very liable to discoloration in the presence of iron. This may to some extent be attributed to the fact that spices always contain tannin, which combines with the iron to form iron tannate. Copper is also frequently the cause of discoloration, particularly in the presence of sulphur compounds, when copper sulphide may be formed. The use of imperfect tin plate is, therefore, to be carefully avoided, as should the food come in contact with iron, discoloration is almost certain to occur. The author has also met cases where discoloration has taken place through the use of copper cooking pots. A third metal which causes this kind of trouble is lead; this is not likely to be present in canned food, but is sometimes met with in the hole-and-cap can through the use of solder.

Metallic contamination.—It is occasionally necessary to examine the contents of a can for lead and zinc, both of which may be present through the use of solder on the inside of a can, and a zinc salt as a flux. For this purpose the methods recommended by Leach in "Food Inspection and Analysis" are satisfactory.

Tin is always present to some extent in the contents of a can, and the author has never yet examined one without finding at least a trace. The tin is usually present as an insoluble salt, and the amount found is higher in the drained solids than in the liquor, although some cases have been known where all the tin present has been in solution. The reaction between the foodstuff and the tin seems to take place most rapidly during the time of processing or cooking, that is when the highest temperatures are reached, and in the case of meat products it seems almost to cease after about four months. The following figures, obtained with a 1 lb. tin of brawn, will make this clear:—

After 48 hours	0·001% Sn
,, 7 days	0·001% ,,
,, 28 ,,	0·0012% ,,
,, 84 ,,	0·0017% ,,
,, 168 ,,	0·0019% ,,
,, 2 years	0·0021% ,,

So far as can be ascertained there is little or no direct evidence that the small amount of tin salts usually found in the food contents of a can can be regarded as poisonous The danger, therefore, that arises from this cause may be regarded as negligible.

THE DETERMINATION OF ACETIC AND BUTYRIC ACIDS.*

BY ERNEST FYLEMAN, B.SC., PH.D., F.I.C.

It is usual in the examination of fermentation products to distil the volatile acids after acidification with sulphuric or phosphoric acid; the total acidity of the liquid so obtained is then found by titration with standard alkali, using phenolphthalein as an indicator. The acetic acid in such products is generally accompanied by a certain quantity of butyric acid, the determination of which by ordinary methods is difficult. The determination of the equivalent weight by means of the barium or silver salts does not give satisfactory results as neutral barium salts decompose, possibly by hydrolysis, on evaporation of the solution, and the silver salts deposit metallic silver under such conditions.

It has been found that butyric acid can be determined in such liquids with a considerable degree of accuracy by boiling with excess of potassium dichromate in a sulphuric acid solution of definite strength. Under such conditions butyric acid is oxidised to acetic acid and carbon dioxide, and reduces the dichromate to the extent of the equivalent of 6 atoms of oxygen. Propionic acid acts similarly, exercising a reducing action equivalent to 3 atoms of oxygen, whilst acetic acid remains almost unattacked. A correction is necessary for the reducing action of the acetic acid, whether originally present or produced by the oxidation of its homologues.

The distillate containing volatile acids is titrated as usual with $N/4$ sodium hydroxide in the presence of a minimum quantity (2 drops) of alcoholic phenolphthalein solution of the usual concentration. It is then boiled down to half bulk in order completely to remove the alcohol from the phenolphthalein solution, and subsequently diluted to such an extent that 20 c.c. of the liquid correspond to approximately 1 c.c. of $N/4$ sodium hydroxide solution.

To 20 c.c. of the liquid 25 c.c. of $N/4$ potassium dichromate solution are added in a conical flask of about 300 c.c. capacity, which is placed under a reflux Liebig condenser; 30 c.c. of concentrated sulphuric acid (96%) are then added through the condenser, with shaking, and the liquid is at once boiled for exactly one hour. It is then cooled, diluted to about 250 c.c. and titrated with $N/4$ thiosulphate solution after addition of potassium iodide, finally using starch paste as an indicator.

As the reducing action of butyric acid is equal to 6 atoms of oxygen, then—apart from the correction for acetic acid—each cubic centimetre of $N/4$ dichromate solution (equivalent to 8 grams of available oxygen per litre) represents $88 \div (6 \times 8000) = 0{\cdot}00183$ g. of butyric acid. Should propionic acid be present this cannot, of course, be distinguished from butyric acid by this method, but as the oxygen absorption is proportional to the increased weight of organic acids, the total weight of organic acids is correctly determined, a matter of technical importance, though a portion of the "butyric acid" found may, in reality, consist of an equimolecular mixture of acetic and propionic acids. As the greater part of the oxidation to acetic acid takes place in a very few minutes, the correction for the reducing action of that acid may without appreciable error be based on the number of molecules of organic acid originally present—that is, on the total acidity; if n is the number of c.c. of $N/4$ sodium hydroxide required to neutralise the quantity of organic acids used in the

* Read at a meeting of the London Section on Jan. 7, 1924.

etermination, this correction is equal to 0·5n. hus, the weight of butyric acid present is equal to ·00183(b—0·5n) where b is the number of cubic entimetres of N/4 dichromate which are reduced. his will be clear from the following numerical esults :—

Acetic acid, g.	Butyric acid, g.	Equivalent c.c. of N/4 NaOH (=n).	C.c. N/4 $K_2Cr_2O_7$ reduced (=b).	Butyric acid calc (g.) = 0·00183 (b-0·5n).
Nil	0·0218	1·0	12·2	0·0222
0·02	Nil	1·3	0·7	Nil
0·01	0·0109	1·15	6·6	0·0110

In the case of propionic acid the equation is :— ght of propionic acid=74(b—0·5n) ÷ (3×8000)= 308(b—0·5n). The following numerical result was ained with this acid. Propionic acid present, g. Equivalent of N/4 NaOH 1·08 c.c., N/4 r_2O_7 7·1 c.c. Propionic acid calculated=0·00308 0·5n)=0·00308(7·1—0·54)=0·0202 g.

few experiments were carried out to investigate effect of variations in the quantity of sulphuric . Using 0·218 g. of butyric acid with 30 c.c. of phuric acid the volume of dichromate reduced 12·2 c.c., with 28 c.c. of acid 11·7 c.c., and with c.c. 13·1 c.c.

The result of reducing the duration of boiling 1 hour to ½ hour was to decrease the volume dichromate reduced from 12·2 c.c. to 11·75 c.c. he method has proved entirely satisfactory in ual practice.

The author is indebted to Mr. H. Langwell and to ssrs. Power Spirits, Ltd., in whose laboratories the ork was carried out, for their kind permission to ublish these results.

COMPARATIVE STUDY OF SOME COAL ARS PRODUCED BY LOW-TEMPERATURE CARBONISATION.*

BY K. B. EDWARDS, PH.D., LOND.

(*From the Cooper Technical Bureau.*)

This paper contains a record of an investigation of al tars produced by low-temperature carbonisation, ommenced by the author in 1920. An extensive echnical acquaintance with products from blast-urnace tar and also comparative examinations of roducts from vertical-retort tars and such tars as ould be obtained from specific low-temperature arbonisation processes, had led the author to the onclusion that all these tars conformed to one type, nd their values were substantially equal and, there-ore, low owing to their unknown character. This iew has received a certain amount of confirmation n recent years.

The utilisation of blast-furnace tar has advanced very little during the last 35 years. Direct distillation at atmospheric pressure gives blast-furnace creosote, a greenish-brown oil of low viscosity, d 0·950–0·980, b.p. 200°–325°, phenolic content 20—35%, with blast-furnace pitch of rather paraffinoid character.

* An abridgment of a thesis submitted for the Ph.D. degree of London University.

Until about 1912 blast-furnace creosote was of very low value, ranging from ½d. to 2½d. per gallon. The increase in value since 1905 is due to the more general use of the creosote as an oil fuel and of the phenol fraction (b.p. 215°–300°) for the production of disinfectants.

The process consists of extracting the creosote with caustic soda solution (about 10%), carbonating the alkali phenolate, and fractionating the separated phenols. The fractions obtained are usually three in number, viz., cresylic acid, b.p. 195°–210°; intermediate acid, 205°–220°; high-boiling acid, 215°–310°. The first two fractions are of relatively low value, and only the high acid yield renders the process profitable. The neutral oils and basic constituents are fit only for fuel, the oils being unsaturated, and the bases unsaleable at any remunerative figure The value of the high-boiling tar acids has been due to the fact that blast-furnace creosote has been the only available source, but no use is known for them except in the manufacture of disinfectants.

Résumé of published literature.

The literature on the subject of blast-furnace tar is extremely scanty. Watson Smith and his co-workers noted the decomposition of blast-furnace tar during distillation, and found in the distillate traces of phenol and the cresols and indications of xylenols, pseudo-cumenols, and possibly naphthols. Their conclusions generally were against any great technical value in these tars. Allen and Angus claimed the phenols to contain methoxyphenols, guaiacol and its homologues, and these statements are still copied into recent literature.

On low-temperature tar much work has been published in the last 20 years, much of which is polemical and of low scientific value, but the work of Bornstein, Jones and Wheeler, Maclaurin, Tideswell and Wheeler, Fischer and his co-workers, Marcusson, and Morgan and Soule, is outstanding. The results of Pictet and his co-workers on vacuum tars do not conform to the results found elsewhere. The observations of Maclaurin are of great interest, and the author has followed up his work and confirmed the main peculiarities noted by him. The published work up to June, 1923, may be summarised as follows :—

Low-temperature tar when subjected to ordinary distillation yields : Pitch, of poor brittle quality. Neutral oil or hydrocarbons, consisting of unsaturated hydrocarbons, paraffins, naphthenes, and probably smaller quantities of aromatic hydrocarbons with traces of methylnaphthalenes. Phenols, consisting of cresols, xylenols, and trimethylphenols with higher phenols of unknown constitution. Nitrogenous bases, mainly secondary and tertiary bases of unknown constitution, with possibly traces of primary bases. Appreciable quantities of phenol, benzene, and toluene are not found by the majority of the workers. The results of Pictet and his co-workers appear to stand alone, and to require further investigation. The presence of oxygenated compounds in the hydrocarbon portion is highly probable, and the presence of pyrocatechol and other dihydric phenols

in perceptible quantities is reported by several observers.

Beyond the technical treatment of these tars on the known lines of blast-furnace tar little advance appears to have been made.

Low-temperature tar dealt with in other ways not involving ordinary distillation yields: Petroleum-soluble portion, alkali-soluble portion, part phenols, part resin; resins precipitated with mineral acids (Maclaurin); tar resins (Marcusson); pyrocatechol (Börnstein, Fischer, and others); orange-red lubricating oils (Fischer and others); phenols, as in ordinary distillation. The presence of acids, alcohols, and ketones is in doubt. No attempt has apparently been made to effect a clean separation of various groups of substances present, and in the opinion of the author, until this is done, little is gained by ascertaining the presence of unimportant traces of various constituents.

All evidence tends to show that the valuable aromatic products present in high-temperature tar are absent in low-temperature products. In addition, crude products such as cresylic creosote, salty creosote, and green (anthracene) oil, which form the main bulk of the distillate from high-temperature tars, will either be absent or degraded to such an extent as to be of much lower value. Examination by the author of products from tars produced in America and the colonies shows that unintentional low-temperature distillation of coal in continuous vertical retorts is producing tars closely resembling blast-furnace tar, with all its undesirable characteristics. The pitch also tends to be brittle and of low value.

Investigation of four typical low-temperature tars.

The author has made a comparative examination of the tars produced by different processes, representative samples of the following tars having been obtained, by the courtesy of the various organisations: (1) Blast-furnace tar; (2) "Coalite" tar; (3) Scottish by-products tar (Maclaurin process); (4) Dundee gas tar.

These four tars were chosen for the following reasons. Blast-furnace tar was considered to be the prototype of low-temperature tars. "Coalite" and Maclaurin tars were produced by two different established methods of low-temperature carbonisation, while Dundee gas works tar was known to be an outstanding example of an "unintentional" low temperature tar, being produced from semi-bituminous Scottish coals in continuous vertical retorts. The blast furnace tar was produced from splint and hard Scottish coal, the "Coalite" tar from a mixture of coking and non-coking Barnsley-district coal, and the Scottish by-product tar from Scottish coking coals.

I. EXAMINATION BY DISTILLATION.

The four tars, blast-furnace (B), "Coalite" (C), Scottish by-products (S), and Dundee gas tar (D), are referred to throughout this work under the letters placed in parenthesis.

Character of the tars.—Tar S was extremely viscous but fairly clean; B was viscous and opaque, and obviously contained solid matter in suspension; D was much less viscous, and C slightly less viscous, the last two being very similar in character.

The specific gravities at 15° C. were: B, 1·151, C, 1·081; S, 1·048; D, 1·115. The tars were freed from water as much as possible before the gravities were taken. When 5 c.c. of the tar were shaken with 10 c.c. of hot distilled water and allowed to settle, the supernatant water from tars B and D gave an alkaline reaction, that from S was neutral, and that from C distinctly acid.

Distillation at atmospheric pressure.—Throughou the work the conditions were kept as uniform a possible. All temperatures were corrected and thermometers checked frequently.

Preliminary tests showed that distillation, carrie to completion (*i.e.*, to incipient coking) at a fi temperature of about 375°, left in the still pitche about 28–35% of the original tar, and so brittle they were technically useless. As it was desir keep within the limits of technical practice, distillation was finished when the thermometer the vapour outlet touched 311°. These prelimina tests were carried out on 500 c.c. of tar in a 1-lit Wurtz flask with the thermometer bulb at the lev of the side tube.

Tars B and C distilled quietly, tars S and D froth and bumped badly. Neither the viscosity n water content would serve as a guide to the lil of frothing, for the viscosity was in the a order C, D, S, B, and the water content in t r B, D, C, S.

During the distillation tar C gave off ulp dioxide, and later hydrogen sulphide and hyd ch acid, but no ammonia. Tar B gave ammor , t of hydrogen sulphide and, in the later sta s, hy cyanic acid. Tar D gave mainly ammonia, wit hydrogen sulphide, while S yielded hydrogen sulphide Tars C and S gave in the condenser and flask trace of sublimed yellow solid material, resembling sulphu but which decomposed with effervescence on fu er heating.

The distillate was collected in one vessel and s r ated from water. The aqueous portion was tinctly acid in the case of tar C and alkaline (ammon from B, D, and S. C resembles in this respe vacuum tars obtained by Pictet and Bouvier, a also those of Jones and Wheeler. The whole distilla in each case was then treated as follow, to ascerta the content of phenols and bases.

Phenols.—The distillate was extracted twice wit an equal volume of hot sodium hydroxide solutio (*d* 1·15), the temperature of the mixture being raise to 50°–60°. A third extraction with concentrate soda solution (*d* 1·45) was found to be unnecessary The alkaline washings were united, allowed to separat from any traces of oils, and subjected to steam distillation until the distillate contained no traces of oils or bases. The distillate containing traces of oils and bases was mixed with 50% of its volume of concentrated hydrochloric acid and used for the extraction of the bases from the oils. The purified alkali phenolate solution, which remained quite clear when diluted with water, was cooled and acidified with hydrochloric

cid, the liberated phenols collected, the acid liquor xtracted with ether, the extract dried over anhydrous odium sulphate, the ether removed at as low a temerature as possible, and the phenols measured.

Bases.—The acidified distillate mentioned above as thoroughly shaken with the washed residue, rom which phenols had been removed and separated fter standing. A final washing with concentrated ydrochloric acid was given, and the acid washings ere united, freed from neutral oil, made alkaline vith 40% sodium hydroxide solution and extracted hree times with ether. The united ether extracts vere dried with solid potassium hydroxide, the ether emoved and, on account of their small volume, the ases were weighed.

During the extraction of the phenols it was found hat the alkaline solution of the phenols on contact with ir gave rise to the crimson colour which is a notable haracteristic of the creosotes from most tars of this ype. The intensity of colour varies with different rs, and in the four under examination D and S ve intense colours, while B was of medium intensity, d C gave very little colour for a low-temperature r. This coloration is looked upon as a grave fect in the use of creosotes in disinfectant manucture, but definite identification of the constituent hich gives rise to the colour has not yet been posble. The following facts, however, are known. The colour-forming substance has a high-boiling point, and tends to concentrate in the higher fractions. It is definitely phenolic in character, being insoluble in alkali carbonate solutions, but soluble in weak caustic alkali. It is a relatively highly acidic phenol, and is precipitated among the last portions of the phenols if acidification is carried out in stages. In the presence of alkali it is oxidised first to the crimson colour and then to a brown, but is stable in neutral or acid solutions. Sunlight materially assists the oxidising process. While many guesses have been made as to the type of phenol producing this effect, the presence of polyhydric phenols being the usual explanation, the author considers that, in the absence of actual isolation of the pure substance, the characters are more those of a leuco-derivative of a condensed phenol compound similar to rosolic acid or aurin. The substance is certainly not either of these, but the indications are that it is of that type, or even more of the type of the coumaranones.

The results obtained in the foregoing examination can best be summarised in the following table :—

TABLE I.

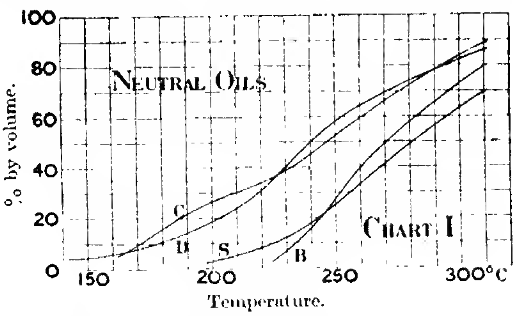
	Blast-furnace tar B. %	Coalite, tar C. %	Dundee gas tar D. %	Scottish by-product tar S. %
Sp. gr. of tar at 15°/15°	1·151	1·081	1·115	1·048
Pitch at 311° by vol	56·6	50·4	62·5	53·0
Water by vol	0·2	5·4	1·5	11·0
Sp. gr. of distillate	0·980	0·968	0·993	0·982
Phenols on distillate by vol.	34·3	33·3	30·0	37·2
Phenols on tar—by vol.	14·6	15·0	10·8	13·4
Bases on distillate, wt./vol.	5·8	2·9	4·4	3·6
Bases on tar, wt./vol.	2·5	1·3	1·6	1·3
Character of pitch	Paraffinoid, mediumly hard.	Very brittle.	Hard and brittle.	Very paraffinoid—soft.

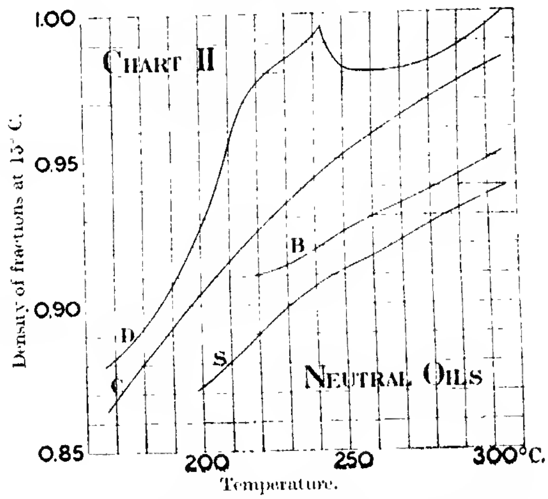
It will be seen that the specific gravities of three of the tars (B, C, and D) fall outside the limits given by Fischer and Glund of 0·95 to 1·06. The results given in the Report of the Fuel Research Board (Beilby, 1922) show that the type of coal carbonised affects the gravity of the tar, different coals carbonised at 600°, giving tars varying in sp. gr. from 1·030 to 1·063. Other factors also probably come into the matter, and specific gravity alone is certainly not a safe guide in determining whether or not a tar is a true low-temperature product.

The yield of pitch is considerably higher than could have been attained by forcing distillation further, but even at 311° the pitches C and D were brittle and poor, while B and S were paraffinoid and of low value. The specific gravity of the distillate is much more uniform than that of the tars, and the phenolic and basic content are closely similar.

In order to obtain sufficient material to work upon, the preliminary distillation was repeated, working upon 2 litres of each tar. The tar was distilled in short-necked round-bottomed 3-litre flasks of uniform dimensions and again uniformity of treatment was attempted as far as possible. The distillate was separated into neutral oils, phenols and bases and each of these was treated as follows.

Neutral oils.—The washed neutral oils were fractionated through a four-pear Young column at the





rate of approximately 2 drops per second, the fractions obtained every 10° being kept separate The results are shown in Charts 1 and 2. Chart 1

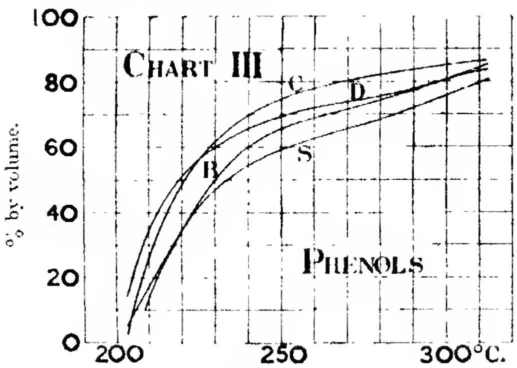
gives the cumulative volume-percentage of the whole, boiling below the indicated temperature, and Chart 2 the sp. gr. of each fraction plotted against the mean boiling point.

The fractionation proceeded normally with the oils from tars B, C, and S. The oil from tar D, however, showed the presence of naphthalene in the fractions between 200° and 250°. The presence of naphthalene is indicated clearly in curve D, Chart 1, by the depression of the volume boiling below 200° and the sharp rise at 215°. The effect is enhanced enormously in Chart 2, where the specific gravities of the fractions of oil D are very considerably increased between the temperatures 200°–270°. Tar D is obviously aberrant and is a mixed product, a relatively small proportion of high-temperature products being imposed on a large proportion of true low-temperature products. A small quantity of crystalline matter obtained from the higher-boiling fraction of oil D consisted as far as could be ascertained of anthracene and phenanthrene. Oils C, B, and S gave smooth curves, and in the author's opinion, clearly demonstrate that, other than for fuel purposes, nothing can be hoped for in the technical treatment of oils of this nature.

Examination of the oils confirmed the presence of paraffins, naphthenes, and unsaturated hydrocarbons. In view of the failure to utilise blast-furnace oil produced by distillation, further work has been postponed until all other avenues of approach have been tried.

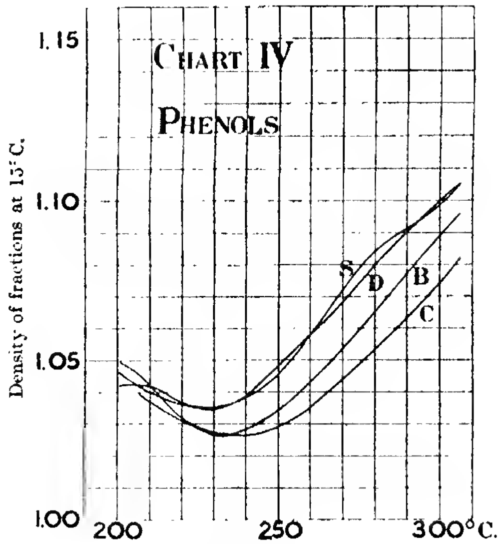
Chart 1 shows clearly that tars B and S have been stripped of their lighter constituents by the excessively large current of gas to which they have both been subjected; also that tar B produces oils very similar to tar S, notwithstanding the difference in sp. gr. of the original tars. Tar C apparently occupies a position midway between D and the others, but is definitely a low-temperature tar.

The oils, although pale yellow to green in colour when freshly distilled, rapidly darkened and were obviously unstable, and no economical means of purifying them could be found.



Temperature.

Phenols.—The carefully dried phenols were fractionated in the same manner and distillations and specific gravity charts were prepared (Charts 3 and 4). Chart 3 shows that there is a very close similarity between all four lots of phenols. Tar D, however, again shows slight signs of high-temperature car-



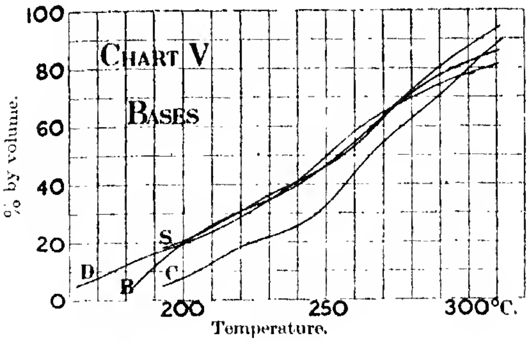
Temperature.

bonisation with a rather higher percentage of cresols and xylenols, while tar C is again intermediate between tar D and the closely allied tars B and S; otherwise the curves are smooth and give little hope that fractionation alone will produce any valuable results.

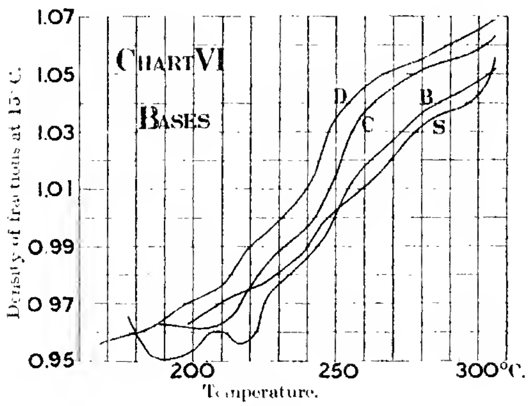
Chart 4 is of extreme interest. The specific gravity of the fractions falls until a temperature of 235° is attained and then rises rapidly. This alone refutes the previously expressed opinion that these tars contained guaiacol and kindred substances. Examination of these curves led to the conclusion that the phenols consisted of monohydric mononuclear phenols mixed with unknown phenolic substances of very high boiling point which possibly decomposed to some small extent during distillation and partly distilled unchanged. These unknown phenols obviously had a high specific gravity; they did not give any noteworthy coloration with ferric chloride, neither did they give the Liebermann reaction. The higher fractions of the phenols were gummy and resinous, and these unknown phenols the author terms "*rhetinols*" for convenience. If the above hypothesis be accepted, the mononuclear phenols should all possess the characteristic "carbolic" odour and taste, and show a gradually falling gravity boiling point curve. During the distillation of the phenols, hydrogen sulphide was given off in all cases, and ferric chloride gave the reactions of pyrocatechol and α- and β-naphthol, but only as being present in traces. The fractions above 230° from al the tars darkened rapidly and obvious decomposition took place at the higher boiling points.

Bases.—The basic constituents were fractionated in an identical manner (Charts 5 and 6). Owing to the small quantity of bases available, the errors

are probably of greater magnitude in this examination than in the case of the oils and phenols. Chart 5 shows that the tar C produces bases of slightly



different boiling point from the tars B, D, and S. The latter are practically identical within experimental error. The curves are all smooth, showing that fractionation alone is of small assistance. Chart 6 shows, however, apparent complexity up to



220°, with slight irregularity round 250°–260°. The quantity of material worked with was too small to permit any definite conclusions and the problem must be attacked on a much larger scale. The close similarity of the four tars is, however, well brought out.

Summing up the foregoing, the following points appeared to be fairly well established:—

1. Tars B, S, and C are all of the same type and contain little or no naphthalene, and generally represent true low-temperature tar as technically produced in Great Britain.
2. Tar D, while showing signs of introduction of high-temperature tar, is very similar in most respects to tars B, S, and C.
3. The phenolic substances of all four tars are substantially identical.
4. The basic constituents are similar.
5. With the exception of naphthalene, in relatively small quantities, in tar D, the whole of the tars produce little of value by direct distillation that has not been available in blast-furnace tar.
6. All the pitches produced are of low value.

The basic hypothesis that low-temperature tars are substantially identical with blast-furnace tar when subjected to ordinary distillation would appear to be proved, and the close similarity of tar D in its main characteristics is also established. Tar D, therefore, is what has been termed an "unintentional" low-temperature tar and will require technical treatment along the same lines. The difference in the percentage of low-boiling oils obtainable is explainable, inasmuch as tars B and S were both produced in a current of hot gas in large volume, while tar C was produced from an experimental plant not fitted with suitable gas-cooling devices.

In view of the above facts it was determined to attack the problem by methods not involving distillation and to carry on the comparative work along these new lines.

II.—Examination by Solvent Extraction.

As it was desired to use a solvent of low cost, volatility, and fire risk, 94% industrial alcohol was employed. The use of alcohol in the treatment of blast-furnace creosote was patented (McDougall and Howles, E.P. 8323, 1912) and a very large scale plant worked under the author's direction was fairly satisfactory as far as solvent cost was concerned.

500 c.c. of the tar were extracted with an equal volume of 94% alcohol, in the cold, with violent agitation. The mixture was allowed to separate and, after separation, the alcoholic layer was poured off and another 500 c.c. of alcohol added, again thoroughly shaken, settled, and poured off. Four extractions appeared to remove practically all soluble matter. After the first extraction with all four tars separation was slow, but the subsequent washings separated easily. The washings from each tar were combined and allowed to stand until clear, when the clear alcoholic solutions were decanted and the residues added to the insoluble matter.

The alcoholic extracts all showed a greenish fluorescence, slight in the cases of tars S, C, and D, while tar B gave an extract which had a strong greenish-yellow fluorescence.

The alcohol was removed from both the extract and the insoluble portion by slow distillation through a 12-pear Young dephlegmator and a sharp "cut" was obtained in all cases; none the less the recovered alcohol showed traces of hydrocarbons, although the quantity was small.

The results obtained can be summarised as follows:

	Tar B. %	Tar C. %	Tar D. %	Tar S. %
Alcohol-soluble material % by vol.	70	64	76	66
Residue	29·8	30·6	22·5	33
Water	0·2	5·4	1·5	11
Sp. gr. extract at 15°/15°	1·060	1·085	1·100	1·075

It will be seen that the specific gravity of the extract bears no relation to that of the original tar. The extracts were deep orange-brown in all cases, while the consistency was thinner and the viscosity was much less than that of the original tars. The viscosity ran in the ascending order, C, D, S, B, but the difference was small.

The insoluble residue contained all the mineral matter in the tar but also much organic matter. On extraction with carbon disulphide the four residues yielded dark, almost dead black substances granular in appearance, on further testing, they were found to be mixtures. The residue insoluble in carbon disulphide contained mineral matter and free carbon and was not examined further. The actual quantities of mineral matter obtained were:—B, 13·0%, C, 4·6%; D, 5·0%; S, 0·6% wt./vol.

Examination of the alcohol extract.

Phenols.—The extracts from which alcohol had been removed were quantitatively examined as to phenol content as already described, with the exception that the purified alkali phenolate solutions were not acidified with mineral acid but were carbonated with carbon dioxide. This course was adopted in order that any carboxylic acid might be separated from the sodium carbonate liquor.

No difficulties arose in this process, but it was notable that very little crimson coloration developed in the alkaline solutions, thus appearing to demonstrate that the material producing the colour is a product of decomposition on distilling the tar. The alkali phenolate solutions frothed strongly and persistently on shaking; this frothing, which has not been noticed before, was accentuated if the phenolates were well diluted, and no apparent hydrolysis took place on dilution. The complete extraction of phenols was assured by allowing the residual oil to stand for 2 or 3 days over stick caustic soda. This was found to add nothing to the already extracted phenols. The alkaline solution was then carbonated with a current of pure washed carbon dioxide until precipitation was complete. The phenols were precipitated as a dark resinous mass and separated, and the carbonate liquor was extracted twice with ether and the ether solution added to the precipitated phenols. As usual, the precipitated phenols contained some soda, and it was found necessary to neutralise with hydrochloric acid before they became workable. The phenolic compounds contained material insoluble in ether, cold alcohol, or alkalis, but soluble in pyridine. This material, which later was found to be present in almost all stages of the extraction, was identified as being similar to Marcusson's "tar resins," and to the materials described under the general term "ulmins," and is so termed throughout this work. The "ulmins" are soluble in many of the tar products, particularly phenols, and still remain in solution in the alkali phenolate solutions, and also in concentrated solutions of the tar products in solvents. The addition of excess of ether or other solvent often precipitated "ulmins." This solute-solvent action is dealt with later, as affecting much of the published work on the action of solvents on tars. The ether solution of phenols was dried, the ether evaporated, and the residue taken as phenols.

Carboxylic acids.—The sodium carbonate liquor from the phenols was made just acid with hydrochloric acid and extracted with ether, the ether dried and evaporated, and the residue redissolved in hot sodium carbonate solution, treated with ether to remove any traces of phenols, reprecipitated, and again taken up in ether, dried, and recovered.

Bases.—The mixture of neutral oils and bases, left after extraction with soda, was treated with dilute hydrochloric acid. The first washing separated well but the second washing precipitated flocculent material, while the third washing gave a semi-solid emulsion which broke up on the addition of ether to a clear top layer, a slightly yellow or orange acid solution, and a large quantity of dark resinous or gummy substances which formed masses on the sides of the separator. This phenomenon was recognised as being similar to that observed by Maclaurin, and was considered (wrongly, as later work will show) to be simply a precipitation of "ulmins" and other materials which had been held in solution by the bases. The clear acid washings were made alkaline and the bases recovered in the usual way.

Hydrocarbons and neutral oil.—The added ether was recovered and the oily residue taken as "neutral oils."

(To be continued.)

ERRATA.

THE PREPARATION OF ETHYL ETHER BY WILLIAMSON'S METHOD.

BY W. B. S. BISHOP.

(This J., Feb. 1, 1924, 23–24 T.)

Page 23, col. 1, line 7 from bottom; col. 2, lines 12 and 25 from bottom, and page 24, col. 1, line 8 from bottom, for "oxide" read "ethoxide."

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

TRANSACTIONS

Vol. XLIII., No. 20.] [May 16, 1924.

A COMPARATIVE STUDY OF SOME COAL TARS PRODUCED BY LOW-TEMPERATURE CARBONISATION.

BY K. B. EDWARDS, PH.D., (LOND.)

(From the Cooper Technical Bureau.)

(Continued from p. 148 T.)

Acid resin.—This term describes the material precipitated by, but insoluble in, dilute hydrochloric acid. The product was extracted with acetone and left a residue of the "ulmins." The acetone solution, after removal of the acetone, left a dark, sticky, semi-solid mass.

The quantitative comparative results can best be expressed as follows:—

	Tar B.	Tar C.	Tar D.	Tar S
Phenols.	%	%	%	%
Volume % on extract ..	30	38	39	36
Volume % on tar ..	21	23	20	23
Sp. gr. 15°/15°	1·074	1·053	1·093	1·098
Character of phenols ..	Thick, somewhat sticky.	Fairly thin, not sticky.	Thick, very sticky.	Very thick, very sticky.
Neutral oils.				
Volume % on extract ..	47	44	42	40
Volume % on tars ..	33	28	32	26
Sp. gr. 15°/15° ..	1·009	1·036	1·048	1·018
Odour	Pleasant aromatic.	Pleasant aromatic.	Naphthalene like	Pleasant aromatic.
Carboxylic acids.				
Wt./vol % on extract	0·16	0·4	0·32	0·16
Wt./vol. % on tars ..	0·13	0·2	0·22	0·12
Bases.				
Wt./vol. % on extract ..	4·4	2·7	3·1	2·8
Wt./vol. % on tar	3·1	1·7	2·1	1·9*

* This tar gave traces of basic substances insoluble in ether or any other solvent except concentrated hydrochloric acid.

Alcohols were absent in each case.

All the tars are seen to behave similarly, and the presence of "ulmins" (tar resins) and carboxylic acids, detected by Marcusson, is confirmed. The absence of alcohols is also in agreement with most workers, excepting Pictet and his co-workers; nonetheless, the author was by no means satisfied that the various products obtained were homogeneous, and details of further examination of the products are given below.

Phenols.—The phenols obtained from each tar were treated with excess of light petroleum (b.p. 70°–120°). Three volumes of light petroleum were used at each washing and three washings were given, allowing 24 hours' standing after each washing to ensure complete precipitation. The washings were united and allowed to stand, when further precipitation occurred. The clear solution was tested with successive additions of solvent, and, when no further precipitation occurred, the petrol-soluble phenols were extracted with soda and recovered in the usual way. The insoluble phenols were dissolved in ether, when precipitation of "ulmins" took place. The solution was diluted until precipitation ceased, filtered, and the ether distilled off. The petrol-insoluble phenols were then obtained as a solid resinous mass and, after removal of all traces of solvent, set to a brittle solid, with practically no odour or taste. This dissolved in dilute caustic soda to a clear brown solution, showing a remarkable foaming on agitation. This substance was definitely phenolic in character, but gave none of the usual phenolic reactions, and was considered to be the material previously termed "rhetinols" from its resin-like character.

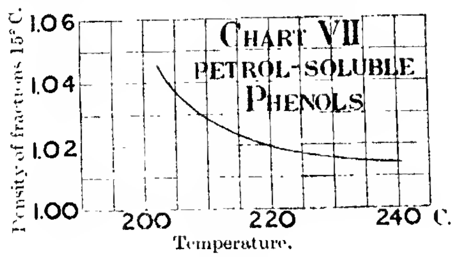
The "ulmins" obtained were of the same type as those previously described.

The petrol-soluble phenols were all thin liquids, without any apparent stickiness. The phenols from the four tars were separately treated, with the following results:—

	Tar B.	Tar C.	Tar D.	Tar S.
	%	%	%	%
Petrol-soluble phenols	51·8	77·6	31·3	46·8
Rhetinols	15·1	20·8	65·8	50·5
Ulmins	3·1	1·6	2·9	2·7
Sp. gr. of petrol-soluble phenols	1·043	1·043	1·059	1·052

It will be seen that the specific gravity of the petrol-soluble phenols has fallen considerably after the removal of the rhetinols, but in view of the experience gained previously, it was considered by no means certain that the whole of the rhetinols was removed. The petrol-soluble fractions were separately distilled, when it was found that, after attaining 260°, the temperature rose rapidly, and the distillation was stopped. The residue in the flask was insoluble in petrol and was identical with the rhetinols previously isolated. The four fractions gave the following amounts of phenols up to 260° (% by volume of petrol-soluble phenols): B, 49%; C, 66·7%; D, 50%; S, 50%.

Owing to the small volume of the phenols and to their apparent identity, the distillates were united and fractionated through a rod and disc column. The distillation proceeded as follows:—Up to 200°, 11%; 205°, 30%; 210°, 42%; 215°, 55%; 220°, 65%; 230°, 75%; 240°, 81%; to 260°, 90%.



The temperature rose rapidly at 250°–260° and still more rhetinols were recovered from the residue in the flask. The fractions were kept separate and a specific gravity/temperature curve drawn (Chart 7). This demonstrates clearly that the hypothesis

stated previously as to the phenols being a mixture of homologues of phenol boiling up to 240°-260° with high-boiling rhetinols is substantially correct. With the removal of the rhetinols of high sp. gr. and b.p. the sp. gr./b p. point curve is a gradually descending one, as would be expected. In view of the small quantity of material available, work on the phenols was suspended and resumed later (*vide infra*).

Neutral oil.—This product also was not homogeneous; treatment by excess of petrol produced a precipitate consisting partly of the ubiquitous "ulmins," and partly of ether-soluble asphaltic material.

The neutral oils were treated with petrol until precipitation ceased (usually about 8 times the volume of oil), the clear petrol solution was decanted, and the solvent distilled off through a 12-pear Young column. The precipitate was then extracted with ether and the ether recovered. The residue was dried *in vacuo* and consisted of "ulmins."

The petrol-soluble oils were all dark red-orange in colour, only slightly soluble in cold alcohol, soluble in hot alcohol, also in ether, carbon tetrachloride, and most solvents. They were highly unsaturated. The sp gr. of the oils was: B, 1·007; C, 1·036; D, 1·045; S, 1·018. The ether-soluble asphalt was obtained in only small quantity as follows: B, 4·4%; C, 3·4%, D, 3·6%, S, 2·2%. This material was very similar to the carbon disulphide-soluble material obtained in the original alcohol extraction and was very dark in colour. Little could be learned of its nature. The "ulmins" were identical with the material previously obtained, and about 3% was obtained from each oil.

The *carboxylic acids* were semi-crystalline, viscous liquids with a low melting point and had an odour resembling that of coconut fatty acids; the quantity was too small for investigation, but they did not resemble humic acid, appearing to resemble naphthenic acid.

Dihydric phenols.—Mixed with the carboxylic acids before purification were perceptible quantities of pyrocatechol. The quantity present was small and could not be definitely ascertained, but was estimated to range from 0·2% to 0·8% of the tar.

Examination of the various asphalt-like materials obtained showed the presence of "ulmins" in all, contaminated with a basic material which was precipitated by hydrochloric acid from benzol solutions, but the salts of which were not soluble in water

Summary of Part II.

Notwithstanding the care taken in the extraction, none of the products, with the exception of the homologues of phenol, could be taken as homogeneous. The figures obtained, while interesting as showing the similarity of the four tars, are not of great value, owing to the impossibility of clean separation, due to the "solute-solvent action" previously referred to. Nevertheless, the following points have been clearly demonstrated:—

(*a*) All four tars contained the brown amorphous powder referred to by Marcusson as "tar resins," and the failure of Tropsch to obtain more than traces of these substances was, in all probability, due to the non-recognition of the solute–solvent factor.

(*b*) The presence of carboxylic acids in all four tars was definitely established, thus confirming the work of Marcusson and Tropsch.

(*c*) The phenolic content of the tars has been divided into two main groups, *i.e.*, homologues of phenol and resinous phenols of high density, practically odourless and tasteless, which have been termed rhetinols, and which are insoluble in light petroleum.

(*d*) The observation of Maclaurin as to precipitation of resinous matter with dilute hydrochloric acid has been confirmed for all four tars, and evidence has been obtained that, when carefully purified, the substance forms salts insoluble in water and benzene but soluble in alcohol.

(*e*) The presence of pyrocatechol and the naphthols is confirmed, although the quantities present could only be gauged approximately.

(*f*) The specific gravity of the low-temperature tar depends, in a considerable degree, on the content of rhetinols and mineral matter, and, in a minor degree, other constituents, and is not a safe guide as to the temperature of carbonisation.

In view of the substantial identity in constituents of the four tars, it was decided to continue the extraction work on much larger quantities of tars C and D only, in order to obtain such quantities of products as to allow of easy purification and more detailed examination. This work is detailed in Part III.

III.—EXAMINATION OF TARS C AND D BY MODIFIED SOLVENT EXTRACTION.

In order to obtain larger quantities of the various fractions in a state of greater purity, 5 kg. each of tars C and D were treated by extraction methods modified in the light of the results obtained in Part II. To ensure cleaner separation of the various constituents a preliminary steam distillation at a temperature of 140° was decided upon, as experiment indicated that decomposition did not occur at or below that temperature in the presence of steam. The steam-distilled portion and the residue were treated separately.

The steam distillation was stopped when the oil/water ratio in the distillate fell to 1/10.

Steam-distilled portion.—The steam distillation proceeded quietly, tar C giving off sulphur dioxide and hydrochloric acid in traces, tar D giving ammonia. The distillates were dark yellow oils, and the residues were black and almost solid, that of tar C being rather waxy and that of D somewhat sticky. The steam-distilled oils were separated, precisely as before, into neutral oils, phenols, bases,

and carboxylic acids, using the processes already given.

The following results were obtained expressed as weight percentages on the tars:

	Tar C.	Tar D
	%	%
Steam distillate composed of:—		
Neutral oils	15·1	10·7
Phenols	6·5	4·1
Bases	0·2	0·33
Acids	0·07	0·02
Total	21·87	15·15

The steam distillation did not give a clean cut, but "tailed off," and therefore can only be considered as an expedient to assist the examination. The neutral oils and phenols were completely soluble in light petroleum. The results of further examination of the products are given later.

Examination of residues.—Preliminary testing showed that alcohol removed a portion only of the residue obtained by steam distillation, and as the extracted material contained "ulmins" which it was desired to leave behind as a residue, alcohol extraction was abandoned. Ether was ideal for the purpose, but was impracticable on a technical scale, but benzol was found to be almost as effective as ether in removing non-ulmin substances and also in possessing to only a small degree, the property of dissolving "ulmins" in the dissolved oils and phenols. Benzene was, therefore, used as a solvent, and the extraction was carried on until the benene was only slightly coloured. A considerable amount of "ulmins" was obtained from each tar by this method. The benzene solutions were diluted with solvent until precipitation ceased.

Phenols.—The phenols were extracted from the benzol solution of the tars in the usual way, no difficulty being encountered; neutralisation was carried out with carbon dioxide and the mother liquor extracted for carboxylic acids. After washing the benzene solution of tar D with caustic soda, an asphaltic substance separated out. This was provisionally relegated to the "asphalt" group. Tar C apparently contained none. The phenols were precipitated as a viscous mass with a high specific gravity, and, after neutralising with hydrochloric acid, were dissolved in ether and recovered as usual.

Bases.—The benzene solutions of the oils and bases were, as before, unworkable with ordinary washing with 1:3 hydrochloric acid. It was found, however, that complete precipitation of this material could be attained by saturating a benzene or petrol solution with a current of dry hydrogen chloride, when rapid absorption took place, with rise of temperature and precipitation of large quantities of dark, sticky material. This precipitation was complete, and the product was insoluble in benzene, petrol, ether, and water, but was soluble in alcohol; it was converted into the free base by caustic alkali and could then be precipitated afresh with acid. Treatment with gaseous hydrogen chloride before removal of the phenols yielded a precipitate containing large quantities of phenols, thus following known work as to the relative order of extraction to be followed.

The benzene solutions were treated, as above, until precipitation was complete, and the precipitate and solution washed thoroughly with water. The water solution contained the ordinary bases and was made alkaline and treated as usual. The bases obtained were of the usual type. Traces of ether-insoluble bases were again noticed.

Bases (acid-water insoluble).—The acid precipitates from the above were washed thoroughly with benzol and, after removal of solvent, were dissolved in 94% alcohol. "Ulmins" were again obtained in quantity, and were filtered off and added to those already obtained. The alcohol was distilled off, the residue treated with excess of 10% caustic soda solution and warmed, the liberated bases dissolved in benzol, dried, and recovered.

Neutral oils.—The benzene solutions, after treatment with hydrochloric acid and subsequent washing, were treated as usual, and the residual oils dissolved in light petroleum. Tar C oils dissolved practically completely, but tar D threw down a further quantity of asphalt-like material differing from the first in being soluble in benzene. This was washed thoroughly and returned as "asphalt" (benzene-soluble). The petrol solutions were distilled and the residue returned as "neutral oils" (petrol-soluble).

Separation of phenols.—The mixed phenols obtained were treated with light petroleum, when the larger portion remained undissolved. Petrol was added to the solution until precipitation ceased and the dissolved phenols were recovered. Three extractions of the residual rhetinols were carried out, and, in the last, heat was applied with very little result, as far as extraction was concerned. The solvent was removed from the residues, which were re-dissolved in ether, when further small quantities of "ulmins" were separated. The ether was recovered and the residues were taken as rhetinols.

The petrol-soluble phenols were viscous liquids with strong phenolic odour. They were distilled under reduced pressure through a fractionating column until the "break" occurred, and the residue in the flask was again treated with light petroleum, when more rhetinols were isolated and added to the main bulk. The petrol-soluble phenols were recovered and added to the distillate.

Percentage by weight.	Tar C.		Tar D.	
Neutral oils				
Petrol-soluble				
Steam-volatile	15·1	14·5	10·7	34·8
Residual	29·4		24·1	
Petrol-insoluble				
Asphalt, benzene-insoluble	—		3·0	9·0
Asphalt, benzene-soluble	—		6·0	
Phenols.				
Homologues of phenol—				
Steam-volatile	6·5	17·7	4·1	17·0
Residual	1·9		0·9	
Rhetinols	9·3		12·0	
Acids.				
Steam-volatile	0·07	0·75	0·02	0·4
Residual	0·68		0·38	
Bases.				
Steam-volatile	0·20	9·0	0·33	9·5
Residual, ether-soluble	0·37		0·20	
Residual, ether-insoluble	0·12		—	
Residual, acid-water-insoluble	8·3		9·0	
Ulmins and mineral matter		19·0		26·3
Water		5·4		1·5
Loss—Polyhydric phenols etc.		3·6		0·6
		100·0		100·0
				0·2

Comparative results.—The preceding table gives the results of this examination of tars C and D. Both tars contained the same products with the exception that tar C apparently contained no asphalts.

The simplification of the method of examination has reduced the number of products, but much further work is necessary before a technical process can be elaborated or before any investigation of the composition of the products can proceed.

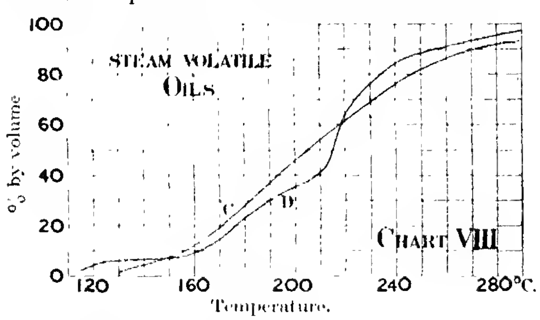
IV. PRELIMINARY EXAMINATION AND CHARACTERISTICS OF PRODUCTS OBTAINED IN SECTION III.

Neutral oils The steam-volatile oils from tars C and D gave distillation figures as follows when fractionated through a four-pear dephlegmator :—

Vol. % boiling below	Tar C	Tar D.	Vol. % boiling below	Tar C	Tar D.
100°		0·4	200°	18·0	37·2
120°	0·1	4·0	220°	65·2	70·8
140°	2·5	6·2	240°	80·0	88·0
160°	12·5	10·6	260°	89·7	93·0
180°	30·0	22·6	280°	93·5	96·6

The above figures confirm those previously obtained. The fraction of tar D oil boiling between 200° and 240° contained considerable quantities of naphthalene which crystallised out on cooling.

The detailed examination of the fractions shown graphically in Chart 8 was postponed for further work, but the presence of aromatic compounds, naphthenes, and paraffins in both tars was confirmed.



Residual oil.—While it is realised that the division of the neutral oils into "steam-volatile" and "residual" is purely arbitrary, it was found convenient to keep the rough divisions as such until further investigations can take place.

The residual oils from both tars were moderately viscous, clear, orange-brown oils, that from tar C being more orange than that from tar D. Both oils deposited crystals of paraffin on cooling. The oils had a remarkably high density, showing a high degree of unsaturation, viz., d^{15}_{15}, tar C, 1·048 ; D, 1·042.

A distillation conducted from a Wurtz flask gave the following figures :—

	Tar C.	Tar D.
Vol. % distilling below	%	%
300°	21	16
320°	33	26
340°	48	38
360°	61	52
Pitch	90	87
Sp. gr. of distillate	1·023	1·017

Decomposition took place during the distillation, particularly above 360°. The residues in each case were porous and apparently coked. The distillates were orange-brown in colour, with strong green fluorescence, were much less viscous than the undistilled oils, and were very similar to each other in appearance. Ordinary distillation is not indicated in the treatment of these oils, and the products obtained are apparently similar to those obtained by Fischer and Gluud and claimed by them to have value as lubricants. Both oils were completely soluble in benzene, acetone, light petroleum, chloroform, pyridine, and ether, but very slightly soluble in 94% alcohol. Concentrated sulphuric acid produced a violent reaction and no separation of unsulphonated oil took place. Methyl sulphate dissolved about 40–50% of the oils.

The inference can be drawn that these heavy oils consist mainly of very unsaturated compounds of complex structure. A thorough investigation is necessary before anything further can be said as to their possible uses or composition. The tars B and S are probably more paraffinoid than tars C and D, but undoubtedly the nature of the coal has a material bearing on this factor.

It is certain that no process will produce from these low-temperature tars, oils suitable for creosoting timber, or for the usual purposes for which coal-tar creosote is used. New uses must, therefore, be found for these products. Fischer and his co-workers have claimed that they possess lubricating properties, but little can be hoped for commercially in this direction, and new outlets must be obtained.

Asphaltic material. This term was used, in the absence of a better, for hydrocarbon materials which were insoluble in light petroleum, but which fall into none of the groups of products which have been isolated.

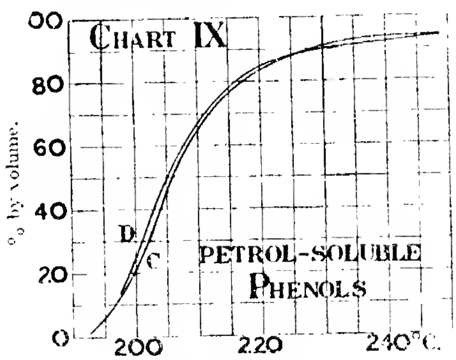
The two asphaltic residues found in tar D were found to be impure, containing "ulmins" and acid-water-insoluble bases, but, after re-treatment, a definite product was obtained, which was easily and completely soluble in benzene, insoluble in light petroleum, only slightly soluble in ether, and insoluble in 94% alcohol. The material was very viscous, sticky and black. Distillation commenced at about 320°, but the temperature rose very rapidly until barely 10% had distilled at 360°. Some 50% of distillate was obtained, but this material appeared to have a phenomenally high coking temperature as the flask became red-hot, with only a film of coked material, while the remainder boiled quite steadily. The distillate was extremely viscous, the later fractions setting to a solid rubbery consistency. Sulphur compounds were present in quantity but decomposition was apparently surprisingly small. No phenols were produced in the distillation nor were ammonia or basic compounds present.

Owing to the difficulty of treatment, little more can be done with this material. It is noteworthy, however, that definite asphaltic compounds have only been obtained from tar D, which shows definite signs of high-temperature products; all other materials provisionally termed asphalts found in Section II. were found to be mixtures and to contain

ttle or none of this product. It is probable that he production of this material is in some way linked p with the production of the aromatic compounds nd is a sign of high-temperature carbonisation.

It is certain that the presence of any large proporion of this material would give the pitch the peculiar roperties which renders high-temperature pitch f value. Little of this remarkably high-boiling nd stable series of compounds can ever be brought ver in ordinary tar distillation and any present must remain in the pitch.

Petrol-soluble phenols.—The steam-volatile phenols and the petrol-soluble phenols obtained from the esidual products were found to be composed almost ntirely of the homologues of phenol, and to contain no methoxyl compounds nor more than traces of ihydric or trihydric phenols. The phenols from ar C and tar D were substantially identical in boiling point, as shown in Chart 9. The actual constituents of this phenolic portion require further extensive



investigation, but little can be accomplished by the present known methods. There is evidence that this series of phenols constitutes the main bulk of the high-boiling blast-furnace tar acid of commerce, which is often stated to contain no homologues of phenol. The remainder consists of rhetinols, which appear to distil unchanged in the presence of phenol homologues.

Rhetinols.—This series of compounds is one of the most interesting products of this investigation. The product obtained after fairly thorough purification by alternate solution in ether, alcohol, alkali, and extraction with light petroleum, is a clear, dark, very sticky, resinous substance, d^{15} 1·115, bright orange-brown in colour in thin layers, with no definite melting point, softening at about 30° and melting to a thick sticky liquid below 100°; it is completely soluble in ether, alcohol, and most organic solvents, but completely insoluble in water and almost completely insoluble in light petroleum and carbon tetrachloride. The product retains "ulmins" most tenaciously, and the purified product so far obtained does not appear to be completely free from this impurity. The purified product is practically tasteless, and has only a faint tarry odour. It is insoluble in solutions of alkali carbonate and bicarbonate, easily soluble in weak caustic alkalis, giving a clear brown solution which foams on agitation. This characteristic is most noticeable. An alcoholic solution gives only a slight brown coloration with ferric chloride; chloroform and alkali gives no colour reaction, while the Liebermann test for phenols and the Liebermann-Storch reaction given by colophony and resin acids give negative results. Bacteriological tests appear to indicate a disinfectant value rather greater than that of tricresol.

The rhetinols can be sulphonated smoothly with ordinary concentrated sulphuric acid, a moderate temperature being developed on mixing, and the sulphonated product is soluble in water, the solution precipitating gelatin solution.

Addition of potassium ferricyanide to the alkali solutions of these rhetinols produces brown, amorphous precipitates, soluble in pyridine, and generally, as far as can be at present ascertained, identical with the "ulmins" obtained from the tars. On sulphonation these artificial "ulmins" do not produce completely water-soluble compounds, thus differing from those prepared by Marcusson, who thus distinguishes between artificial "ulmin" products produced from tars and natural products from coal. There would also appear to be some evidence that, on standing (and also possibly by the action of reagents), the rhetinols are gradually converted into "ulmins" Owing to the great difficulty of complete purification, judgment on this point must be suspended They absorb bromine rapidly, giving dark amorphous products.

When distilled at atmospheric pressure, the rhetinols commence boiling at about 300°, with decomposition into water, homologues of phenol, aromatic hydrocarbons, and pitchy residues, with at least 40% of the rhetinols passing over apparently unchanged. At 11 mm. pressure the decomposition still takes place. The product could therefore not be purified by distillation. The rhetinols appear to be the intermediate stage between "ulmin"-like compounds in the coal and the homologues of phenol, and the first stage of the process is one of reduction. Distillation of the "ulmins" from the tars, or of the artificial "ulmins" alone, does not appear to produce either rhetinols or phenols. A distillation at atmospheric pressure through a 4-pear fractionating column, keeping the top of the column at 300°, and re fractionation and separation of the distillate, gave 4% of water, 12—15% of homologues of phenol, 7% of neutral oils, and over 50% of a very brittle pitch. Even under these conditions some 25% of the rhetinols distilled unchanged. The distillate contained in abundance the substances producing the crimson colour with alkali, the alkaline solution becoming intensely crimson. The rhetinols were free from any trace of this material; there is, therefore, no escape from the conclusion that this colour-producing material is a product of decomposition of the rhetinols, and its absence from any distillate is due either to the absence of rhetinols or to the presence of sufficient homologues of phenol

to permit little or no decomposition of rhetinols during distillation.

Ammonia and hydrogen sulphide were given off during the distillation, and nitrogen was present in the rhetinols. This may be present as an impurity only, but ordinary bases were eliminated in the purification; none the less, purification is extremely difficult and judgment must be reserved.

The complete decomposition of the rhetinols is very difficult. A plain distillation commences at 290°—300°, and the temperature rises steadily, whilst the distillate may amount to two-thirds of the original material. This again decomposes on distillation, but decomposition is slow owing to the formation of mixtures of undecomposed rhetinols and the decomposition products.

The pitch produced is extremely brittle, insoluble in caustic alkalis, soluble in pyridine, but only yields traces to ether. The ether solution has, however, a brilliant yellow green fluorescence.

The homologues of phenol produced are typical products. Phenol is present in small quantity, but the main part appears to be composed of the homologues boiling between 210° and 240°.

A distillation of the phenols obtained from the foregoing experiment gave the following results:—b.p. 200°, volume boiling up to 210°, 7%; 215°, 20%; 220°, 47%; 225°, 60%; 230°, 75%; 240°, 83%; 245°, 94%. Phenol was detected in the aqueous portion of the distillate, and the results of distillation show that the homologues of phenol produced by destruction of rhetinols resemble those present in low-temperature creosotes. It is therefore probable that the latter have been formed in this way. The hydrocarbons produced were definitely aromatic in character and were of low boiling point, resembling the lower fractions of high-temperature creosote. The quantity obtained was insufficient for further investigation, and the foregoing results and findings may be subjected to modification in future work on larger quantities. As stated previously, purification is most difficult, and there is very strong reason to believe that the product is unstable on keeping, "ulmins" being apparently produced on standing. There would also appear to be a close affinity between the rhetinols and the acid-water-insoluble bases.

During the purification of the rhetinols a small quantity of light brown, amorphous, "ulmin"-like material was obtained which differed from that previously dealt with, in being completely soluble in aqueous caustic soda and cold alcohol. Sodium carbonate solution dissolved only traces on boiling. This material would appear to be similar to the products classed under the term "ulmic acid," but again, a close examination will be necessary before any definite statements on the point can be made.

The presence of rhetinols and of the residue from decomposed rhetinol, together with the large percentage of "ulmins," is probably the main cause of the brittleness of low-temperature pitch, and not a large proportion of paraffins as suggested by Marcusson. In the author's experience the presence of paraffins does not give the glass-like, brittle pitches given by the tars worked upon.

The importance of these rhetinols cannot be overestimated. There is no evidence that such products are present in the coal, but they are undoubtedly a half-way stage between some primary coal constituent and the homologues of phenol found in coal tar. The author desires to reserve the further investigation of these substances to himself and his colleagues.

"*Ulmins.*"—Under this description have been put all the brown amorphous substances insoluble in ether or petrol but soluble in pyridine, which have been obtained in quantity from the tars. The author has used the term "ulmin," inasmuch as the materials described in the literature as "ulmins" appear to coincide in general characteristics with the material obtained, but it is not intended to suggest that the "ulmin" is identical with that obtained from coal.

The "ulmins" obtained are brown, amorphous substances insoluble in water, petrol, or ether, but partially soluble in chloroform, boiling alcohol, and benzol; completely and easily soluble in pyridine, phenol and its homologues, and rhetinols. In their characteristics these materials closely resemble the material extracted from coal with pyridine and are undoubtedly Marcusson's "tar resins."

The "ulmins" are readily sulphonated, dissolving quietly in sulphuric acid to a dark red-brown solution. The sulphonated product does not dissolve completely in water, a light flocculent substance separating from an apparently colloidal solution, which foams on shaking. The "ulmins" themselves are insoluble in caustic alkalis, and boiling does not give even a colloidal suspension. Extraction with solvent showed that the products obtained were by no means homogeneous, hot alcohol extracting a portion, benzene a further quantity, and, generally, even on this section, much investigation is necessary before coming to any definite conclusions.

Acid-water-soluble bases.—These bases were of the usual type of high-boiling coal-tar bases, possessing the normal basic odour and dissolving in aqueous acids to orange-coloured solutions. The proportion of secondary bases was high, and primary bases seemed to be absent. No detailed examination has yet been possible.

Acid-water-insoluble bases.—These compounds are very remarkable, apparently forming salts insoluble in water. The purification of the material obtained in the examination was attempted by re-solution of the basic material in benzene and re-precipitation with dry hydrogen chloride. The precipitated material was dissolved in alcohol and the ever-present traces of "ulmins" removed, and the alcohol-soluble material dissolved in ether, after warming with alkali. From ether, dilute hydrochloric acid removed the bases as a very voluminous, gelatinous precipitate which emulsified the layers of ether and acid, so that dry hydrogen chloride again was used as precipitant. Very serious losses occurred in this attempt at purification and it would

appear that the product is extremely unstable. The purified product was a practically solid, resinous substance, d^{15} 1·14, soluble in ether, from which it was removed almost entirely by aqueous hydrochloric acid as a brown, flocculent precipitate which passed, on warming, to a black, resinous mass, practically insoluble in water. On distillation the purified free base began to boil at 280° and the temperature rose rapidly to over 400°, about 50% only distilling, the remainder being pitch. The distillate, which was orange in colour and viscous, appeared to consist almost entirely of acid-water-soluble bases of very complex character. Ammonia was not detected during the distillation, which would tend to show that the ammonia produced by distillation of the rhetinols was not due to admixture of this material. Better means of purification are being sought, when larger quantities of material become available for further examination. The existence of these bases affords, no doubt, an explanation of the low yield of ammonia and nitrogeneous bases of the usual type in low-temperature tar work. The material undoubtedly remains undecomposed in the pitch, and assists in rendering it brittle. No use can, at present, be seen for this material.

Carboxylic acids.—The purified products were brown resinous solids with a peculiar coconut-like odour. Slight signs of crystallisation were occasionally observed, but the crystals were soft and resinous, and could not be produced at will, or in a form suitable for purification. A minute quantity of flat, needle-shaped crystals was obtained by sublimation, but beyond negative tests for benzoic, salicylic, and allied acids, little could be done, as the total quantity was less than 0·1 g.

The acids appeared to have a strong resemblance to the resin acids, being soluble in ether and alcohol, but insoluble in light petroleum and carbon tetrachloride, even on boiling. The Liebermann-Storch reaction for abietic acid gave a negative result. The analytical constants obtained were as follows :—d^{15}_{15}, 1·22 ; mean mol wt. (calculated from neutralisation value to phenolphthalein), 227 ; iodine value (Wijs, 8 hours), 113. The specific gravity is extremely high and the iodine value agrees very closely with that calculated on the basis of the acids containing only one double bond. The product obtained differs entirely from that obtained by Marcusson, who considers his material to resemble humic acids. The material from these investigations resembles more closely the natural resin acids, particularly those semi-liquid acids present in rosin oil obtained by dry distillation of colophony.

V. General Summary.

1. The hypothesis that low-temperature tars closely resemble blast-furnace tar is shown to be substantially correct.

2. The tar produced by carbonisation of bituminous coal in continuous vertical retorts is also shown to be mainly the product of low-temperature carbonisation, and, although there may be present certain amounts of aromatic products, the general character of the tar is that of a low-temperature tar, and the products obtained by ordinary distillation have all the bad qualities of blast-furnace products.

3. Ordinary distillation of low-temperature tar produces products which are of low value, with the exception of high-boiling tar acid and fuel oil.

4. The method of plotting the gravity of successive fractions against the mean boiling point is valuable, in showing the presence of aromatic compounds, such as naphthalene, and also in the examination of the phenolic compounds.

5. The examination of tars by the solvent method, while full of pitfalls, shows a close similarity in composition of the four tars examined, and that the type of coal carbonised affects the respective proportions of ingredients, but the process of carbonisation is only important when carbonisation is carried out in a large volume of gas, when the lower-boiling products are washed out of the tar.

6. Low-temperature tar is shown to contain the following groups of products :—

(*a*) Ulmin-like substances, insoluble in ether, soluble in pyridine and phenols.

(*b*) Neutral oils, distilling up to and above 400°, containing paraffins, naphthenes, and aromatic compounds, but mainly consisting of highly unsaturated hydrocarbons.

(*c*) Homologues of phenol, with a new class of phenols (rhetinols) resinous in character and possibly containing nitrogen, distilling with decomposition at and above 300° but forming binary mixtures with phenol homologues in which the rhetinol distils unchanged.

(*d*) Basic materials of novel character, combining with acids to give salts insoluble in water.

(*e*) Much smaller quantities of carboxylic acids of a resinous character , pyridine and quinoline type bases ; traces of ether-insoluble bases, and of substances resembling ulmic acids.

7. The presence of tar resins and carboxylic acids claimed by Marcusson is confirmed, and the results of Tropsch are shown to be low, probably owing to the solubility of the ulmins in other constituents.

8. The absence of alcoholic compounds of the type found by Pictet and Bouvier is in agreement with the results of other workers.

9. The presence of pyrocatechol, α- and β-naphthol in the tars is in conformity with the results of Continental workers, but is of no technical value, as the quantity is too small.

10. The phenolic constituent of the creosotes produced from these tars is a mixture of homologues of phenol and undecomposed rhetinols. The statements that these phenols contain guaiacol and other methoxyl compounds, polyhydric phenols or diphenyl compounds, are definitely disproved. The

term "phenoloids" is unsound and should be abandoned.

11. The production of the colouring matter present in many of these creosotes is shown to be caused by destruction of the rhetinols during distillation, and the substance is probably either a condensed phenol compound present in a leuco form or a coumarone derivative.

12. The presence of asphaltic substances is definitely proved in tar D. It is doubtful whether such substances exist in true low-temperature tars.

13. The rhetinols are demonstrated to be an intermediate stage in the production of phenol and its homologues from some coal constituent, and it is suggested that the production of rhetinols is a reduction process from ulmin compounds, as oxidation of rhetinols produces ulmin substances.

14. The acid-water-insoluble bases are suggested as a similar intermediate stage to ammonia and pyridine bases.

15. The specific gravity of the raw tar is no guide to temperature of carbonisation, and Fischer's limits of 0·95–1·06 are incorrect.

16. The observations of Maclaurin are confirmed, but it is shown that his methods are incomplete, and give mixtures of products.

17. The production of orange-red viscous oils by Fischer and Glund is confirmed, but the value of the product is doubted.

18. The absence of any products of known technical value, particularly phenol, is abundantly proved, and it is clearly shown that the high value placed on low-temperature tar is not justified on present knowledge.

19. Owing to the difficulty of purification, no quantitative figures on single solvent treatment are of value, and no product can be taken as homogeneous without extensive purification. Much of the laborious chemical examination and ultimate analyses published are valueless for this reason, and the author has deliberately refrained from attempting such, until much more thorough purification can be accomplished.

20. The danger to the chemical and technical industry of what is termed "unintentional" low-temperature carbonisation is clearly demonstrated. No treatment of tars such as tar D will produce satisfactory materials for the purposes for which high-temperature tar products are at present used, and no technical use can yet be found for the main bulk of this type of tar.

The author intends to continue the investigation of the products obtained; he considers that an examination of high-temperature tar by the same methods will be of value, and proposes to include such an examination in future work.

As far as possible, every care has been taken to keep within the facts, and possibly the author has been over-cautious in interpreting and in drawing deductions. It is felt very strongly, however, that there have been far too many hypotheses and loose statements published in connexion with the subject, and, in view of the complexity of the problem as demonstrated so clearly in Section II., nothing but laborious and painstaking ground work will give a clear view of the problem to be solved, and, until the main facts are laid bare, the isolation of traces of easily found constituents, and the chemical investigation of unidentified mixtures, is confusing the issue and not adding anything to knowledge.

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TRANSACTIONS

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THE UTILISATION OF LOW-GRADE AND WASTE COALS IN POWER PRODUCTION.*

BY W. S. COATES.

A low-grade coal is one which is difficult to burn in a boiler furnace, and has a relatively low heating value. A waste coal is not necessarily low-grade. Its calorific value may be high, but owing to the large proportion of dust in it, it cannot command a high price. Some examples of these coals are given below:—

(1) *Duff* is the name given in Scottish, North of England, and certain Welsh collieries, to the poorest qualities of coal, generally in a fine state of division, obtained during dry screening. The name "smudge" is given to the same coal in Yorkshire and Midland collieries.

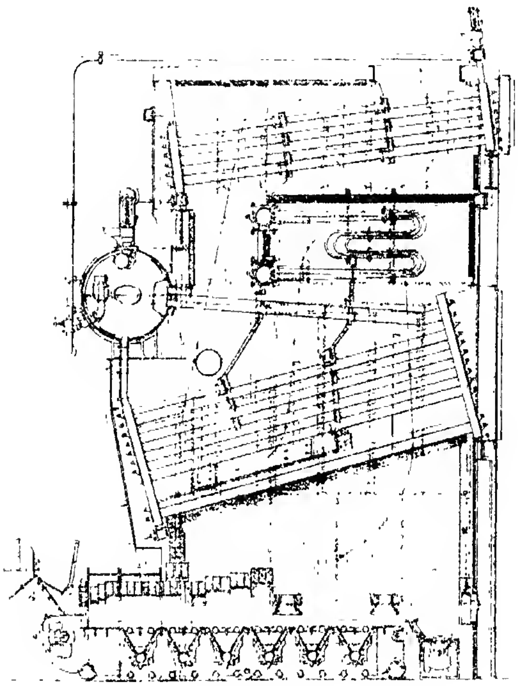

Fig. 1.

(2) *Splints* is a cannel coal which has a characteristic slatey structure, and decrepitates on heating. It yields a gas of high illuminating power by destructive distillation, and was formerly used in conjunction with gas coal for gas making. The coke does not "bind," but retains the original shape of the coal, and partly for this reason it is difficult to burn on a chain grate.

(3) *Bands*, the strata lying between the coal seam proper and the rock.

(4) *Pond duff* and *washer slurry*, the fine dust removed from the coal in the washing plant. The moisture content is exceptionally high and may reach 30%.

(5) *Rough smalls* is that coal, obtained during single screening, which passes through a $\frac{5}{8}$-inch screen. It generally contains therefore a relatively high proportion of fine slack and it is not unusual for 40–50% to pass through a $\frac{1}{4}$-inch sieve.

(6) *Dross*, is the name given to fine slack in Scotland.

(7) *Culm* or *gum* is the fine slack from anthracites.

A section through a Babcock and Wilcox water-tube boiler fitted with compartment type stoker and superheater, is shown in Fig. 1. The space occupied by the boiler tubes and economiser tubes (which are inclined at 15° and 8° respectively with the horizontal) is divided into three passes by horizontal and vertical baffles, the path of the hot gases through these passes is shown by the arrows. The steam generated in the boiler tubes rises together with the water, to the high end of the rear headers and is conveyed along the horizontal tubes to the front drum in which the steam is liberated. The water returns to the boiler tubes through the short tubes connecting the front headers to the drum. The steam is conveyed to the superheater (which is located at the top of the first and second boiler passes) by the dotted pipe, and it leaves the unit at the top superheater box.

The furnace.

Generally speaking it is much more difficult to consume completely the "volatile matter" evolved during the combustion of the coal, than it is to burn the carbonaceous matter in the coke.

The complete combustion of the hydrocarbon gases (methane, ethane, ethylene, benzene, etc.) presents no difficulties provided that there is an adequate supply of oxygen, that the temperature is above the ignition point (*i.e.*, at least about 1500° F. or 815° C.), and that combustion is completed before the cooler portions of the boiler are reached. The higher the proportion of the more complex hydrocarbon gases, the longer is the flame produced and therefore the more combustion space is required to prevent contact of the flame with the comparatively cool boiler surface.

The complex heavy hydrocarbons which are present in the tarry vapours are much more difficult to burn, partly because of the higher temperatures required for the reaction between them and oxygen, and partly because at the high temperatures existing in the furnace they may break down, free carbon

* Read at a meeting of the Newcastle Section on Nov. 28, 1923.

and much more complex substances being produced, which require still higher temperatures for complete combustion. If, therefore, the temperature of the reacting gases is lowered to a point below which the reaction cannot take place, black smoke results and passes through the boiler accompanied, in the majority of cases, by unburnt hydrocarbons and carbon monoxide. This chilling may be caused by flooding the combustion chamber with a large excess of cold air or by allowing the flames to impinge on the cool surface of the boiler tubes. When black smoke is formed it cannot be consumed in the boiler, no matter how much oxygen is present, because the existing temperature is much below the ignition point of the combustible matter in the smoke. The absence of black smoke does not necessarily indicate complete combustion, because carbon monoxide and other combustible gases may escape unaccompanied by carbon. The only satisfactory way to ensure complete and smokeless combustion is to maintain as high a temperature as possible in the furnace, an adequate supply of air for the reaction (though not in excessive quantities), and intimate mixture of the air with the combustible gases. The average speed of the gases through the combustion chamber may reach 20 to 30 feet per second at full rating, and up to 6 cb. ft. of volatile matter may be distilled off per pound of coal. Only a fraction of a second, therefore, is available in which the reaction takes place. If, however, an insufficiency of air is present for the tarry vapours, they may pass through the boiler unconsumed and a brown smoke will be emitted at the chimney. Brown smoke is, therefore, indicative of greater fuel losses than black smoke.

The foregoing remarks lead to the conclusion that the higher the proportion of volatile matter in a coal, the more difficult is smokeless combustion. In fact, it is found in practice that it is very difficult indeed to burn completely fuels containing more than say 27% of volatile matter. The famous Welsh steam coals contain between 10 and 15% of volatile matter and little ash; they are free-burning coals, that is to say the volatile matter distils off and is ignited at a comparatively low temperature, and are quite easily consumed without smoke formation. Generally speaking, so long as a coal is free-burning, the lower the volatile content the easier is smokeless combustion.

Induced draught is generally sufficient to consume completely a good grade of bituminous or semi-bituminous coals—that is, coals, free from slacks, of which the calorific value is above, say, 11,000 B.Th.U. per pound, the ash content is not high, and the volatile matter is such that ignition of the coal is easily obtained. Such coals generally swell and cake to some extent, and the resistance to the flow of air through the fuel bed which is thus set up brings about a thorough mixing of air and fuel. Under induced draught conditions, the fan has the double function to perform of drawing the air supply through the fire and of pulling the products of combustion through the boiler. It has been found, however, with certain classes of inferior coals having a calorific value below 11,000 B.Th.U. per pound, and a high ash and low volatile content, and especially if the proportion of slacks is high, that complete combustion is more easily obtained by assisting the air supply through the fuel bed. The "balanced draught stokers" have been designed with this end in view. In large power stations the bunker coal is of necessity a mixture of several classes of fair and low grade qualities, and it is often advantageous to be able to use either induced or balanced draught at will.

Fig. 1 shows a longitudinal section of the latest design of "compartment type" balanced draught stoker of Messrs. Babcock and Wilcox, Ltd. The quantity of coal burnt per hour is controlled by varying the speed of the grate by means of the eight-speed epicyclic gear-box interposed between the main drive and the grate drive, and also by varying the thickness of the fuel-bed by means of the guillotine door in front of the furnace. Closing-in doors are fitted to the stoker front, and by means of a forced draught fan, an undergrate air supply is fed into boxes mounted between the upper and lower portions of the grate. The air leaves the boxes through a number of narrow openings of variable width. The boxes are so proportioned that the air supply under each two feet length of the grate is under control. When these openings are wide open and the air pressure is suitably adjusted, a balanced draught is obtained at the fuel bed. The boiler can be operated as an induced draught installation, when the closing-in doors are open and the forced air supply is cut off.

A stoker which has been designed for burning fuels with a high volatile content, and such waste fuels as washer slurry which are high in moisture, is the Class E underfeed stoker manufactured by the Underfeed Stoker Co. This is shown in longitudinal and transverse sections in Figs. 2 and 3. C (Fig. 2)

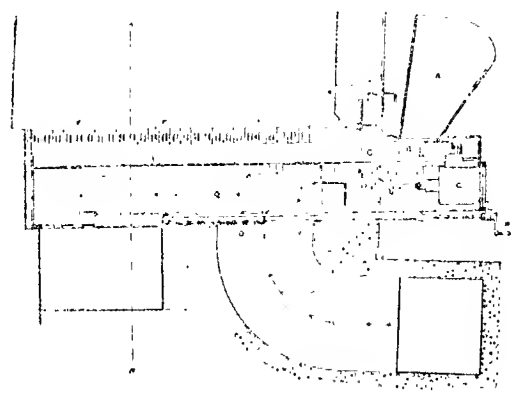

FIG. 2.

is a steam motor, the piston of which actuates simultaneously the sliding bottom, E, of the coking-retort, and the coal ram, B, which drives the coal into the retort from the bottom of the hopper, A. The coal is thus carried to the back end of the furnace and is forced to rise in the retort, ultimately overflowing on to the hollow grate bars, F, which are alternately fixed and moving. The moving bars work trans-

rsely to the retort, and receive their motion from e rocking bars, H, shown in Fig. 3. The clinker deposited on the dumping bars, K. The air supply ters the box, Q, below the coking-retort and part it passes through the openings, R, where it mixes th the volatile matter as it passes upward through

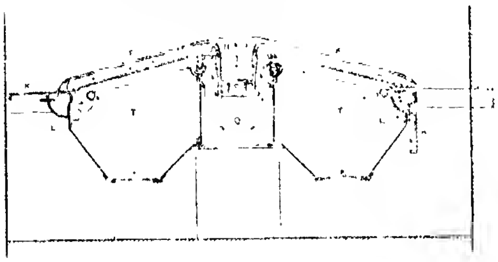

FIG. 3.

the incandescent fuel, the temperature of the reacting gases being therefore very high. The remaining air is heated on passing through the bars, F (which are thus kept cool), into the hot air chamber, T. From here the air rises and passes through the small spaces between the bars into the coked fuel.

Combustion of the carbon in the coke.

The reaction between carbon and oxygen has been studied by many chemists for over 100 years, but even to-day its mechanism is not clearly understood. At least two facts, however, appear to be established: (*a*) that whatever may be the conditions under which carbon and oxygen interact, both carbon monoxide and carbon dioxide are always produced; (*b*) that perfectly dry carbon dioxide is not reduced by perfectly dry carbon, even at bright red heat. It would appear, therefore, that no matter how excessive may be the air supply passing through the incandescent coke on the grate, carbon monoxide is always present in the gases above the coke, and therefore an adequate supply of oxygen above the grate, that is, in the combustion chamber is vital. The fact that perfectly dry carbon dioxide and carbon do not yield carbon monoxide, even at high temperatures, shows that water vapour plays a large part in the reactions taking place on the grate, but the rôle of the water vapour is, at present, unknown. Water vapour is always present in the air passing through the grate, and water is also present in the coal. Hence, if any carbon dioxide is produced in the lower layers of the incandescent coke it will be reduced to carbon monoxide as it passes through into the upper layers, the amount of carbon dioxide so reduced being dependent on the prevailing conditions. Above red heat carbon and carbon dioxide react under normal conditions, in accordance with the equation, $C + CO_2 = 2CO$, but, at the same time, some of the monoxide dissociates into carbon and carbon dioxide. Hence, a reversible system seems to be set up which may be expressed, $C + CO_2 \rightleftharpoons 2CO$. It will be noticed that an increase in volume occurs when the reaction proceeds from left to right; therefore a decrease in pressure at any given temperature would result in an increase in the equilibrium proportion of the monoxide, and *vice versâ*. The dissociation of carbon monoxide being an exothermic reaction, it is evident that an increase in temperature at any given pressure would favour the formation of the monoxide. This reversible system has been studied by Rhead and Wheeler, who found that the velocity of the reaction between carbon and carbon dioxide at any given temperature is many times faster than that at which carbon monoxide dissociates at the same temperature. The findings of Rhead and Wheeler may be summarised thus, the combined pressures of the gases being one atmosphere:—

	Relative percentages of	
Temperature, °C.	Carbon dioxide	Carbon monoxide
850	6.2	93.8
950	1.3	98.7
1050	0.4	99.6
1200	0.06	99.94

It is not implied, however, that whatever the temperature of the fuel bed may be, the above proportions of monoxide and dioxide corresponding to that temperature will be found in the gases as they leave the fuel bed. These results lead to the conclusion that the larger proportion of such gases is carbon monoxide, but there does not appear to have been much work done on the analysis of the gases immediately above the fuel on a chain grate.

The combustion of 1 lb. of carbon to the dioxide is accompanied by a heat evolution of about 14,600 B.Th.U., whereas only 4400 B.Th.U. accompanies the combustion to the monoxide. A direct loss thus results of over 10,000 B.Th.U. per lb. of carbon incompletely burnt. The importance of an adequate air supply above the fuel bed is, therefore, evident, and it is of equal importance to ensure thorough mixing of the air supply with the combustible gases. The best practical method of achieving this is the avoidance of thin places in the fuel bed and of bare wings and dumping bars, since the incoming air will take the lines of least resistance and in all probability pass straight through the combustion chamber and into the flues.

An efficient furnace is one in which as much as possible of the energy in the coal is converted into heat. The chief losses are:

(1) The heat carried away by the nitrogen present in the air required for combustion, which cannot of course be avoided. Although the difficulties seem to be insurmountable at present, a probable future development will be the enrichment with oxygen of the air supply to the furnace. The nitrogen : fuel ratio will thus be reduced, and much higher rates of combustion will be possible.

(2) The heat carried away by excess air over and above that required for combustion. It is impossible to burn any fuel with the theoretical air supply; at least 25% over and above this is required when burning coal on a grate. The actual excess required depends entirely on the characteristics of the coal and cannot be calculated. That air supply is adequate which will burn the coal with the production of the highest amount of carbon dioxide in the flue gases, unaccompanied by combustible gases.

If carbon could be burnt with the theoretical air supply, the gaseous products would contain 21% of carbon dioxide. The average semi-bituminous

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coals contain 3—4% of hydrogen, and the gaseous products obtained by burning these in the theoretical air supply would contain 18·5% of carbon dioxide. It should be possible to obtain 14% of carbon dioxide in the waste gases after complete combustion of a coal of fair quality, this representing about $(18{\cdot}5/14 - 1) \times 100\%$ of excess air, that is, slightly over 30%. With a low-grade coal like duff, it is almost impossible to obtain complete combustion with more than 10—11% of carbon dioxide. This represents 85% and 70% of excess air. By exercising careful control over the furnace, this excess air can be kept at a minimum, but it cannot be eliminated.

(3) The sensible heat in the ash and clinker cannot be recovered, and fortunately it is not high. Very heavy losses may, however, be incurred by the imprisonment in, or absorbtion by, the ash of carbonaceous matter. The fusion temperature of ash varies considerably, but is generally between about 2000° and 2800° F. (1095° and 1540° C.), being usually lower in a reducing than in an oxidising atmosphere. If the ash softens during its passage through the furnace, absorption of carbon by it is inevitable, thus effectively preventing combustion of that carbon. Pieces of coke may also be imprisoned in the clinker and consequently would be isolated from the air supply. If a coal contains 25% of ash and the ash contains 20% of combustible matter, a direct loss of $(20/100) \times 25\%$ or 5% of the coal is incurred: this loss is difficult to avoid when the ash has a low fusion point.

A high furnace temperature is essential for high efficiency. This is obtained by burning the fuel completely at as high a rate as possible, with as little excess air as possible. With fuels containing much volatile matter, higher rates than 25—30 lb. of coal per square foot of grate area per hour cannot, generally speaking, be maintained without the production of smoke.

Some fuels are met with which are not free-burning although they may contain over 15% of volatile matter. These can only be consumed completely under forced draught, whereby a more thorough mixing of the fuel and air supply is obtained.

The compartment type balanced draught stoker shown in Fig. 1 may be used for these fuels. If the openings of the forced air boxes are made narrow, the undergrate air supply leaving them, is divided into many streams travelling at a high velocity. The air pressure requires to be increased over that necessary for balanced draught conditions, but the narrow openings obviate too large an excess of air passing through the fuel bed. The effect is, in fact, similar to that on a blacksmith's forge.

It has been found advantageous to wet a coal containing much duff or slack. The actual effect of this wetting is not clearly known, but in spite of the loss entailed in evaporating the added water, the following facts indicate the benefits which are obtained: A higher percentage of carbon dioxide in the flue gases and consequently a higher furnace temperature; an increased fuel consumption per square foot of grate area; less combustible matter in the ash and clinker, which is more friable and easier to handle; a more uniform density of the fuel bed, with consequently a more even distribution of the air throughout it.

When burning low-grade coals the furnace temperature is never as high as when burning better coals, partly owing to the lower calorific value of the former and also to the greater excess air required for complete combustion.

The boiler.

The transmission of heat from the fire to the absorbing surface takes place in two ways: by direct radiation from the incandescent fuel on the grate and from the flame in the combustion chamber, and by convection and conduction through the water tubes from the hot gases traversing the boiler passes.

Radiation.—Probably the larger proportion of the heat absorbed by the boiler is radiated to it, the energy so received by the gas side of the water tubes being conducted by them, as sensible heat, to the water on the other side. Stefan found that the amount of heat radiated from an incandescent "black" body, that is one with a dull surface, is proportional to the fourth power of its absolute temperature. The value of this law from a furnace operating point of view is exemplified by the case of two furnaces, the temperature of one being 2500° F. (1370° C.) and of the other 2700° F. (1480° C.). The latter furnace theoretically radiates more heat than the former in the ratio of nearly 1·3:1, that is to say, that increasing the furnace temperature by 200° F. from 2500° F. results in about 30% more heat being radiated to the absorbing surface. Hence the supreme importance of maintaining as high a furnace temperature as is consistent with complete and smokeless combustion.

Convection and conduction.—If the opposite sides of a steel plate 1 in. thick and 1 sq. ft. area are maintained at a constant temperature difference of 1° F., 450 B.Th.U. will be conducted through the plate, at a uniform rate, per hour. If the temperature difference is $d°$ F. and the thickness of the plate is t in., the amount of heat passing through each square foot per hour will be $450d/t$ B.Th.U. If the temperature on the gas side of the water tubes in a boiler is 1600° F. (870° C.), and on the water side is 500° F. (260° C.), the amount of heat passing through a 3/8-in. thick steel plate will be $450 \times 1100 \times 8/3 = 1{,}320{,}000$ B.Th.U. per square foot per hour, which is equivalent to an evaporation of $1{,}320{,}000/970$, or nearly 1400 lb. of water per square foot of heating surface per hour. In actual practice, between 5 and 6 lb. of water are evaporated per square foot per hour. This enormous difference is explained by the presence of a non-conducting gaseous film on the gas side of the water tube and of a water film separating the water from the tube on the other side. It has been found that a better heat transmission is obtained by maintaining a high velocity of the hot gases and also by causing them to flow at right angles to the tubes rather than along them. The object of the horizontal and vertical baffles in a water-tube boiler is thus explained. The above calculation also shows that the material of which the tubes are made and the

thickness of the plate make little difference to the heat transmission.

Owing to the fact that the waste gases leave the boiler unit at a higher temperature than the air supply enters it, a certain proportion of the heat in the coal is lost, which is roughly $100t/T\%$, where $t°$ F. is the temperature of the gas and $T°$ F. the temperature of the furnace. The temperature of the gases leaving the boiler itself cannot be lower than the saturation temperature of the steam; thus, in the case of a boiler working at 250 lb. pressure, the temperature of the gases cannot be lower than 420° F. (216° C.). In practice the gas temperature is always much higher than the saturated steam temperature. Some of this heat is, however, recoverable either in water economisers which preheat the feed water entering the boiler, or in air heaters which preheat the air-supply for the combustion of the coal.

Any factors, therefore, which result in a poor heat transmission through the boiler heating surface and give rise to too high waste-gas temperatures (such as scale or dirt on the tubes or short-circuiting of the gases between passes owing to faulty baffles) will lower the efficiency of the unit.

Another source of loss which should not be overlooked is the dissipation of heat from the boiler walls and the steam piping. The latter can be cheaply and efficiently lagged with a preparation of magnesia and asbestos. An ideal boiler casing would be a thick brick wall lined with white glazed tiles on the outside; this would, of course, be much too costly in practice. Modern practice is to enclose the boiler in a double steel casing; the annular space contains stagnant air which is an effective heat insulator. Those boilers which are encased in brick walls should be thickly tarred on the outside to prevent the infiltration of air as far as possible.

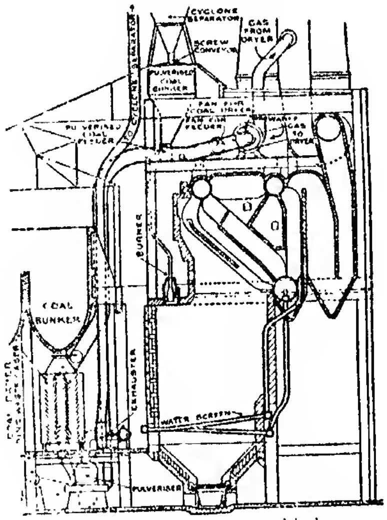
Pulverised fuel.

Pulverised fuel is not used extensively in this country for steam raising purposes, but during recent years rapid strides in this direction have been made in America and on the Continent, and successful results obtained. So far as our present experience enables us to judge, low-grade fuels can be efficiently utilised under boilers by pulverising, mixing with the necessary air, and burning the mixture under the same conditions as a gaseous fuel.

The very large surface area of the coal-dust ensures such an intimate mixture with the air supply that combustion is completed with a much smaller excess of air over that theoretically required, and a much lower content of combustible matter in the ash than is obtained with chain grate stokers.

It is only intended here to outline very briefly the two general systems which are adopted, illustrating one example of each.

In the "central system," which is generally adopted in large installations, the coal required for a number of boilers is prepared in a central pulverising plant. The powdered coal is stored in bunkers and conveyed to each boiler through a pipe line by a screw-conveyor or other suitable means, and is finally blown into the furnace as a cloud in the necessary air-supply for combustion, by means of a fan. Damp powdered coal has a tendency to cake rather than to flow easily, and for this reason it is usually necessary to reduce the moisture content of the original coal to 2 or 3% by drying in a current of hot air. Unfortunately, the drying plant adds considerably to the cost of the installation. The latest arrangement of the "Lopulco" system of the Underfeed Stoker Co., Ltd., is shown in Fig. 4. This installation is at



"Lopulco" system of pulverised fuel.

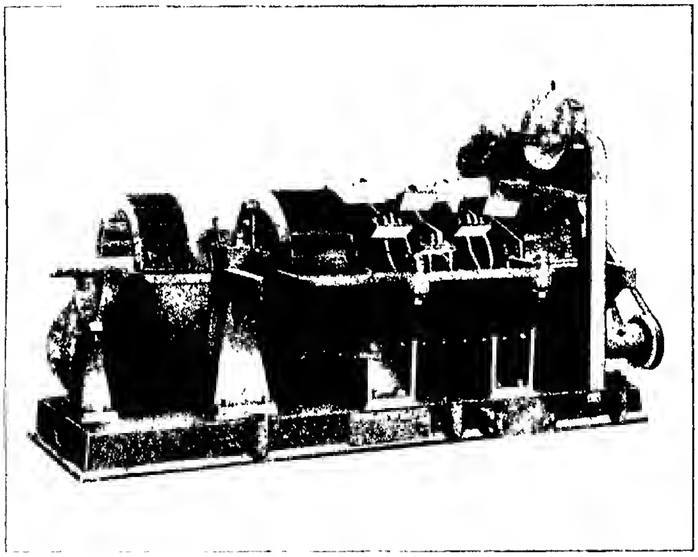
FIG. 4.

present being erected for the Société Anonyme Union d'Electricité, at their Vitry Power Station, Paris. There will be four Delaunay-Belleville boilers, each evaporating 140,000 lb. of water with a coal consumption of nearly 6 tons per hour, at normal load.

The coal is dried, in a portion of the flue-gases, on its way to the pulveriser, where it is lifted by means of a plough and thrown between the rollers of Raymond mills. The pulverised coal is carried away in an upward current of air, supplied by the exhauster, to the cyclone separator. The coal settles in the storage bunker, the air returning to the pulveriser. There is, therefore, a closed circuit including pulveriser, exhauster, and cyclone separator, thus eliminating the danger of explosion in the boiler-house through the presence of fine coal dust in the air.

There are ten burners to each combustion chamber, the capacity of which is 12,000 cb. ft. above the water-screen. The primary air for combustion is already mixed with the coal when it enters the combustion chamber. The secondary air, which is preheated by passing through the hollow furnace walls, is admitted through ports in the front wall of the furnace.

In the "unit system" there is a pulveriser for each boiler furnace. No bunkers or pipe-line for the powdered fuel are required, and, generally, it is not necessary to reduce the moisture content of the coal below 10%. A typical plant is the "Turbo" pulveriser manufactured by the Powdered Fuel Plant Co., which is shown, with the top cover removed, in Fig. 5. It consists essentially of a steel-lined cylinder containing a high-speed shaft co-axial with it, on which are mounted (1) a fan which draws air through the cylinder, and (2) steel beaters so arranged as to divide the pulverising compartment into four sections. There is ample clearance between the beater tips and the steel lining. The coal falls on to a distributor which feeds it into the first section of the pulverising compartment, where it is violently agitated. The smaller coal is drawn through each section until fine enough to be discharged by the fan into the furnace. The larger coal lags behind, owing to the high centrifugal force, until it is small enough to be carried away. The fineness of the coal is therefore determined by the speed at which the air passes through the cylinder, which is under control. The second fan shown in the illustration is external to the pulveriser, and supplies the secondary air for combustion, which may be cold or preheated.



The Turbo-Pulveriser.
FIG. 5.

The presence of "tramp" iron in the coal is a source of danger to the pulverisers. If it is present in large quantities a magnetic separator is necessary, but adventitious pieces of iron are usually eliminated by some device peculiar to each plant.

The disposal of the ash produced when burning powdered fuel under boilers has proved to be a difficult problem. Neglecting the grit which is carried through the boiler, the ash may be discharged in either the liquid or solid state. Provided that the combustion chamber is not too large, the ash can be maintained above its fusing temperature and discharged in the liquid state. There is, however, a tendency for the liquid ash to flux with the brickwork if its temperature is too high, and, on the other hand, if the temperature drops the ash may yield a pasty mass which might choke the outlet, thus necessitating a complete shut down of the plant.

The combustion chamber may be built large enough to ensure the temperature of the lower portion being below the fusion point of the ash, which may thus be discharged in the form of dust or nodules. The combustion chamber shown in Fig. 4 is fitted with a water-screen which consists of a number of tubes connected to the boiler. This screen is an effective portion of the boiler heating-surface being subject to the radiant heat of the furnace, and the temperature in the ash chamber below it is always lower than the fusion point of the ash no matter what the operating conditions may be.

Some of the more evident advantages of pulverised fuel firing over combustion in a mechanical stoker are briefly thus:

(1) Higher boiler efficiencies are possible owing to the lower excess air required for complete combustion and to the lower proportion of the combustible matter left in the ash.

(2) During no-load periods the fuel can be cut off, thus eliminating banked fires and stand-by losses.

(3) Practically all grades of fuel can be easily burnt.

(4) The control over the furnace is much more exible, and the fires can be instantly adjusted r any desired boiler rating.

The thanks of the author are due to Messrs. abcock and Wilcox, Ltd., the Underfeed Stoker Co., td., and the Powdered Fuel Plant Co., Ltd., for eir generosity in lending the blocks used for lustrating this paper, and in supplying information.

Discussion.

Dr. G. Weyman said that the efficiency of the generation of electricity from coal was in any case very poor in comparison with other methods of power production and therefore too much attention could hardly be given to the subject. As Mr. Coates had pointed out, there were still available large quantities of low grade and waste coal which could be used for the purpose. It seemed that for several reasons the coal should be either carbonised or completely gasified and the products burnt afterwards in the boiler plant. The volatile matter in coal needed so large an excess of air and required so large a combustion area that high efficiencies were almost impossible. The smoke and burning gases obscured a considerable proportion of the direct radiation from the red-hot solid fuel, and it was very doubtful if the boiler actually received the amount of heat by radiation from the fire that was usually reckoned on. The boiler plants of to-day appeared to have been entirely designed in relation to the combustion of the volatile portion of the fuel and depended upon the flame heat and convected heat of the excess of air passing from the furnace, and it was, in fact, customary to direct radiant heat back on to the fire in order to obtain accelerated combustion of the volatile matter. If the volatile matter were removed and the solid fuel then burnt under the boiler, the boiler and furnace could be designed to take full advantage of the radiant heat and would certainly be smokeless and more efficient.

Prof. Briscoe pointed out that in the combustion chamber the flame itself radiated much heat. Whatever the theoretical explanation might be, the experiments of Nicholson showed that in an ordinary Lancashire boiler the greater proportion of the total evaporation occurred in the immediate neighbourhood of the furnace. Present practice in boiler furnaces represented a mere opportunist development of the ordinary kitchen range and employed a principle which was essentially unsound. The fuel bed in any ordinary furnace was both a gas-producer and a means, frequently the sole means, whereby secondary air was admitted to burn the gas produced. It was inefficient, irregular in action, and uncontrollable in both functions. Conditions which promoted formation of combustible gas hindered the supply of air to burn it, and *vice versâ*; so that it was difficult to attain and quite impossible to maintain, even approximately, a correct adjustment of air to combustible matter. Clearly it would be much sounder to make the fuel bed efficient as a gas-producer and relieve it entirely of the function of supplying air. It would then be possible, by means of properly designed ducts and adjustable ports distributing a single forced or induced air supply, to maintain a proper ratio between the primary air supply (which would be wholly used in the production of combustible gas and might receive a proper addition of steam to control fuel-bed temperatures) and the secondary air supply, which could be maintained, within a few per cent., at the rate required for complete combustion.

TRAVANCORE ESSENTIAL OILS.—II. *OIL* FROM THE LEAVES OF *CALAMINTHA UMBROSA*, BENTH.

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Preliminary note.

The herb from the leaves of which this oil was obtained grows wild in some localities, notably Veapuram, Ayur, in Travancore, and is locally known as Karimthumba (Malayalam *Kari*, black). The leaves and the root possess a strong, pleasant and camphoraceous aroma, due to the presence of an essential oil which does not appear to have been examined before.

A large quantity of the leaves was collected for the author in September, 1923, by Mr. I. C. Chacko, Director of Industries, and distilled with steam in an air-dry condition (moisture = 40%) in a large copper still, when a 0·35% yield, calculated on the dry leaves, of a light yellow oil possessing a strong, rather complex, but not unpleasant odour, was obtained.

The oil had the following characters: d^{27}_{4}, 0·8854; n_D^{27} 1·4760; $[\alpha]_D^{30} = -45{\cdot}2°$, acid value, 0·5; ester value, 15·9; ester value after acetylation, 40·7; aldehydes by the neutral sulphite method, 6·5%. The oil was insoluble in 80% alcohol, sparingly soluble in 85% alcohol (7·8 vols.), soluble in 90% alcohol (0·7 vol.).

In view of the low density and refractive index of the oil, the difficulty with which it dissolves, even in 85% alcohol, and the ester values, it would appear to consist mainly of hydrocarbons. Only 70 c.c. of the oil were available for the following investigation.

Fractional distillation.

The oil dried over anhydrous sodium sulphate was distilled under reduced pressure, first over a boiling water bath (fractions 1–3) and then rapidly over a free flame, and the following fractions were obtained.

TABLE 1.

No.	B.p.	Pressure mm.	Yield %	n_D^{27}	$[\alpha]_D^{30}$
1	to 80	26	20	1·4687	62·5
2	80–85	26	32	1·4685	−68·3°
3	Above 85	26	14	1·469[illegible]	−73·8°
4	105°–110	17	27	1·4900	5·2°
	Residue and loss (by diff.)	..	7	—	

Fractions 1, 2, and 3 would appear to contain the same compound. Fractions 1 and 2 were mixed and distilled repeatedly over sodium under atmospheric

pressure, and finally 12 c.c. of a colourless oil were obtained, of b.p. 176°–177°; d^{27}_4, 0·8565; n_D^{27} = 1·4700; α_D^{30} = —73·35°. *l*-Limonene has b.p. 175°–176°; d, 0·8472; n_D^{27} = 1·4746; α_D^{30} = –105°.

Bromination of the oil yielded a halogen derivative which proved to be *l*-limonene tetrabromide.

In spite of repeated fractionation and distillation over sodium, the *l*-limonene separated from this oil was heavier but had a higher refractive index than pure *l*-limonene, probably due to the presence of small quantities of another hydrocarbon, which, however, could not be separated.

Fraction 4.—The aldehyde content of this fraction was found by the sodium bisulphite method to be 10%. The residual oil had n_D^{28} = 1·4930; α_D^{30} = + 5·4°; d^{28}_4, 0·9293. It was soluble in 3·4 volumes of 75% alcohol. At this stage, unfortunately, the small quantity of oil remaining was lost. In view of the ready solubility in alcohol it would appear to be an oxygenated product.

Summary

1. The essential oil from *Calamintha umbrosa*, Benth., is rich in hydrocarbons.

2. It contains *l*-limonene (about 65%), an aldehyde (6·5%), an ester, and an alcohol (12% if $C_{10}H_{18}O$).

3. Owing to its high hydrocarbon content, the oil is not expected to be of much direct use in perfumery.

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THE ACIDS OF CAMEL HUMP FAT.

BY NORMAN McCLELLAND.

The hump of a young but full-grown and healthy camel (*Camelus dromedarius*) which died recently in the Wellington (N.Z.) Zoological Gardens, contained 80 lb. of fat with only a small amount of connective tissue. The investigation of the acids of this fat, which was steam-rendered, forms the subject of this note.

The only figures found in connexion with camel fat are the following by Henriques and Hansen[1]:—

[1] Abderhalden's "Biochemisches Handlexicon," III., 186; see also J.C.S. 1901, A, ii., 405.

Fat.	Iodine value.	Setting point.
Hide	38·7	34·5°
Stomach (oment)	36·5	35·0°

The values obtained by the author for camel hump fat are:—d^{100}_{15} 0·872; m.p., 35°—36°; insoluble fatty acids, 92%; unsaponifiable matter, 0·4%; saponification value, 205—206; iodine value, 37·4; m.p. of fatty acids, 45°—46°; titre value of solid fatty acids, 210—211.

The fat was saponified and the solid and liquid acids were separated by crystallisation from alcohol.

Solid acids.—The mixture of solid fatty acids after esterification with ethyl alcohol yeilded two main fractions on repeated fractionation at 15 mm.: (1) b.p. 195°—200° and (2) b.p. 210°—215°; there was also a small residuo boiling above 215°. Fraction (1) was identified as ethyl palmitate by its m.p., the m.p. of the methyl ester, and the m.p. and mol. wt. of the free acid.

Fraction (2) on similar grounds was proved to be ethyl stearate.

No pure substance could be isolated from the intermediate fractions, which appeared to be only mixtures of palmitic and stearic esters.

The residue boiling above 215° was found to consist of impure stearic acid. It is concluded that no higher fatty acids are present except possibly in very small quantity.

Liquid acids.—Lewkowitsch's modification of Hehner and Mitchell's bromide test having shown that acids giving tetra- and hexa-bromides were absent, the liquid acids were converted through the potassium and lead salts into the acid, and this into the barium salt, which was recrystallised and the acid then liberated. The oily acid had m.p. 11°, mol. wt. 280. From these results, the lead content of its basic lead salt, and the fact that it was converted by nitrous acid into elaidic acid and by alkaline permanganate into 9.10-dihydroxystearic acid, azelaic acid, and pelargonic acid, it was proved to be oleic acid.

The acids present in the fat are thus palmitic, stearic, and oleic acids; the approximate composition of the mixed fatty acids is palmitic 37%, stearic 16%, oleic 47%.

The author wishes to thank Professor Easterfield for a quantity of material.

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TRANSACTIONS

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ARYLAMINE SALTS OF THE NAPHTHALENESULPHONIC ACIDS. 1.—THE SALTS OF 2.6- AND 2.7-NAPHTHALENEDISULPHONIC ACIDS.

BY R. B. FORSTER, D.SC., PH.D., F.I.C., AND C. M. KEYWORTH, M.SC., A.I.C.

The arylamine salts of naphthalenesulphonic acids have been mentioned by various authors, but hitherto no systematic study of any one sulphonic acid has been published (*cf.* Erdmann and Suvern, Annalen, 1893, **275**, 297; Perkin and Cope, Chem. Soc. Trans., 1894, **65**, 845; Ambler, J. Ind. Eng. Chem., 1920, **12**, 1081; Lynch, *ibid.*, 1922, **14**, 964, Wales, *ibid.* 1922, **14**, 317; Perkin and Sewell, J., 1923, 27 T).

The 2.6 and 2.7 acids can be readily purified and identified by means of their arylamine salts and in a much easier manner than by means of their inorganic salts. The salts with amines differ widely in solubility. Thus the 2.6 acid can be readily separated from the 2.7 by means of the aniline salt. Certain amines, which are associated technically and which are not easily separated by ordinary methods, can be separated by means of their salts with 2.6- and 2.7-disulphonic acids.

The salts of the 2.6 acid are usually sparingly soluble in cold water and have a very high m.p. or are infusible below 360°, whilst those of the 2.7 acid are much more soluble and melt at lower temperatures, and are often difficult to crystallise from an aqueous solution. The arylamine salts of these acids may be obtained by several methods:—

(1) Addition of a cold concentrated solution of the hydrochloride of the base to a cold concentrated solution of the sodium salt of the acid and allowing to stand.

(2) Addition of boiling concentrated solution of the hydrochloride of base to a boiling concentrated solution of sodium salt of the acid, concentrating, and extracting the precipitate with alcohol if necessary.

(3) Addition of the sulphate of the base to the calcium salt of the acid.

(4) Addition of the free acid to the free base with the addition of a little hydrochloric acid.

Molecular quantities of acid and amine were taken, but a slight excess of amine and hydrochloric acid was always added. In general the salt crystallises on cooling and standing, but in a number of cases the mixture had to be concentrated and in some cases evaporated to dryness, and the residue extracted with alcohol. A large excess of the amine tends to inhibit crystallisation.

The salts, obtained usually, consist of 1 mol. of the disulphonic acid with 2 mols. of a monoamine, or 1 mol. in the case of a diamine. Acid salts, however, can be obtained of 1 mol. of base and 1 mol. of disulphonic acid, depending upon the relative quantities of each used.

All the salts are more or less soluble in water and also in ethyl alcohol, though in the latter solvent the solubility is usually much less. No other organic solvent (except, in a few cases, methyl or amyl alcohol) was found satisfactory for recrystallisation purposes. The salts can be precipitated from an alcoholic solution by the addition of ether, acetone, ethyl acetate, benzene, etc. The majority of the salts form supersaturated solutions which only crystallise on long standing or prolonged stirring. In most cases the salt is hydrolysed on boiling in aqueous solution; hydrolysis also occurs in alcoholic solution, though this can be prevented by the addition of a small quantity of hydrochloric acid or the hydrochloride of the base. In the case of the more sparingly soluble salts, the hydrolysis is not so very marked.

The purity of the salts has been checked by three methods. (1) m.p., (2) titration, (3) solubility. The titration was carried out as described by Perkin and Sewell (*loc. cit.*), a quantity of the salt suspended in water being heated to the boil and then titrated with $N/10$ sodium hydroxide, using phenolphthalein as indicator. The end-point is sharp. The solubility was determined by evaporating to dryness a weighed volume of the saturated solution of the salt.

Preparation of the pure 2.6 and 2.7 acids. A mixture of 2.6-, 2.7-, and 1.6-disulphonic acids prepared by sulphonating naphthalene in the usual manner, was separated, by the usual method, into the crude 2.6 disodium salt and the 2.7 disodium salt; the latter contains a considerable percentage of 1.6 salt. They were then purified by means of the aniline salts. It is necessary to allow sufficient time for the aniline 2.7 salt to crystallise out, as highly supersaturated solutions are formed which are very difficult to crystallise, especially when the 1.6 acid is also present. The aniline 1.6 salt is more soluble than the aniline 2.7 salt. The yield obtained is about 60% of 2.6 acid and about 30% of 2.7 acid, the remainder being chiefly the 1.6 acid.

All the halogen-substituted aniline salts of 2.7-naphthalenedisulphonic acid assume a reddish colour on exposure to moist air, and especially if very slightly impure. The 2.7- and 2.6-naphthalenedisulphonates of dimethylaniline, diethylaniline, and quinoline were difficult to isolate, as were also the monomethyl- and monoethyl-aniline salts of the 2.7 acid. In all cases the arylamine salt of the 2.7 acid was more soluble and of lower m.p. than the corresponding salt of the 2.6 acid.

In the laboratory the β-naphthylamine salts are convenient for obtaining the acids in a pure state, as β-naphthylamine 2.6-naphthalenedisulphonate is

only sparingly soluble in hot water, whereas the corresponding salt of the 2.7 acid is much more readily soluble (about 2 parts per 100) under the same conditions.

The β-naphthylamine 1.6-disulphonate was found to be more soluble than the 2.7 salt, and if present in not too large a quantity, will remain in solution while the 2.7 salt crystallises out.

In the case of the ring-substituted amines of the benzene series, the salts of ortho compounds are more soluble than those of the meta, and those of the meta more soluble than those of the para. The increase in melting point seems to follow in the order, *m, o, p.* The solubility in alcohol is usually in this order also.

Two salts of 2.6-naphthalenedisulphonic acid with *p*-toluidine were obtained, an acid salt consisting of 1 mol. of the base and 1 mol. of acid, also a normal salt (2 mols. of base and 1 mol. of acid), the former being much more soluble. In all other cases only the normal salts of monoamines were prepared.

The salts of diamines consisted invariably of 1 mol. base to 1 mol. acid.

All melting points recorded are corrected.

Experimental.

Aniline 2.7-naphthalenedisulphonate.—A hot solution of 19 c.c. of aniline and 23 c.c. of concentrated hydrochloric acid in 100 c.c. of water was added to a hot solution of 35 g. of crude sodium 2.7-naphthalenedisulphonate in 100 c.c. of water. On cooling and filtering a slight precipitate of aniline naphthalene-2.6-disulphonate separated, and on allowing the mother liquor to stand for two days, 15 g. of a mixture of aniline 2.6- and 2.7-naphthalenedisulphonates were obtained; on further standing 17 g. of practically pure aniline 2.7-disulphonate separated.

It is moderately soluble in ethyl alcohol and amyl alcohol and sparingly soluble in methyl alcohol and xylene, and practically insoluble in other organic solvents. On recrystallisation from alcohol it undergoes slight decomposition. It is best recrystallised from water containing a trace of hydrochloric acid, from which it is obtained in the form of white needles melting at 251–252°. It tends to form supersaturated solutions, especially if any impurities are present. Its solubility in water at 13° is 3·90 parts per 100 by weight. On exposure to moist air the crystals become reddish-pink.

Aniline 2.6-naphthalenedisulphonate.—A boiling solution of 4 g. of aniline and a slight excess of hydrochloric acid in 20 c.c. of water was added to a boiling solution of 5 g. of sodium 2.6-naphthalenedisulphonate in 30 c.c. of water. On cooling, the aniline salt separated out in the form of long needles or prisms. It is easily soluble in hot water but sparingly soluble in cold, 100 parts of water only dissolving 0·82 part at 13°. It is only slightly soluble in alcohol. When heated to 345° it darkens slightly but does not melt. 0·3694 g. required 15·15 c.c. $N/10$ NaOH = 99·5% theory.

o-Toluidine 2.7-naphthalenedisulphonate.—Owing to its solubility, this salt is very difficult to prepare. It was obtained by dissolving 10 g. of sodium 2.7-naphthalenedisulphonate, 7 g. of *o*-toluidine, and excess of hydrochloric acid in 30 c.c. of water and allowing the solution to stand a considerable time. It is very soluble in alcohol but insoluble in the usual organic solvents. It is best recrystallised from acidified water, from which it was obtained in white needles, m.p. 238°. On exposure to air it develops a green colour. Solubility in water at 15°, 6·1 parts per 100 by weight. 0·4592 g. required 18·0 c.c. $N/10$ NaOH = 98·5% theory.

o-Toluidine 2.6-naphthalenedisulphonate.—By dissolving 3·3 g. of sodium 2.6-naphthalenedisulphonate, 2·2 g. of *o*-toluidine, and 3 c.c. of glacial acetic acid in about 20 c.c. of water and allowing to stand overnight, this salt was obtained in the form of fine white needles, m.p. (decomp.) 338°. Solubility in water at 15°, 0·78 pt. per 100. 0·2116 g. required 8·5 c.c. $N/10$ NaOH = 100·5% theory.

m-Toluidine 2.7-naphthalenedisulphonate, obtained on cooling a solution of 5 g. of sodium 2.7-naphthalenedisulphonate, 3·3 g. of *m*-toluidine, and 3 c.c. of hydrochloric acid in 15 c.c. of water, crystallises from alcohol in fine needles, m.p. 211°. It is almost insoluble in the other usual organic solvents. Solubility in water at 20°, 3·37 pts. per 100.

m-Toluidine 2.6-naphthalenedisulphonate separated immediately on adding a solution of 3 g. of *m*-toluidine and 3 c.c. of hydrochloric acid in 10 c.c. of water to a solution of 5 g. of sodium 2.6-naphthalenedisulphonate. The salt crystallises from water in feathery needles, m.p. 329°. Solubility in water at 20°, 0·372 pt. per 100. 0·450 g. required 17·9 c.c. $N/10$ NaOH = 99·8% theory.

p-Toluidine 2.7-naphthalenedisulphonate was obtained by dissolving 5 g. of sodium 2.7-naphthalenedisulphonate, 3·3 g. of *p*-toluidine, and 3 c.c. of glacial acetic acid in the minimum quantity of water; on cooling, a good yield of the salt was obtained. It recrystallises well from 90% alcohol or water. From the former it was obtained in white needles m.p. 299°, which develop a yellow colour on exposure to air. Water at 15° dissolves 1·07 pts. per 100. 0·2572 g. required 10·15 c.c. $N/10$ NaOH = 99·1% theory.

p-Toluidine 2.6-naphthalenedisulphonate.—Both the acid and the normal salt were obtained in this case. 10 g. of *p*-toluidine dissolved in dilute acetic acid were added to a solution of 33 g. of sodium 2.6-naphthalenedisulphonate; the total volume of the solution was 210 c.c. On long standing it deposited white needles of the acid salt. These were recrystallised from acidified water but did not melt below 360°. Solubility in water at 20° = 1·51 pts. per 100. 0·2234 g. required 11·2 c.c. $N/10$ NaOH = 99·1% theory. On addition of a second molecule of *p*-toluidine to the solution, the normal salt was precipitated immediately. Like the acid salt, it crystallised in fine needles which do not melt below 360°. Solubility in water at 20° = 0·20 pt. per 100. 0·3576 g. required 14·3 c.c. $N/10$ NaOH = 100·3% theory.

a-Naphthylamine 2.7-naphthalenedisulphonate.—A solution of 3 g. of *a*-naphthylamine in 40 c.c. of water and 5 c.c. of hydrochloric acid was added hot to a solution of 4 g. of sodium 2.7-naphthalenedisulphonate. On standing overnight a good yield of crystals was obtained, which on recrystallising

from water had m.p. 305°—309°. Solubility in water at 20°, 0·85 pt. per 100. The crystals become violet on exposure to air. At 100° water dissolves its own weight of the salt.

a-Naphthylamine 2.6-naphthalenedisulphonate was obtained in a similar manner to the *a*-naphthylamine salt of the 2.7 acid, in fine feathery crystals which did not melt below 360°. Water dissolves 0·5 pt. per 100 at 15°. 0·4396 g. required 15·4 c.c. $N/10$ NaOH=100·6% theory.

β-Naphthylamine 2.7-naphthalenesulphonate.—A boiling solution of 4 g. of *β*-naphthylamine in 50 c.c. of water and 3 c.c. of hydrochloric acid was added to a boiling solution of 5 g. of sodium 2.7-naphthalenedisulphonate in 50 c.c. of water. The salt separated immediately in fine needles, easily recrystallised from water, m.p. 295°. Water dissolves 0·15 pt. per 100 at 15°. The solubility of this salt is much greater at all temperatures than that of the corresponding 2.6-disulphonate, and it may be used as a means of separating the two acids, especially if the percentage of the 2.6 acid is not very large. The salt of the 2.7 acid becomes yellow on exposure to air.

β-Naphthylamine 2.6-naphthalenedisulphonate, prepared in a similar manner to the salt of the 2.7 acid, is very sparingly soluble in cold water, 100 pts of water at 15 only dissolving 0·02 pt. of salt. It may be obtained in fine white needles by recrystallising from water. It does not melt below 360°. 0·1676 g. required 16·2 c.c. $N/10$ NaOH = 99·5% theory.

Separation of 2.6- and 2.7-naphthalenedisulphonic acids.—Separation by means of the *β*-naphthylamine salts. 5 g. of potassium 2.7-naphthalenedisulphonate, $C_{10}H_6(SO_3K)_2, 2H_2O$, and 3·5 g. of sodium 2.6-naphthalenedisulphonate, $C_{10}H_6(SO_3Na)_2.H_2O$, were dissolved in about 80°—100 c.c. of water, and the solution heated to boiling. To this was added a solution of 2·86 g. of *β*-naphthylamine in a like amount of boiling water and 4 c.c. of hydrochloric acid; the volume of the mixed solutions was approximately 200 c.c. On standing for 24 hours the *β*-naphthylamine salt of the 2.6 acid was filtered off; yield 6·30 g (99·0% of theory). To the filtrate more *β*-naphthylamine hydrochloride solution was added but not sufficient to combine with the whole of the 2.7 acid present. By this means 3·53 g. of salt of m.p. 300°—302° were obtained. This showed it to be the slightly impure *β*-naphthylamine salt of the 2.7 acid. The remainder of the *β*-naphthylamine was then added as hydrochloride, whereupon 3·48 g. of the pure *β*-naphthylamine salt of the 2.7 acid, in the form of fine needles, m.p. 296°–298°, were obtained.

The 2.6 and 2.7 acids may also be separated by means of their aniline salts. For example, if just sufficient aniline hydrochloride is added to a solution of the potassium salts of the mixed acids to form the salt of the 2.6 acid present, the aniline salt of the 2.6 acid will separate in a practically pure condition. From the mother liquor, on evaporation, the familiar large, rectangular prisms of the potassium salt of the 2.7 acid can be obtained. *a*-Naphthylamine can also be used for the separation as the *a*-naphthylamine salt of the 2.7 acid will dissolve in its own weight of water at 100°, whereas the solubility of the corresponding 2.6 salt is only 4·72 parts per 100 at the same temperature.

The following salts were also prepared:—

m-Xylidine 2.7-naphthalenedisulphonate.—Colourless, long, flat plates from water, m.p. 292°—293°. It is readily soluble in hot water or alcohol but sparingly in the cold. Water at 20° dissolves 1·0 part per 100. 0·4012 g. required 15·2 c.c. $N/10$ NaOH= 100·4% theory.

m-Xylidine 2.6-naphthalenedisulphonate separated as a white colloidal precipitate and could not be obtained in crystalline form. Solubility in water at 20°, 0·35 part per 100. Does not melt below 360°. 0·6220 g. required 23·3 c.c. $N/10$ NaOH = 99·2% theory.

Cumidine 2.7-naphthalenedisulphonate.—An immediate white precipitate was obtained on mixing hot solutions of the base and acid. It is sparingly soluble in alcohol or water; m.p. 333°—335°. Solubility in water at 15°, 0·14 part per 100.

Cumidine 2.6-naphthalenedisulphonate Does not melt below 360°. Solubility in water at 15°, 0·06 part per 100.

ψ-Cumidine 2.7-naphthalenedisulphonate.—Fine white needles, very sparingly soluble in cold water but may be recrystallised from water or alcohol; m.p. 329°—330°.

ψ-Cumidine 2.6-naphthalenedisulphonate.—Very sparingly soluble in water but may be recrystallised from a large quantity of water. Does not melt below 360°. Solubility in water at 15°, 0·09 part per 100.

Benzidine 2.7-naphthalenedisulphonate. Prepared from benzidine hydrochloride and sodium 2.7-naphthalenedisulphonate, crystallised in elongated plates; not melting below 360°. It is very sparingly soluble in water or alcohol. 100 parts of the former only dissolving 0·11 part of the salt at 12°. In contradistinction to the previous salts, it, and the other diamine salts prepared, consist of only 1 molecule of base to one molecule of disulphonic acid. 0·2784 g. required 11·75 c.c. $N/10$ NaOH=99·6% theory.

Benzidine 2.6-naphthalenedisulphonate is precipitated immediately in white needles, practically insoluble in boiling water, on mixing boiling solutions of the base and acid. It does not melt below 360°. 0·5298 g. required 22·4 c.c. $N/10$ NaOH = 99·6% theory.

Tolidine 2.7-naphthalenedisulphonate separated in glistening elongated plates when recrystallised from a large quantity of water; its solubility in water at 20° is 0·13 part per 100.

Tolidine 2.6-naphthalenedisulphonate separated in elongated plates when recrystallised from water. It is more soluble in hot water than the corresponding benzidine salt, but its solubility in water at 15° is 0·09 part per 100. Neither this nor the preceding salt melts below 360°.

Dianisidine 2.7-naphthalenedisulphonate: grey, elongated plates on recrystallisation from water, m.p. 318°. 100 parts of water at 15° dissolve 0·08 part of the salt. 0·3950 g. required 14·7 c.c. $N/10$ NaOH=99% theory.

Dianisidine 2.6-naphthalenedisulphonate was very difficult to recrystallise and did not melt below 360°. Its solubility in water at 15° was 0·07 part per 100. 0·5944 g. required 22·2 c.c. $N/10$ NaOH=99·4% theory.

Dichlorobenzidine 2.7-naphthalenedisulphonate.—Recrystallised from water in cream-coloured needles which did not melt below 360°. Solubility in water at 15°, 0·08 part per 100.

Dichlorobenzidine 2.6-naphthalenedisulphonate, colourless needles very sparingly soluble in hot water, was obtained by extracting the crude product with boiling water. Does not melt below 360°. Solubility in water at 15°, 0·07 part per 100.

o-Anisidine 2.7-naphthalenedisulphonate recrystallised from alcohol in fine needles, m.p. 229°. It is very soluble in water and alcohol.

o-Anisidine 2.6-naphthalenedisulphonate is much less soluble in water than the corresponding 2.7 salt. It may be recrystallised from water, giving colourless needles, m.p. 295°. Solubility at 15°, 2·45 parts per 100.

p-Anisidine 2.7-naphthalenedisulphonate.—On recrystallisation from alcohol melted at 265°. Solubility in water at 15°, 1·54 parts per 100.

p-Anisidine 2.6-naphthalenedisulphonate.—Cream-coloured plates on recrystallisation from water; m.p. 326°. Solubility at 15°, 0·11 part per 100.

o-Phenetidine 2.6-naphthalenedisulphonate, m.p. 281° colourless needles Solubility in water at 15°, 1·14 parts per 100. 0·5342 g. required 19·1 c.c. $N/10$ NaOH=100·5% theory. We were unable to obtain the *o*-phenetidine salt of the 2.7 acid.

p-Phenetidine 2.7-naphthalenedisulphonate, greyish-brown crystals, which on recrystallisation from alcohol formed brown plates, m.p. 230°. Readily soluble in cold water.

p-Phenetidine 2.6-naphthalenedisulphonate separates immediately when hot solutions of the acid and the amine are mixed. Recrystallised from water in light brown plates, m.p. (decomp.) above 300°. Solubility in water at 13°, 0·13 part per 100.

m-Chloroaniline 2.7-naphthalenedisulphonate, from the sodium salt and *m*-chloroaniline hydrochloride, crystallised in fine coloured needles, m.p. 260°. Very soluble in hot water. Solubility in water at 15°, 0·97 part per 100.

m-Chloroaniline 2.6-naphthalenedisulphonate is much less soluble than that of the 2.7 acid and separates on mixing hot solutions of the hydrochloride of the base and the sodium salt of the acid. It crystallised from water in colourless plates which did not melt below 360°. Solubility in water at 15°, 0·12 part per 100.

p-Chloroaniline 2.7-naphthalenedisulphonate, fine white needles, m.p. 265°, by recrystallisation from alcohol. Solubility in water at 15°, 1·6 parts per 100. 0·5106 g. required 18·4 c.c. $N/10$ NaOH=97·8% theory.

p-Chloroaniline 2.6-naphthalenedisulphonate may be recrystallised from either 50% alcohol or water, yielding colourless plates which begin to melt with decomposition at 300°. Solubility in water at 15°, 0·14 part per 100.

m-Bromoaniline 2.7-naphthalenedisulphonate recrystallised from alcohol had m.p. 257°. Solubility in water at 15°, 0·29 part per 100.

m-Bromoaniline 2.6-naphthalenedisulphonate, white glistening leaflets from water, m.p. above 350° (decomp.). Solubility in water at 15°, 0·122 part per 100. 0·3274 g. required 10·35 c.c. $N/10$ NaOH=99·9% theory.

p-Bromoaniline 2.7-naphthalenedisulphonate, recrystallised from water melted at 266°. Solubility in water at 15°, 1·31 parts per 100. 0·5690 g. required 18·0 c.c. $N/10$ NaOH=100% theory.

p-Bromoaniline 2.6-naphthalenedisulphonate may be crystallised either from water or from 50% alcohol. White plates, which do not melt below 360°. Solubility in water at 20°, 0·133 part in 100. 0·3252 g. required 10·3 c.c. $N/10$ NaOH=100·1% theory.

1.2.4-Dichloroaniline 2.6-naphthalenedisulphonate white, glistening needles, m.p. 295°. Solubility in water at 10°, 0·46 part, and at 20°, 0·63 part per 100. 0·7402 g. required 24·0 c.c. $N/10$ NaOH=99·2% theory.

Monomethylaniline 2.6-naphthalenedisulphonate gave on recrystallisation from water grey needles, m.p. 272°. Solubility in water at 20°, 3·22 parts per 100. 0·3472 g. required 13·9 c.c. $N/10$ NaOH =100·5% theory.

The authors desire to acknowledge their indebtedness to Professor Heilbron for permission to carry out some of the experimental work in connexion with this paper in the Laboratories of the University of Liverpool.

THE USE OF THE LEAD CATHODE IN THE ELECTROLYTIC METHOD FOR THE DETERMINATION OF MINUTE QUANTITIES OF ARSENIC.*

BY T. CALLAN, M.Sc., PH.D., F.I.C.

The electrolytic method for the detection of minute amounts of arsenic depending on the formation of hydrogen arsenide at a metallic cathode and its subsequent detection by means of a mirror formed by passing the gas through a heated tube (Marsh-Berzelius) or by its action on mercuric chloride paper (Gutzeit) is now in very general use. The influence of the nature of the cathode was very exhaustively studied by Sand and Hackford,† who examined the relative sensitivity of various metallic cathodes, *e.g.*, platinum, lead, zinc, copper, etc., finally coming to the conclusion that lead was the most suitable metal for the purpose.

The lead cathode has subsequently come into common use and is generally regarded as being satisfactory. In the course of many hundreds of determinations of minute quantities of arsenic using lead cathodes, it has been

* Read at a meeting of the Manchester Section on Jan. 11, 1924.
† Chem. Soc. Trans., 1904, **85**, 1018–1028.

repeatedly noticed that the sensitivity of such cathodes is liable to vary very considerably from time to time. Thus a cathode which with 0·01 mg. of As_2O_3—a relatively considerable amount—gave a very decided stain on mercuric chloride paper when used in the apparatus subsequently described, after being in use for some days would often give a considerably weaker stain or even fail to give a stain with the same amount of added arsenic. Further, after standing for a few days such a cathode would in many cases recover its sensitivity whilst in others it failed to do so. Again if a number of new cathodes prepared from the same piece of lead wire were used regularly, whilst one might retain its sensitivity for weeks another might lose it after only a few days' use, but all would become eventually much less sensitive.

Owing to this irregular behaviour the continuous use of lead cathodes necessitates considerable precautions if the results obtained are not to be very misleading. Where a lead cathode is used only occasionally, however, no such difficulties have usually been experienced. With a view to elucidate the cause of such irregularities a series of experiments were undertaken. Sand and Hackford* showed that the addition of copper, iron, and certain other metallic salts caused serious loss of sensitivity of a lead cathode, and it was thought possible that the observed loss of sensitivity might be due to accumulated traces of such metals. A very considerable number of experiments were made, the following series being typical.

Three lead cathodes were used; two were made from new wire, the other having been in use at irregular intervals for about a year, and all were carefully cleaned and burnished. They were then used as cathodes in three electrolytic cells. The cell used was a modification of that suggested by Trotman (J., 1904, 178) and consisted of a glass tube prepared by cutting off the closed end of a test tube to give a cylinder approximately 3·5 × 11 cm. fitted with a bored rubber stopper and closed at the flanged end by a diaphragm of parchment paper secured by a rubber band. The cathode consisted of a length of lead wire about 35 cm. long and about 4 mm. in diameter, coiled into a spiral, and was brought directly through a gas-tight hole in the stopper to a screw connector to make contact with the source of current, which was taken from the lighting mains. In the majority of experiments the Gutzeit method of detecting the evolved hydrogen arsenide was employed, as this method lends itself to rapid repetition experiments and is sufficiently sensitive, 0·001 mg. As_2O_3 giving a definite stain on mercuric chloride paper. The evolved gases were passed through a glass tube containing, first, dry cotton wool, then cotton wool soaked in lead acetate solution and dried, and then passed through a glass tube 7 cm. long with a slight constriction at the bottom which would just accommodate a strip of mercuric chloride paper 4 mm. × 5 cm. Confirmative tests were made in a number of cases using the Marsh-Berzelius method. The current used in most experiments was 4—5 amps., the anode in every case being a piece of platinum foil welded on to a stout platinum wire. The electrolyte used was 15—20% sulphuric acid. Each cell gave a definite stain when 0·001 mg. of As_2O_3 was added. Further a strong stain was obtained with 0·01 mg. (a blank test immediately afterwards gave absolutely no stain), and finally a second addition of 0·001 mg. gave a definite stain. Hence the cathodes were not only sensitive but did not show any tendency to retain arsenic even when as much as 0·01 mg. was added.

The three cells were then run continuously for 12 hours using a current of 3—4 amps. At the end of this time 0·01 mg. of As_2O_3 was added to each cell. In each case only very weak stains were obtained corresponding to about one-fifth to one-tenth of the actual amount of arsenic added. Since no addition of any kind was made to the cells, the loss of sensitivity of lead cathodes after prolonged use cannot have been due to the gradual accumulation of traces of impurities from outside sources. The cathodes were then dipped into dilute nitric acid (1 : 2), washed in running water, and replaced in their respective cells. One cathode was then found to be sensitive, *i.e.*, a definite stain was obtained from 0·001 mg. and a strong stain from 0·01 mg., whilst the others were insensitive. The three cathodes were then again immersed in cold dilute nitric acid (1 : 1) for about 10 minutes, and washed in running water, and on testing all were found to have completely regained their original sensitivity. This recovery, however, was only temporary, as after only a few continuous experiments, and in some cases a single experiment, the cathodes rapidly became less sensitive but not all to the same extent. On standing overnight immersed in water they largely regained their sensitivity, but this also was only temporary, the cathodes becoming insensitive again after a brief use. In a similar series of experiments cathodes which definitely showed 0·002 mg. As_2O_3 failed to show that amount after being in use for two to three hours; they were completely reactivated by immersing in warm dilute nitric acid for a few minutes but not sufficiently long for any visible attack on the lead to be made. Cathodes which had become inactive owing to continuous use could only be revived to a small extent by vigorously brushing their surfaces.

Repeated experiments showed clearly that whilst a short treatment with cold or warm nitric acid would temporarily reactivate a lead cathode, on repeating the treatment several times, or if the cathode were left in the acid until it was vigorously attacked, the nitric acid had the opposite effect, *i.e.*, the cathode became quite insensitive although it possessed a brilliant metallic surface.

In one experiment as much as 0·03 mg. As_2O_3 was added to a cell containing a lead cathode which had been repeatedly treated with dilute nitric acid, but only a very small proportion of the arsenic was given off as hydrogen arsenide. On removing an aliquot portion of the cell solution and testing

* *loc. cit.*

by means of zinc and acid, the arsenic added to the cell was fully accounted for.

A number of lead electrodes were rendered insensitive by treating with hot dilute nitric acid until a vigorous gas evolution was obtained, making them the cathodes in the electrolytic cell for about one hour, and again treating with nitric acid. The cathodes after this treatment showed a bright metallic surface. Such electrodes only gave rise to a faint stain on mercuric chloride paper when as much as 0·01 mg. As_2O_3 was added to the cell. Similarly, when used as cathodes in the Marsh-Berzelius test only very weak mirrors were obtained with as much as 0·01 mg. As_2O_3. 1 c.c. of a 10% solution of cadmium sulphate was then added to the cells containing these inactive cathodes, when they immediately regained their full activity. When a similar amount of cadmium sulphate was added to cells containing cathodes which had become insensitive by continuous use for some hours, they also became more sensitive, but not *completely* so.

There appear, therefore, two ways in which lead cathodes may become insensitive.

(*a*) By prolonged use as cathode in dilute sulphuric acid solution. This is possibly due to the electrode becoming coated with a film of lead sulphate or oxysulphate, although in that case one would expect the electrode to be re-activated by treatment with a hot concentrated solution of ammonium acetate. Such, however, is not the case, but such inactivity may be removed by a mild treatment with dilute nitric acid.

(*b*) By removal of traces of metallic impurity from the surface of the cathode, giving a condition analogous to that into which the cathode can be brought by repeated treatment with nitric acid.

Inactivity due to this cause may be remedied by the addition of a trace of cadmium to the cell immediately prior to adding the solution to be tested. This would suggest that chemically pure lead is a much less efficient cathode than ordinary "pure" lead. It would also possibly explain why a lead cathode which, after only quite a short use, had become inactive, in many cases recovers its activity after allowing to rest for a few days, it being conceivably due to the formation of a superficial coating of pure, hence inactive, lead, which subsequently became of its normal "purity" by the migration of traces of foreign metals to the surface.

In spite of its limitations, however, the lead cathode undoubtedly remains an efficient and, if proper precautions are taken, reliable substitute for the expensive platinum cathode, which latter, indeed, also suffers from the liability to become insensitive under certain conditions (*e.g.*, roughening of its surface).

The abnormalities of the lead electrode described in the foregoing have only been observed where the same electrodes have been in continuous use for some hours or where a new electrode has deliberately been rendered insensitive by alternate treatment with nitric acid and use as a cathode.

In order to ensure that lead electrodes are always in a sensitive condition, it is strongly recommended that after each test they should be dipped for a few minutes in warm dilute nitric acid, removed immediately there is any sign of gas evolution, and well washed. Cathodes treated in this way have remained sensitive when used continuously for long periods. After treatment with nitric acid and washing, a trace of cadmium in the form of sulphate may be added to the cell, but this is not usually necessary unless the nitric acid treatment has been severe.

The procedure recommended by Sand and Hackford* in the case of new cathodes—that they be thoroughly scraped and cleaned by immersion in boiling strong nitric acid for 3 or 4 minutes—is not advisable, since this procedure generally results in reducing the sensitivity of the cathode to a considerable degree, and if prolonged may indeed render the cathode quite insensitive.

In conclusion, the author desires to express his thanks to Mr. J. D. Holiday, who has carried out a large number of experiments which have served to confirm the conclusions arrived at above, and also to Messrs. British Dyestuffs Corporation (Blackley), Ltd., in whose Central Analytical Laboratory the work was carried out.

* *loc cit.*

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TRANSACTIONS

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LATHAM RESEARCH FELLOWSHIP.

The immediate purpose of the research to be described in the paper which follows is adequately stated by the author: but there is a further purpose obvious to critical observers, which is to establish working links between the systematic or "pure" chemistry of cellulose and the somewhat specialised development of the subject by way of physiology or biology and chemical industry. Whilst the latter have contributed important sections of exact science, the records of research work in this field express the general absence of the dominating *Leit motif*.

In the particular case of "oxycellulose," investigation has originated in the problems and exigences of industrial bleaching and dyeing operations with the restricted objective of establishing safe limits of oxidising treatment and recognition by qualitative tests of reaction beyond these limits. As a result there is an accumulation of literature which requires co-ordinating and re-editing from the critical standpoint of systematic chemistry. Thus the reactions of cellulose with oxidants are necessarily complex. Specific oxidation products of ultimate component groups are not easily identified: associated reactions of the order of interior migrations may be those of the complex, or take place in the proximate component group of C_6 or C_{12} dimensions. Hence the necessity of a methodical investigation of the oxidation of such compounds of known constitution and configuration, the results of which must afford a critical basis of re-examination of the literature of "oxycellulose," and also of "hydrocellulose."

The present research is modestly set forth by the author as only preliminary and not sufficiently exhaustive as a basis of theoretical discussion of the major questions. But attention may be called to certain results which on further verification and extension should furnish material of critical value for this purpose:—

(*a*) The addition of HOCl to β-glucosan as a reversible reaction: with increasing molecular proportion of the oxidant, the determination of hydrolysis to dextrose at ordinary temperatures.

(*b*) The production of lævulinic acid in the oxidation of sucrose by hydrogen peroxide.

It is in such methodical systematic study of reactions that results of significant importance are observed.

Thus the reactions under (*a*) would explain some particular aspects of the ordinary textile bleaching processes, but beyond this they are suggestive of a deductive basis of research of the fundamental problem.

The observations under (*b*) indicate an exceptionally labile equilibrium of the H.OH groups of the hexoses in presence of oxidants, tending to interior migrations, of the order of fermentation phenomena.

C. F. CROSS.

THE MECHANISM OF THE OXIDATION OF TYPICAL CARBOHYDRATES WITH HYDROGEN PEROXIDE AND HYPOCHLOROUS ACID.

BY JAMES CRAIK, M.A., B.SC., LATHAM RESEARCH FELLOW.

The problem of research which forms the subject of the present report was entrusted by Mr. C. F. Cross, F.R.S., to the author on his appointment as Latham Research Fellow in 1921. Stated briefly, the object of the work was to explore the action of simple oxidising media on selected carbohydrates with a view of gaining information as to the effect of these reagents in the technical treatment of cellulose. As a research of this nature must of necessity cover a wide field and its completion on scientific lines would demand the services of many workers for a period of years, it was considered advisable to limit the number of reagents employed and to study their effects as fully as possible in the time available.

The standard literature of the sugars contains numerous references to the oxidation of carbohydrates with acid and alkaline media. In particular, exhaustive studies have been made of the products formed on subjecting carbohydrates to the action of nitric acid, potassium permanganate and dichromate, silver oxide, and other common oxidisers.

J. U. Nef and his collaborators (Annalen, 1907, **357**, 214; 1910, **376**, 1; 1914, **403**, 204) spent nine years investigating the oxidation of the simple sugars in the presence of alkali and made a detailed study of the behaviour of carbohydrates dissolved in aqueous alkali hydroxides towards oxidising agents such as air, hydrogen peroxide, and the oxides of mercury, silver, and copper. It was ascertained (*ibid.*, 1914, **403**, 204) that the oxidation of 47 sugars resulted in the formation of carbon dioxide, formic, glycollic, oxalic, and *dl*-glyceric acids, four trihydroxybutyric acids, eight tetrahydroxyvaleric acids, and eight pentahydroxyhexoic acids. These results speak sufficiently for the complexity of the oxidation changes involved.

At an earlier date Cross, Bevan, and Smith had pointed out (Chem. Soc. Trans., 1898, **73**, 463) that only one reference (C. Wurster, Ber., 1887, **20**, 2631) could be found in the literature where the effect of hydrogen peroxide on the sugars had been tested, and this author dismissed the topic with the remark that glucose and cane sugar were remarkably stable towards this reagent. On the other hand, Fenton (Chem. Soc. Trans., 1894, **65**, 899; 1895, **67**, 48; 1896, **69**, 546) oxidised tartaric acid by means of hydrogen peroxide in the presence of ferrous salts with surprising results, and later applied the same reaction to the oxidation of polyhydric alcohols (*ibid.*, 1899, **75**, 1). As Cross, Bevan, and Smith stated in the paper already mentioned, these results disclose several points of interest with regard to the mode of action of hydrogen peroxide, more

particularly the oxidation of the residue —CH(OH)·CH(OH)— to —C(OH):C(OH)—. They therefore undertook the oxidation of a few typical carbohydrates by hydrogen peroxide in the presence of iron salts, but, apart from this development, there has been practically no further attempt to apply neutral oxidising agents to the carbohydrates.

As already explained, the purpose of the present work was to study in detail the mechanism of the oxidising action of hydrogen peroxide and hypochlorous acid on non-reducing sugars, with the ultimate intention of applying the results to starch and cellulose. These two reagents were selected as they are strong oxidisers and, as one of them is neutral and the other a weak acid, they are unlikely to cause profound molecular alteration in the sugars employed. In addition, both reagents are applied technically to cellulose.

In the present work the oxidation reactions were studied under conditions in which the ratio of the available oxygen atoms to each C_{12} unit in the carbohydrate was either $\frac{1}{2}$, 1, 2, or 5. In addition to non-reducing sugars, it was found necessary to use controls in which dextrose and lævulose were used. The progress of the reactions was traced :—

(1) Polarimetrically,
(2) By determining the rate of disappearance of the available oxygen,
(3) By determining any change in acidity,
(4) By determination of variations in the reducing action on Fehling's solution,
(5) By the action of phenylhydrazine acetate at 20°, 60°, and 100° on the products of the oxidation,
(6) By isolation and identification of the individual products.

Considering the ultimate object in view, the oxidation was allowed to proceed at ordinary temperature in all cases.

It was thought advisable to start with saccharides of simple and known constitution, and for this reason sucrose was selected as a test substance in view of its non-reducing properties. In addition the possibility was open that this compound, containing, as it does, one γ-sugar residue in combination, would possess the property of combining directly with one atom of oxygen without molecular rupture (Irvine, Fyfe, and Hogg, Chem. Soc. Trans., 1915, **107**, 524). In addition, lactose and maltose were selected for experiment as representative of reducing disaccharides differing in essential structure from sucrose.

A survey of the results taken in conjunction with recent developments in the chemistry of starch and cellulose quickly showed that they had no direct bearing on the oxidation of cellulose, and it was deemed advisable to introduce another series of test substances. The oxidation of β-glucosan was accordingly undertaken as, although this component is not present in cellulose, it bears, as an anhydride possessing the formula $C_6H_{10}O_5$, a closer resemblance to the group of polysaccharides than do any of the sugars proper. In addition, the compound is now the most accessible of the anhydro-sugars and may be employed in large-scale experiments. The principal results obtained in this section of the work are now described.

The action of hydrogen peroxide on disacchari
Sucrose, maltose, and lactose.

In the absence of a catalyst the above disacchar were stable at ordinary temperatures towards hy gen peroxide, but in the presence of ferrous sulpl oxidation proceeded rapidly even at room temp ture. In the case of sucrose, where the ratio of av able oxygen was over $\frac{1}{2}$ atom per C_{12} unit, it ascertained that the oxidising agent attacked of the primary alcoholic groups and converte into the carboxyl group. The acid thus for effected inversion of the remaining sucrose and scission products then underwent independent ox tion, to give a complex series of acids. This deve ment of free organic acid increased rapidly as amount of active oxygen was increased. Formic acetic acids were then produced in quantity, there was no evidence of the presence of gluc acid, the molecular rupture giving essentially a with two and three carbon atoms in the ch Judging from the action of phenylhydrazine on products of the change, lævulinic acid was prese a surprising result considering the conditions.

The precipitates yielded by phenylhydrazine somewhat indefinite and consisted mainly of phe glucosazone together with mixed hydrazides organic acids, the separation of which was diffi The combined results of the experiments prove

1. If direct addition of oxygen to the suc molecule takes place the product is not neu but acidic.
2. The lævulose residue in sucrose, although o γ-type, does not undergo oxidation in the s manner as γ-methylglucoside.
3. The formation of free acid precedes hydrol
4. Once hydrolysis commences, the oxida becomes rapid and is ultimate.

No part of the evidence obtained seems to have bearing on cellulose problems beyond the fact any reaction which liberates a reducing sugar in presence of hydrogen peroxide leads to rapid dest tion of the sugar molecule.

In pursuing a parallel series of experiment maltose and lactose it was apparent that the rea attacked the reducing group of the sugar with formation of maltobionic acid and lactobionic respectively. As in the case of sucrose, these products effected the hydrolysis of the paren saccharides, and oxidation of the fragments ens Such changes are notoriously complex, and hydr peroxide was abandoned in favour of hypochlo acid, as the possibility was not excluded that reagent might act in an entirely different mann

The action of hypochlorous acid on the disacchar
Sucrose, maltose, and lactose.

In the principal experiments the amount of h chlorous acid was adjusted so that one atomic pr tion of oxygen was available for each C_{12} unit c carbohydrate. As before, the disaccharides ployed were sucrose, maltose, and lactose. these bioses no organic acids were formed as pro of oxidation, the result offering a sharp contra that obtained with hydrogen peroxide. Sucros

narkably stable towards hypochlorous acid; in t, when the oxidation was carried out in the presce of a base to neutralise the hydrochloric acid med by the decomposition of the oxidising acid, ·6% of the original weight of sucrose persisted after mplete utilisation of the hypochlorous acid. Even the absence of a base reaction was comparatively w and no acidity was developed. The final value the specific rotation of the oxidised solutions did t coincide with that calculated from the compoion of the residual sugar as determined from the pper-reducing power. Similar results were obtained th maltose and lactose, the same optical lag being orded in all the experiments. In the case of tose the specific rotation actually diminished in ace of increasing.

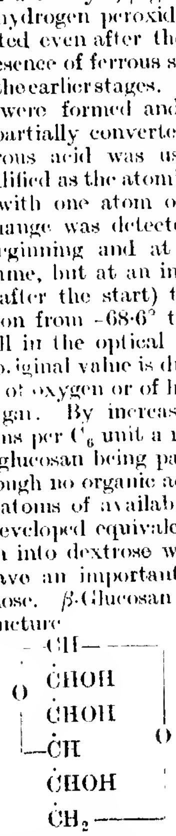
In view of these results the general conclusion may drawn that hypochlorous acid acts on the disacarides through the preliminary formation of an lditive compound. Attempts to isolate such a mpound were naturally unsuccessful, but the comned physical evidence is strongly in favour of its istence.

he action of hydrogen peroxide and hypochlorous acid on β-glucosan.

In the absence of a catalyst, β-glucosan proved to stable towards hydrogen peroxide, practically no ange being detected even after the lapse of several ys, but in the presence of ferrous salts reaction was pid, especially in the earlier stages. Both volatile and on-volatile acids were formed and simultaneously e glucosan was partially converted into dextrose.

When hypochlorous acid was used the reaction s profoundly modified as the atomic ratio of oxygen reased. Thus, with one atom of oxygen per C_6 it, very little change was detected. The specific tation at the beginning and at the end of the tion was the same, but at an intermediate stage out two hours after the start) the value of $[\alpha]_D$ owed a diminution from $-68·6°$ to $-55·2°$. In all obability this fall in the optical activity followed a return to the original value is due to the tempory addition either of oxygen or of hypochlorous acid the anhydro-sugar. By increasing the ratio of ygen to two atoms per C_6 unit a remarkable result s obtained, the glucosan being partially converted to dextrose although no organic acids were formed. nally, with five atoms of available oxygen per C_6 it acidity was developed equivalent to $N/20$ acid, d the conversion into dextrose was accelerated.

These results have an important bearing on the idation of cellulose. β-Glucosan has been shown possess the structure

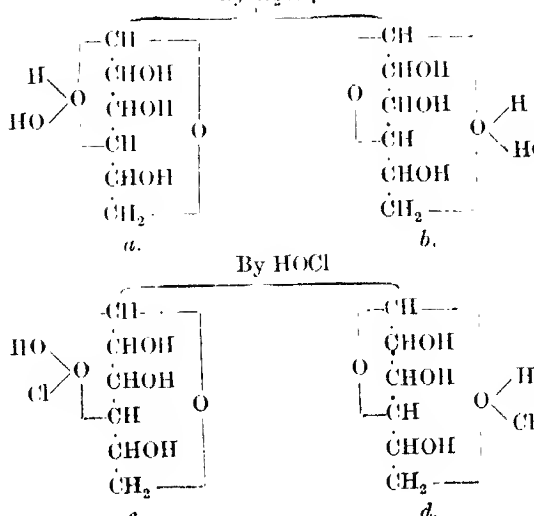


Even if Pictet's views as to the relationship of β-glucosan to cellulose are not accepted, the former compound must be regarded as being closely related to the unit of the polysaccharides. Now, glucosan is not readily hydrolysed, even on heating with sulphuric acid, to regenerate dextrose, yet the results of the present research have shown that in the absence of stable acids the anhydro-ring can be opened out at ordinary temperatures, and that dextrose is then formed. This points clearly to the idea of a preliminary addition of hypochlorous acid to one of the ring-forming oxygen atoms (probably that connecting the terminal carbons). If this view be correct, a necessary consequence is that the oxidation of β-glucosan should follow an entirely different course when occasioned by oxidising agents which do not admit of molecular addition. The point has been established in the course of a parallel research, carried out by Irvine and Oldham, who subjected glucosan dissolved in methyl alcohol to the action of silver oxide. Essentially three acids are formed containing respectively 3, 4, and 5 carbon atoms in the chain, one of these compounds being a ketonic acid containing two hydroxyl groups. In this type of oxidation no dextrose is liberated, and the molecule suffers progressive disruption.

Action of hypochlorous acid on starch and cellulose.

The most important result disclosed in the experiment just described is that dilute hypochlorous acid is capable of effecting at ordinary temperatures the hydrolysis of n-saccharides or anhydro-sugars. Emphasis must be laid on the example of β-glucosan, which requires prolonged boiling with 4–5% sulphuric acid in order to open the anhydro-ring, yet undergoes the same change at 16° in the presence of 1·8% hypochlorous acid. Both reagents effect hydrolysis, yet the mechanism of the change cannot be identical in both cases. The opening of a ring compound is generally explained by preliminary addition, and applying this principle to the hydrolysis of glucosan, we have the alternatives :—

By H_2SO_4



Types *a* and *c* may reasonably be excluded as the product is the butylene-oxide form of dextrose; *b* may be transformed directly into the reducing sugar, but *d* can undergo this reaction only after secondary changes involving the liberation of oxygen. It is highly significant that in the presence of one molecular proportion of hypochlorous acid, glucosan is stable.

Evidently support would be lent to the above views if it could be shown that polysaccharides behaved in the same manner as glucosan and underwent hydrolysis with low concentrations of hypochlorous acid. In the case of starch this has been confirmed, and as much as 80–90% of the compound is converted into a mixture of soluble dextrins, maltose, and dextrose after 48 hours' action in the cold. The properties of cellulose render a strictly comparative study difficult, and the experiments carried out on this polysaccharide could not be extended beyond the point of ascertaining the concentrations of hypochlorous acid at which: (1) oxycellulose, (2) oxalic acid first make their appearance. The results, which are given in the experimental part, are capable of considerable theoretical discussion, but this would be premature in the case of a preliminary research of this nature.

EXPERIMENTAL.

The action of hydrogen peroxide on sucrose.

(*a*) *Without a catalyst.*—Typical experiments only are quoted. The sucrose solution used in these experiments was $M/6$ (5·7%). Three experiments were carried out with the ratio of available oxygen contributed by the hydrogen peroxide in the proportion of 1, 2, and 5 atoms per C_{12} unit. There was no rise in temperature on mixing; the optical activity remained constant; no action on Fehling's solution was developed and no organic acids were formed. It was therefore evident that sucrose was quite stable to hydrogen peroxide in the absence of a catalyst.

(*b*) *With a catalyst.*—Fenton and Jackson (Chem. Soc. Trans., 1899, **75**, 1) oxidised polyhydric alcohols with hydrogen peroxide in presence of ferrous sulphate; they used the catalyst in the proportion of 1/10 atom Fe'' as crystalline ferrous sulphate per molecule of the alcohol. Similar ratios were used in the present work, the concentration of the sucrose solution being $M/6$. The oxidations were studied under conditions in which the oxygen ratio per C_{12} unit was either ¼, ½, 1, or 2. Unfortunately, owing to the turbidity and brown colour of the solution, caused by the oxidation of the ferrous salt, it was impossible to study the progress of the reaction polarimetrically. The disappearance of active oxygen and the development of acidity were determined by direct titration. When the decomposition of the hydrogen peroxide was complete, a portion of the liquid was evaporated to dryness under diminished pressure at a bath temperature of about 35°. On extracting the residue with 80% alcohol at the boiling point and distilling the solvent in a high vacuum, a syrup was obtained, the copper-reducing power of which was determined before and after hydrolysis.

As these experiments were carried out on e similar lines, it is most convenient to displa results in tabulated form.

Ratio of oxygen in H_2O_2 per C_{12} unit	¼	½	1	
Rise in temperature (on mixing).—				
Initial	18°	19°	15°	
Maximum	21°	22°	21°	
Acidity developed	$N/22·3$	$N/20$	$N/20$	I
Time to completion, min	25	30	30	
Ratio of copper values before and after hydrolysis	—	68·1%	68·1%	6

The action of hydrogen peroxide on lactose in pr of ferrous sulphate.

(*a*) 0·463 gram of crystalline ferrous sulphat solved in 5 c.c. of water was added to 100 c.c. of lactose solution; this was well mixed wi solution of hydrogen peroxide (previously titr containing 0·266 g. of available oxygen. The perature rose on mixing from 15·5° to 19°. acidity developed, and the rate of disappearan active oxygen were determined at regular inte

Time in min.	Acidity.	Disappearance of oxygen. % of total
10	$N/17$	43·8
90	$N/14·9$	97·0
120	$N/14$	99·5
150	$N/13·7$	100·0

(*b*) With two atoms of oxygen the rise in tempe ture on mixing was from 19° to 21·5°, and at the of two hours a sudden rise to 30° took place.

Time in min.	Acidity.	Disappearance oxygen % of total.
10	$N/18·4$	16·1
30	$N/17·8$	24·3
90	$N/9·5$	92·2
120	$N/7·7$	99·3
150	$N/7·3$	100·0

(*c*) By using a smaller proportion of the oxidis viz., ½ atom oxygen per molecule of lactose, t reaction followed the same course as above but t oxidation was not so complete.

Time in min.	Acidity.	Disappearance c oxygen % of total.
10	$N/19·6$	72·6
30	$N/17·3$	87·5
90	$N/17·1$	92·2
120	$N/15·4$	96·8
150	$N/15·3$	100·0

In each case the residual sugar was isolated already described for sucrose. Analysis of the products showed that there was an increase molecular rupture during oxidation as the amou of oxygen was raised from ½ atom to 2 atoms, thus:–

Proportion of oxygen per C_{12} unit.	Reducing power before hydrolysis. % of that of dextrose.
½	80·0
1	80·3
2	95·72

The oxidation of maltose with hydrogen peroxide i presence of ferrous sulphate.

(*a*) *One atom available oxygen to one molecule mal ose.*—100 c.c. of maltose solution containing 5·7 g of pure maltose were mixed with 5 c.c. of ferrou sulphate solution containing 0·463 g. of crystallin ferrous sulphate; 25 c.c. of hydrogen peroxide solu

ı (0·266 g. available oxygen) were added and the :ture was well stirred with a thermometer. The ıperature rose from 16° to 19°. An examination intermediate stages showed :—

Time in min.	Acidity.	Disappearance of available oxygen, % of total.
10	$N/13{\cdot}7$	40 0
90	$N/10\ 4$	98 3
120	$N/10\ 3$	99 1
150	$N/10{\cdot}3$	100 0

b) *Two atoms available oxygen.*—On mixing the ıtions of maltose and hydrogen peroxide the nperature increased 3°, and after 90 minutes m the start there was another rise from 14·5° iginal temperature) to 30°. The figures shown low were recorded :—

Time in min.	Acidity.	Disappearance of oxygen, % of total.
10	$N/18\ 5$	18 1
30	$N/12\ 3$	42 3
90	$N/8$	98 1
120	$N/7\ 9$	99 3
150	$N/7\ 85$	100 0

(c) By decreasing the amount of available oxygen ½ atom the rate of the reaction was :—

Time in min.	Acidity.	Disappearance of oxygen, % of total.
10	$N/23$	82 8
30	$N/21\ 27$	92 18
90	$N/21\ 4$	93 75
120	$N/10{\cdot}7$	94 53
150	$N/19\ 6$	100 0

In all cases the residual products were isolated ter removal of volatile acids and inorganic salts. ıe syrup obtained was tested with Fehling's solution fore and after hydrolysis. A comparison of the o copper values showed :—

Atomic proportion of oxygen.	Reducing power before hydrolysis % of that of dextrose
½	69 0
1	79 93
2	84 0

idation of disaccharides with hypochlorous acid.

The hypochlorous acid was prepared by an unpubhed method devised by Principal Irvine which lded a solution free from chlorine and more ghly concentrated than that obtained by ordinary ocesses.

The progress of the oxidation was traced larimetrically in addition to the controls employed th hydrogen peroxide.

(a) *The action of hypochlorous acid on sucrose.*—this series of experiments 1 atom of available ygen was used per C_{12} unit. 50 c.c. of sucrose lution (5·7%) were mixed at room temperature th 50 c.c. of hypochlorous acid solution (0·87%). e reaction was slow, 1 atomic ratio of oxygen uiring almost 24 hours for complete utilisation. organic acids were formed, the acidity developed ng exactly equivalent to the hydrochloric acid m the decomposition of the hypochlorous acid ed. There was a steady decrease in the value the specific rotation as shown below :—

Time in hours from start.	$[\alpha]_D$.	Disappearance of active oxygen, % of total.
0	+66 6°	3 44
2	+61·7°	—
4	+55·7°	68·7
7·5	+54 7°	88·0
22	+54 0°	100·0

On isolating the residual sugar after all oxidation had ceased, the copper value was 23·3% of that obtained on complete hydrolysis. The specific rotation calculated on this hydrolysis should have been $[\alpha]_D$ +46·4°. The actual drop in optical activity was from $[\alpha]_D$ +66·6° to +54°.

(b) *The action of hypochlorous acid on lactose.*—In the following experiments 1 atom of available oxygen was allowed per C_{12} unit. 50 c.c. of $M/6$ lactose solution were mixed with 50 c.c. of hypochlorous acid (containing 0·87% HOCl). The reaction proceeded very slowly, extending over a period of 48 hours. During this time no organic acids were formed and the specific rotation changed from +52·5° to +47·6°.

Time in hours from start.	$[\alpha]_D$.
0	+52 5°
2	51 5°
6	51 3°
20	51 3°
44	49 6°
48	47 6°

On isolation of the residual sugar, analysis gave a copper-reducing value of 81·9% of that determined after hydrolysis. This partial hydrolysis of lactose should give the optical change $[\alpha]_D$ +52·5° to +66·6° in place of +47·6°.

(c) *Action of hypochlorous acid on maltose.*—For each C_{12} unit, 1 atom of available oxygen from the hypochlorous acid was used. The solutions were mixed as before in the above proportions. The reaction was extremely slow, the maltose reacting completely with the hypochlorous acid only in 80 hours. No organic acids were found as products of the oxidation. Polarimetric readings showed a gradual decrease from $[\alpha]_D$ +134° to +123·5°.

Time in hours.	$[\alpha]_D$.
0	+134°
24	+125 9°
48	+119 6°
80	+123 5°

The total product was isolated and the reducing power determined before and after hydrolysis, the ratio being 69·0%. Here again the analytical results are not consistent with the optical activity, and the general conclusion may be drawn that the oxidising agent acts on the sugar through the preliminary formation of an additive compound.

Oxidation of β-glucosan.

(a) *The action of hydrogen peroxide on β-glucosan.*—(1 atom of available oxygen in hydrogen peroxide per C_6 unit). In the absence of a catalyst hydrogen peroxide gave negative results. After standing for seven or eight days only slight traces of acidity were developed and over 50% of the hydrogen peroxide still remained. In presence of ferrous sulphate the reaction proceeded fairly rapidly.

60 c.c. of a 2·7% solution of glucosan, containing ferrous sulphate, were mixed with 60 c.c. of hydrogen peroxide solution (0·266% available oxygen). The reaction extended over a period of 24 hours. The acidity developed was equivalent to $N/23$ acid, almost half of which was due to volatile acids. The

progress of the reaction can be followed from the table below:—

Time.	Acidity	Disappearance of oxygen. %
10 min.	$N/40$	45·5
40 ,,	$N/38·4$	51·0
60 ,,	$N/37$	57·8
16 hours	$N/27·4$	94·3
20 ,,	$N/25·9$	95·1
21 ,,	$N/25·3$	96·2
24 ,,	$N/23·2$	100·0

A portion of the liquid was evaporated to dryness under diminished pressure. The residue was boiled under a reflux condenser with 80% ethyl alcohol, the solution being filtered and evaporated to a syrup in a high vacuum. This residual product reduced Fehling's solution, and the copper values determined before and after treatment with dilute acid showed that the oxidation had yielded: dextrose, 10·7 parts; unchanged glucosan, 48·3 parts; non-volatile acids, 41·0 parts.

(*b*) *The action of hypochlorous acid on β-glucosan.*—Owing to the prolonged time necessary for the preparation of pure hypochlorous acid, it was decided to utilise bleaching powder as the source of the oxidising agent. A good specimen of bleaching powder was shaken for a considerable time with distilled water. After standing for a few hours the insoluble calcium salts were filtered off, and the calcium hypochlorite present in the filtrate was determined by analysis. The solutions of the carbohydrate and calcium hypochlorite were mixed in the desired proportions and the hypochlorite was then decomposed by blowing carbon dioxide through the solution from time to time until the oxidation was complete.

(1) 1 *Atom of available oxygen in hypochlorite per* C_6 *unit.* 100 c.c. of a 2·7% solution of β-glucosan were mixed with 100 c.c. of hypochlorite solution, containing available oxygen in the above proportions. There was no variation in temperature on mixing or during the reaction. The total disappearance of oxygen extended over a period of 20 hours, and during that time no acidity was developed. The optical activity underwent the following change:—

Time, hours.	$[\alpha]_D$.
0	−68·6° start
2	−55·2° minimum
24	−68·6° final value

On isolating the residual products, a syrup was obtained which did not reduce Fehling's solution. This was to be expected, since the final value of $[\alpha]_D$ was −68·6°.

(2) 2 *Atoms of available oxygen per* C_6 *unit.* The solutions were well mixed and carbon dioxide was blown through the solution from time to time. The polarimetric readings indicated a fall in the specific rotation from −68·6° to −43·7° after 27 hours.

Time, hours	$[\alpha]_D$.
0	−68·6°
6	−51·1°
24	−42·9°
27	−43·7°

The residual products when isolated, showed a reducing action on Fehling's solution. On the basis of titrations before and after hydrolysis the composition of the mixture was: dextrose, 1 part; unchanged glucosan, 3·44 parts.

(3) 5 *Atoms of available oxygen provided for ea* C_6 *unit.* In these proportions the reaction proceed more vigorously. Within 10 minutes of mixing t temperature rose from 16° to 39°. Acidity w developed to the extent of $N/20$ acid. Polarimet readings were impossible during the intermedia stages owing to the turbidity of the solution a evolution of gas. At the end of 50 hours, when t oxidation ceased, the specific rotation had chang from $[\alpha]_D$ −68·6° to −27°.

100 c.c. of the solution were neutralised a evaporated to dryness; the residue was boiled unc a reflux condenser with alcohol, filtered, and evap ated under diminished pressure to a syrup whi reduced Fehling's solution. The copper reduci value found after boiling with dilute acid, show that a 30·2% conversion of glucosan to dextrose h taken place during the oxidation: dextrose, 1 pa unchanged glucosan, 3·3 parts.

The action of hypochlorous acid on starch.

(*a*) 0·87 *g. of hypochlorous acid* (*from calcium hy chlorite*) *per* 2·7 *g. of starch.* A solution of 5·4 g. Japanese potato starch in 100 c.c. of water was mix with 100 c.c. of hypochlorite solution, the conc tration of which was adjusted to give the abo proportion of available oxygen. The reaction w very slow, the hypochlorous acid being utilised or after the lapse of several days. On examining t solution polarimetrically, it was found to be dext rotatory, the value of α increasing as the availal oxygen was used. Only a very slight acidity w observed at the end of the reaction.

When all oxidation had ceased, 100 c.c. of t solution were evaporated to dryness under diminish pressure. The residue was boiled under a refl condenser with alcohol, filtered, and the alcoho solution evaporated to a syrup under reduced pressu From 2·7 g. of starch the syrup obtained in this w weighed 1·9581 g., showing that about 75% of t starch had been transformed into soluble produc The syrup reduced Fehling's solution, the cop reducing power being 33·7% of that obtained af boiling with dilute acid.

Precipitates produced by the action of phen hydrazine, as was the case in the earlier stages of t work, were somewhat inconclusive, but indicat that maltose, together with its oxidation produc was present.

(*b*) 1·74 *g. of hypochlorous acid* (*from hypochlor solution*) *per* 2·7 *g. of starch.* In these proportic over 90% of the starch reacted. The results w very similar to those quoted above, and examinati of the residual syrup indicated a copper reduci power equal to 90% of that obtained on comple hydrolysis.

The action of hypochlorous acid on cotton cellulose.

(1) 0·87 *g. of hypochlorous acid* (*from calcium hy chlorite solution*) *per* 2·7 *g. of cellulose.* Cott cellulose was found to be remarkably stable to hy chlorous acid when present in the above proportic and when the concentration was 0·87 g. of hy chlorous acid per 100 c.c. After 48 hours the hy chlorous acid was exhausted, but an examinati

the oxidation products showed that 86% of the llulose still remained intact. Only traces of oxy-llulose and oxalic acid were found.

(2) *1·74 g. of hypochlorous acid per 2·7 g. of cellu-se (concentration of acid, 1·74 g. per 100 c.c.).* Even these proportions the change was not exten-ve, although the formation of oxycellulose and alic acid was increased. The weight of the residue om 2·7 g. of cellulose was 2·0711 g., showing a loss weight of 23·2%.

(3) *4·35 g. of hypochlorous acid (from hypochlorite lution) per 2·7 g. of cellulose.* 2·7 g. of cellulose ere mixed with 100 c.c. of acid of 4·35% concentra-on. At the end of the reaction, which extended er almost 48 hours, the residue and filtrate were amined; 20 c c. of the filtrate gave on evaporating dryness, 1·9120 g. of residue. Calcium and lorine were determined in another 20 c.c., the lts being: Ca, 0·69 g; Cl, 0·80 g. Difference, 41 g. No volatile acids were found as products the oxidation.

From 2·7 g. of cellulose the residue weighed 1·9532 g owing a loss in weight equivalent to 27·66%. The sidue in this case was not fibrous but amorphous. was partially soluble in alkaline solution (to the tent of 88·6%). From this alkaline solution the ycellulose could be reprecipitated by means of ids, salts, or alcohol. It gave no blue coloration ith iodine in potassium iodide. Concentrated lphuric acid attacked and dissolved it giving a dark rown solution. It reduced Fehling's solution on oiling.

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DEHYDRATION OF ALCOHOL BY MEANS OF GLYCERIN.*

BY EDMUND KNECHT AND ERIC FRANK MULLER.

It is well known that pure glycerin readily takes up a certain proportion of water which it retains tenaciously at the boiling point of water and even beyond that temperature. It was considered of interest to ascertain whether this property might be utilised for the dehydration of ordinary alcohol, with a view of working out a rapid and convenient process for the preparation of "absolute" alcohol.

In a preliminary experiment some ordinary alcohol (of about 95% strength) was mixed at random with glycerin and distilled from a water bath; pure alcohol came over.

In order to ascertain to what extent pure alcohol is retained by pure glycerin at 100°, a quantitative distillation was carried out. Absolute alcohol (40 g.) mixed with pure glycerin (10 g.) was distilled from a water bath until no more liquid came over, and the distillate collected in a flask provided with a loosely-fitting cork; 37·8 g. of alcohol were recovered, so that 2·2 g. had remained in the glycerin, equivalent to 5·5% of the alcohol taken. By heating the residue in the flask to 180°, a further recovery of 2·15 g. of alcohol was effected, so that the loss was practically nil. (Correction was made in this and other instances for the volume of alcohol vapour remaining in the distillation flask.) This result might appear to indicate that a process based upon the use of glycerin as a dehydrating agent would result in a loss of alcohol if the distillation were carried out on the water bath only. It was shown, however, that if the alcohol contains water the latter appears to be selectively absorbed by the glycerin. This was seen to occur on distilling a mixture of 89·80 g. of alcohol, 9·93 g. of water, and 23·91 g. of glycerin from a water bath: the distillate collected between 78° and 79° weighed 88·77 g., which is equivalent to a 98·8% recovery.

In a further experiment, a litre of commercial alcohol mixed with 24% (by weight) of glycerin and distilled from a water bath gave a yield of 93% of alcohol which came over between 78° and 78·5° and corresponded to a 98% product.

The distillate, tested for glycerin, gave a negative result providing that no more was collected after the thermometer (bulb in vapour) had reached 80°. Beyond this temperature traces of glycerin are liable to pass over; at 85° an appreciable amount (0·05%) was found in the distillate.

From the results of these preliminary trials it was inferred that a single distillation was not sufficient to yield a completely dehydrated product when employing what was considered to be a reasonable amount of glycerin, *i.e.*, an amount which would not unduly depress the final yield. The amounts of glycerin suitable for a first distillation were roughly gauged as follows:—

For 10% water present, 25% glycerin by weight
5% „ „ 20% „ „ „
2% „ „ 15% „ „ „

Double distillation.—By following up the first distillation by a second, in which less glycerin is added, it was found possible to remove almost the whole of the remaining water, as is shown by the following examples:—

50 c.c. of commercial alcohol distilled with 10 c.c. of glycerin gave a yield of 46 c.c. of alcohol, b.p. 78°—79°. The 46 c.c. of this partially dehydrated product were then mixed with 7 c c. of glycerin and redistilled, the distillate, amounting to 42 c.c., being collected up to 78°. The final product showed b.p 77·8°—77·9° and *d* 0·7900

In a further trial 150 c.c. of commercial alcohol on being double distilled with glycerin gave a yield of 126 c.c. of alcohol, b.p. 77·8°—77·9°, d^{15} 0·7950, representing a yield of 84%.

It is thus evident that the proposed method gives a satisfactory product with very little trouble and in sufficiently good yield to be of some practical value in the laboratory. The action of the glycerin, unlike that of burnt lime, is instantaneous, and after adding it to the alcohol distillation can be proceeded with at once.

In testing the final products, the boiling point and specific gravity only were relied upon, as it was

* Read at a meeting of the Manchester Section, on Feb. 1, 1924.

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found that the usual copper sulphate test was too slow to allow of its convenient application to alcohol of high concentration. Incidentally this test was tried on a series of mixtures of alcohol and water, and the results are briefly stated below. They show the time which was found to be required for the first indication of a blue tinge in the copper sulphate.

Water % by weight	0·6	1·24	1·72	2·44	2·73	3·43	6	12
Time in hours	120	26	8	6	5	4	2·5	0·4

The copper sulphate used for the purpose was prepared by precipitating a concentrated solution of ordinary copper sulphate with alcohol and heating the resulting crystalline powder in an air oven to 180°. The tests were carried out in small, well-stoppered glass bottles.

Various alternative modes of procedure have suggested themselves for carrying out the dehydration, and have been tried with more or less success.

One of these, which was quite obvious, was to effect the distillation of the mixture of alcohol and glycerin in a small distillation flask, the mixture being run in continuously through a tap funnel. The result obtained was satisfactory, but it cannot be said that this procedure offers any advantage in the ordinary way.

In a second modification it was sought to effect the whole rectification in a single operation. To this end, the vapour distilling over from a mixture of commercial alcohol and glycerin was caused to pass through a series of three narrow cylindrical wash-bottles, each of which contained a small amount of glycerin. The wash-bottles were contained in a water-bath heated to 78°, and the vapour after leaving the third and last bottle passed directly into the condenser. This modification gave a satisfactory result in that an alcohol passing over entirely at 78° was obtained in a single operation.

A third modification was to cause the vapour issuing from the mixture of alcohol and glycerin to pass through an inverted upright condenser filled with glass beads, over which glycerin was allowed to trickle at the rate of about one drop in five seconds. The tube containing the glass beads was kept hot by blowing a current of steam through the outer jacket of the condenser. The vapour thus dehydr condensed in the ordinary way. This although somewhat more complicated than tl gave a very satisfactory result, in that co alcohol was found to give a yield in a single c of 85% of a product showing d^{15} 0·7959.

The products obtained did not in any ca 100% purity, though it is easy to effect by the a dehydration yielding a 99·5% product. A it is not improbable that further dehydratio be effected by the use of a large excess of g it would seem preferable to resort to the use o lic calcium for the removal of the last traces o

The cost of the process for laboratory use is of the way as far as the glycerin is concerned, 1 of glycerin is sufficient to dehydrate 3 lb. of a this being equivalent to an additional cost of 4 per pound on the latter. On the other hand are compensating advantages in the great re in the time required and in greater cleanliness operations. In case the process were to be em on any extended scale it should be possible to re ate the glycerin in a separate plant.

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The work detailed in this paper was carrie at the Manchester Municipal College of Techn during June and July, 1923, and the paper was w up in August of the same year. The paper announced in the syllabus of the Manchester Se in October, 1923. In the interval between dates and the time of reading the paper, Ma published an elaborate account of his process fo commercial dehydration of alcohol (Chimie et In trie, Oct., 1923), which is based upon practically same principle as our own. The points of differ are: (1) That whereas Mariller's process is inte for large-scale work, ours was originally only inte for laboratory use. (2) In our process, the glyc is added to the alcohol, though we have also opera subsequently by dehydrating the vapour. (3) Mar makes no mention of the possibility of the prese of glycerin in the distillate, whereas we have fo that unless certain conditions are observed distillate will be contaminated. Our paper c tains, in addition, some account of the copper sulph test for determining the strength of alcohol.

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UXITE AS A REFINING AGENT FOR PETROLEUM DISTILLATION.*

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rom the very earliest times practitioners in the of refining have recognised the remarkable acity possessed by certain substances, particularly rcoal and various porous earths, for selectively orbing from natural products in common use ces of impurities which impair the colour, odour, flavour of the material. Among the many sub- nces which possess these absorptive properties high degree are bone charcoal, specially prepared etable charcoals, fuller's earth, floridin, certain ys of Californian and Japanese origin, silica, and mina. Some of the most effective of these belong the category of inorganic gels which have been rmed by the dehydration of a hydrogel such as icic acid or aluminium or ferric hydroxides.

A very cheap and convenient gel is the mineral uxite, which is a soft rock composed principally hydrated aluminium and ferric oxides associated ith varying amounts of silica, lime, titania, and gnesia. The mineral in its natural state has no sorptive qualities, but by roasting to an appro- iate temperature most of the water of combination expelled, whereby the peculiar porous structure developed upon which the refining efficiency epends. Careful study has proved the interesting ct that the chemical composition of a bauxite as no bearing on its effectiveness as a refining agent; auxites of very dissimilar composition will give entical results on the refinery, whilst successive mples with identical chemical analyses may be ntirely different in behaviour (3rd Report of the ritish Association Committee on Colloids, p. 91 *seq.*).

As a refining agent for petroleum, bauxite has narked advantages over many other substances hich also possess adsorptive properties. The size f the pores and nature of the surface happen to be ust appropriate for the purpose in view, namely, he adsorption of the organic sulphur compounds and colouring matter which it is desirable to remove rom petroleum distillates. It is cheap, can be used n granular form (which obviates the need for filter presses and accelerates the filtration process), and an be recovered indefinitely (apart from loss due o disintegration). Though it is now known that auxite when suitably prepared has the power of electively adsorbing both colouring matter and ulphur compounds, the latter property is of com- paratively recent discovery. The use of this material or decolorising kerosene and paraffin wax, however, was adopted by the Burmah Oil Company many ears ago.

The procedure used at the Burmah refinery was as follows:—The bauxite was placed in cylindrical filters measuring approximately 8 ft. by 2 ft. 6 in., and holding about 1 ton, and the kerosene or wax was filtered through until the colour of the outcoming oil was no longer up to the required standard. The spent bauxite was then extracted with benzine in a Merz extractor by continued percolation (after the manner of the Soxhlet apparatus) until no further removal of the adsorbed coloured compounds could be brought about.

The extracted bauxite, after removal of adherent benzine, was then passed through a vertical furnace into which it was dropped from a hopper at the top and fell from one sloping firebrick plate to another until it passed out at the bottom. During the whole period of its passage it came into direct contact with the hot gases (mixed with excess of air) from an oil burner, which oxidised any carbon- aceous matter or hydrocarbons remaining after the extraction. It was then cooled as quickly as possible, when it was seen to be as clean and bright as new bauxite. For decolorising paraffin wax, the filters were steam-jacketed in order to keep the wax in a molten state.

When it became necessary to purify kerosene which contained both coloured matter and odoriferous sulphur compounds, it was found that it was not necessary to remove the sulphur compounds by chemical treatment before using the bauxite for decolorising (though this procedure may still be preferable in certain circumstances on considerations of cost), and that an appropriate bauxite treatment would effect the double purpose.

In June 1918 the first series of successful experi- ments on desulphurising kerosene and benzine by means of bauxite was recorded.

The bauxite was first heated to dull red heat in an oven and used at 200°. This reduced the sulphur in kerosene from 0·134% to less than 0·02%. It was found, moreover, that under the same conditions, but allowing the bauxite to cool in the open air before use, the resulting sulphur was 0·11%. In the light of recent research the first result was due, not to the temperature at which the bauxite was used, but to the absence of moisture from the pores. The proportion of bauxite to kerosene was varied in a series of experiments from 2 to 9 lb. per gallon with the results shown in Table I.

It is interesting to note that in this investigation, mention is made of the rise in temperature which ensues when the kerosene comes in contact with the adsorbent material. This temperature rise became, eventually, the fundamental principle of the "ergo- meter," an apparatus by means of which the efficiency of bauxite is tested.

The following conclusions were arrived at from these experiments:—

* Read at a meeting of the London Section on May 5, 1924.

(1) Bauxite is a colloidal adsorbent of the first order for organic sulphur derivatives.
(2) Freshness of preparation gives best results—*i.e.*, ignition immediately before use.
(3) Bauxite *per se* is a complete and sufficient refining agent for kerosene.
(4) Other sulphurous distillates are also capable of purification by this process.

It was found that the adsorbed sulphur compounds could be to a large extent removed from the exhausted bauxite by means of superheated steam, and to a lesser extent by hot water.

TABLE I.

Material	Treatment.	Sulphur. %
Kerosene	None	0·131
,,	9 lb. bauxite hot from oven, temperature approx 200°* ..	0·017
,,	4 lb. bauxite hot from oven (200°)*	0·017
,,	9 lb. bauxite not freshly ignited	0·110
Kerosene	5 lb./gal. hot from oven	0·018
,,	2 lb./gal. cooled after ignition	0·098
Kerosene	3 lb./gal. hot from oven	0·03
,,	2 lb./gall. hot from oven	0·08
,,	Untreated	0·15
White spirit	Untreated	0·078
,,	2 lb./gall. hot from oven	0·022
,,	Spirit ex steamed bauxite	0·18
Benzine	2 lb./gall. hot from oven	0·014
,,	Untreated	0·078
,,	Spirit steamed out of the spent bauxite	0·44

* Minimum time from oven to treatment

The size of mesh which the bauxite would pass was found to have considerable bearing on the efficiency of the desulphurisation. Very broadly, the smaller the size of particle the greater the efficiency for removing colour, but the slower the rate of filtration; whilst for desulphurisation it was found that 30/60 mesh was the optimum size for small scale working, 20/90 mesh has to be used on the works scale to save waste and to ensure that the oil is in contact with the bauxite for a sufficient length of time.

At this stage refinery opinion on the bauxite process was that it was an excellent decolorising and desulphurising agent, but inconsistent in results. This was afterwards proved to be due to inefficient roasting. Distilling the oil through bauxite was found efficient but inconvenient, whilst filtration through bauxite dust was too lengthy an operation as well as inefficient as regards sulphur removal, though good for decolorising. By agitating oil and dust together, some excellent kerosenes were prepared, but simple filtration through bauxite of 30/60 mesh has proved to be the most convenient method of working the process.

In spite of the fact that bauxite has been used for many years in the refining of petroleum, the mechanism of the reactions which takes place has only been explained recently. It is now practically certain that the phenomenon is one of surface adsorption, and the action of bauxite upon sulphurous oils appears to be strictly analogous with known cases of true adsorption.

(1) Material such as roasted bauxite containing large numbers of microscopic pores is well known to possess an enormous surface area and consequent surface energy.
(2) When oil is allowed to come into contact with freshly-ignited bauxite a considerable rise in temperature is observed, due to the su energy being converted into heat energy
(3) Bauxite obeys Freundlich's rule, which m summarised as follows: $(x/m)^n$ is propor to c, where (in this case) $x = \%$ of to adsorbed by bauxite, $m =$ wt. of bauxit 100 parts kerosene, $c = \%$ of sulphur in sene before filtration, $n =$ a constant.

This formula has been deduced from, and prov apply in, many cases which cannot possibly be than true adsorption—cases in which any che action is out of the question. This being so, reasonable to suppose that the action of bauxi sulphurous kerosene is also true adsorption, the same fundamental law holds in each case.

Experimental verification of the Freundlich la applied to the adsorption of sulphur and colour pounds from kerosene by bauxite.

As a starting point, residue from soda-wa naphtha was used (sulphur, 0·3%; colour in Lovibond cell, Y 8·4, R 2·5). Samples (150 of a wide range of sulphur and colour concentra were prepared by treatment with quantities of ba varying between ¼ to 10 lb. per gallon. As colours to be measured extended far beyond range of the usual tintometers, a column of the lic of which the colour had to be measured, was mat against an equal column of the original crude k sene diluted with benzine, in the Saybolt colorim The colour concentrations so measured were expre as percentages of crude kerosene (thus the colo the original kerosene = 100).

A. Colour.—Six of the above samples with col ranging between 100% and 1·7% were treated ½ lb. of bauxite per gallon. The bauxite (2 mesh) was roasted 1 hour at 500°–540°, and co in a desiccator. 70 c.c. of each sample of kero were shaken for 10 minutes with 3·5 g. of bauxit 20°–21° in the mechanical shaker (5% by wei or ½ lb. per gal.):—

TABLE II.

Initial colour.	Final colour	% Colour removed	x/m
100	52	48	9·6
58	32	45	5·2
42	21	50	4·2
14·2	5·5	61	1·[illegible]
4·6	2·2	52	0·45
3·5	1·7	62	0·34
1·7	0·8	53	0·17

The values of x/m (amount of colour adsorbed gram of bauxite), plotted against the initial co concentrations, give approximately a straight Hence, for coloured compounds, x/m is proportiona the initial concentration of the colour, and Freundlich law is followed approximately, constant $n =$ 1.

B. Sulphur.—Six of the above samples hav sulphur concentrations ranging between 0·23% 0·017% and colours from 3·5% to 0 were trea with 2 lb. of bauxite per gallon. The bauxite prepared in same manner as before. 70 c.c. of e sample were shaken as before, with 14 g. of baux *i.e.*, 2 lb. per gallon. (See Table III.)

In this case x/m = grams of sulphur adsorbed gram of bauxite. These values, when plotted aga

initial sulphur concentration, give a graph ìich more or less approximates to a straight line. the logarithms of the quantities are plotted, a rve is obtained which approximates more closely a straight line. Hence we conclude that for lphur compounds the adsorption only approxi- ıtely follows the Freundlich law. The mean ıdient of the log curve indicates that the value n is of the order of 1·3, *i.e.*, $(x/m)^{1\cdot 3} = k.c.$

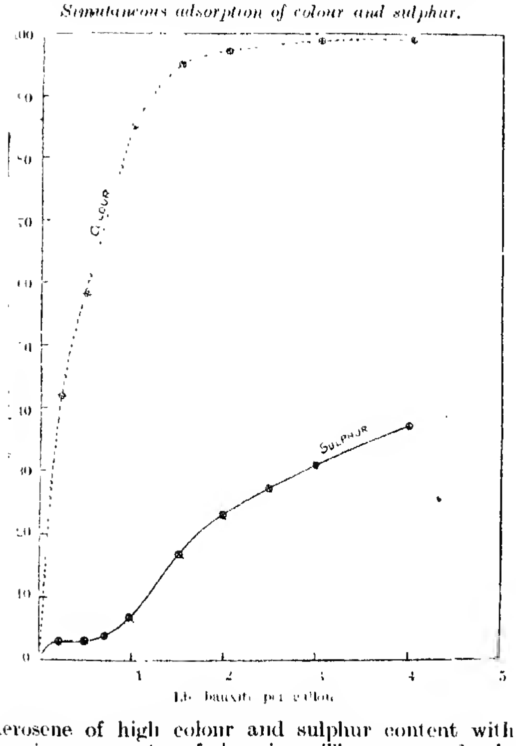
TABLE. III.

al S.	Initial colour.	Final % S.	% S re- moved.	$\frac{x}{m}\times 100$.	$\text{Log}\frac{x}{m}\times 100$	Initial S (g.)	Log Initial S (g.)
0	1·9	0·232	19·7	0·222	$\bar{1}$·3463	0·158	$\bar{1}$·1987
30	3·5	0·20	13	0·117	$\bar{1}$·0682	0·128	$\bar{1}$·1004
07	1·4	0·168	18·9	0·152	$\bar{1}$·1818	0·113	$\bar{1}$·0719
26	0·6	0·103	18·3	0·090	$\bar{2}$·9542	0·069	$\bar{2}$·8388
96	0·2	0·074	23	0·086	$\bar{2}$·9345	0·052	$\bar{2}$·7160
27	—	0·017	37	0·039	$\bar{2}$·5911	0·015	$\bar{2}$·176.

The deviation is no doubt due to the disturbing luence of coloured compounds which are prefer- tially adsorbed.

With regard to the question as to whether the eundlich law holds good for the simultaneous sorption of both colour and sulphur compounds, e results are best understood by reference to the companying figure. This was obtained by treating

Simultaneous adsorption of colour and sulphur.



kerosene of high colour and sulphur content with varying amounts of bauxite. The curve clearly shows that the coloured compounds are adsorbed much more rapidly than, and in preference to, the sulphur compounds. Thus until 85% of the colour has been removed only a small fraction of the sulphur is taken up, but once most of the colour is adsorbed then the removal of sulphur follows the usual course.

The point representing colour 3·5 (Table III.) lies considerably below the line x/m sulphur. The comparatively high colour concentration has lowered the adsorption of sulphur. This bears out the theory of preferential adsorption of colour.

Bauxite as a polymerising agent.

Like all substances possessing a structure consisting of ultramicroscopic capillary tubes, bauxite has the power to bring about chemical changes in compounds with which it comes in contact. This is mostly in evidence among unsaturated hydrocarbon compounds (*e.g.*, pinene and amylene are converted into dipolymerides), and is also seen in the case of the sulphur compounds present in petroleum oils. Decomposition and polymerisation both take place, the intensity of the reactions being favoured by increase of temperature.

If cracked spirit, which contains a large proportion of unsaturated hydrocarbons, is filtered cold through bauxite, the filtrate will be a deeper colour than the original, and if colourless beforehand the spirit will issue from the filter with a deep yellow colour. By maintaining the bauxite at about 100° an orange-brown filtrate is obtained, but if the temperature is raised above the final boiling point of the spirit, say 200°, the issuing vapour on condensing will be perfectly colourless and substantially free from sulphur compounds. The explanation of these results is as follows:—Polymerisation of unsaturated compounds takes place in contact with the bauxite to gums of high molecular weight and boiling point and possessing a dark colour. In the cases of filtration cold and at 100° the incoming liquid dissolves these gums and washes them out of the bauxite, but in the vapour filtration the gums remain in the filtering material because their boiling point is above the surrounding temperature. A similar reaction takes place in the case of the sulphur compounds, the majority of which are very reactive and readily undergo polymerisation.

Two methods of refining petrol or cracked spirit are therefore available: (*a*) by passing the liquid into bauxite maintained at a temperature of about 200°, when it instantly vaporises and passes through the filtering medium in the state of vapour, and (*b*) by passing the liquid through bauxite maintained at 100° and re-distilling the filtrate in the ordinary way. In process (*a*) the gumming polymers remain behind in the bauxite and gradually contaminate it, but a finished product is obtained in one operation. In process (*b*) the polymers are washed out of the bauxite, and thus the active life of the latter is maintained for a longer period. In the subsequent distillation the polymers, being of high boiling point, remain behind in the still, and a colourless distillate is obtained which is free from those compounds which form gum in cracked spirit on standing. The sulphur compounds in petrol are removed in the same way as the gum-forming compounds in cracked spirit. Sulphur compounds in kerosene can also be removed by an adaptation of process (*b*), wherein kerosene is

filtered through bauxite at a temperature of 100°—130° and then cooled and filtered through bauxite at the ordinary temperature. By polymerising the sulphur compounds in the hot filter they are rendered more easily removable by the cold filter than would have been the case if the hot filter were replaced by a cold one. A crude kerosene with a sulphur content of 0·31% was filtered through bauxite maintained at 120° at the rate of 1 lb. per gallon, and the filtrate then re-filtered through cold bauxite at the same rate. After the passage through hot bauxite the sulphur content was 0·26%, and after the subsequent cold filtration it fell to 0·16%. Ordinary filtration through 2 lb. of cold bauxite gave a filtrate with a sulphur content of 0·21%.

The present method of using bauxite may be divided into the following stages:

(1) *Filtration.*—A predetermined volume of oil is filtered through a definite weight of bauxite.

(2) *Steaming out.*—The filter is steamed out until no further kerosene can be removed economically.

(3) *Make up.*—Fresh bauxite is ground to size, and the required quantity added to make up for losses in working.

(4) *Roasting.*—The fresh make-up bauxite and the spent material are roasted in excess of air to remove moisture, the last traces of kerosene, and firmly retained organic matter and carbon, thus freeing the pores for a new run.

In order to understand the conditions required for successful filtration, it is necessary to consider the coloured compounds and sulphur compounds contained in the oil, which may be divided roughly into two groups:—

(1) Those in true solution (sulphur derivatives);

(2) Those in colloidal suspension (colouring matter).

Solid matter in coarse suspension can be removed by purely mechanical filtration through non-adsorbent material such as sand, but matter in solution or colloidal suspension can only be taken out by true adsorption into the pores of some active material of the nature of bauxite. The top layers of the bauxite are therefore engaged in removing the suspended coloured compounds, which cover over the pores and prevent the matter in solution from being adsorbed until it reaches a lower stratum, at which point all the suspended material has been left behind. As soon as these coloured compounds have been removed the bauxite is ready to deal with the sulphur compounds, which are hardly touched at all until the major part of the colour has already gone.

Taking, then, the successive layers of bauxite in a filter, the top is occupied in mechanically removing suspended matter, the next layer takes out the rest of the colour, and the lower layers eliminate the sulphur compounds. In this way, the three active zones move downwards until the coloured compounds are being extracted at the very bottom of the filter. But as no sulphur is taken out until almost all colour has gone, it will be seen that at this stage no sulphur is being eliminated at all. In other words the bauxite is exhausted for desulphurising purposes; it is still capable, however, of removing colour.

For this reason "series-filtration" gives the efficient and economical results. The principle u: lying series-filtration is that of putting the va layers of a large filter into a number of sm filters, so that each layer is capable of rejectic soon as it is exhausted, while no layer is rejected completely exhausted both for decolorising desulphurising.

In working the series-filtration much light thrown on the elimination of colour and sul compounds, for it was found that it was only the filtrate came in contact with fresh bauxite in last filter that any substantial desulphurisation place. Colour was progressively removed in pas through the series of filters, but sulphur compo were only removed in the last filter, as is shown ir following table:—

TABLE IV.

Filter.	Colour of filtrate (Saybolt).	% S in filtrate.	% of tot removed by
1	16°	0 286	8
2	17°	0 286	0
3	18°	0 286	0
4	19°	0 252	19
5 (fresh bauxite)	22°	0 129	60

The principle of first removing colour in orde allow the bauxite full scope to use its desulphuri properties, was employed by placing a layer floridin above the bauxite in the filter. Floridin better decolorising but poorer desulphurising ag than bauxite, and thus each material is made perform that operation for which it is best sui Better results were thus obtained than by using ei material separately. In the following experiment filters were run until the issuing kerosene gav positive reaction with sodium plumbite:—

TABLE V.

Bauxite. g	Filtrate c c	Bauxite and floridin. g g	Filtrate. c c.	Increas %.
10	75	10 + 0	75	—
11	82	10 + 1	90	+ 9
12	90	10 + 2	110	+22
13	97	10 + 3	120	+24
14	105	10 + 4	130	+24
20	150	10 +10	120	−20

The "increase" is the entire amount filtera before a positive reaction occurs with sodium plui ite, by replacing certain amounts of bauxite by eq weights of floridin. Practically no advantage gained by replacing more than 20% of the baux by floridin, and at some point between 30 and 50% diminution in efficiency commences to take place

With 17% floridin and 83% bauxite, the follow figures were obtained:—

TABLE VI.

	Bauxite.	Bauxite and floridin
At 6 lb per gall.	S = 0 122%	S = 0 09%
,, 3 lb ,,	S = 0 163%	S 0 14%
	Original S 0 265%	

By mixing the bauxite and floridin intimate together no advantage is obtained over bauxite alo since a portion of the latter is then occupied in : moving colour instead of being free to adsorb sulph compounds.

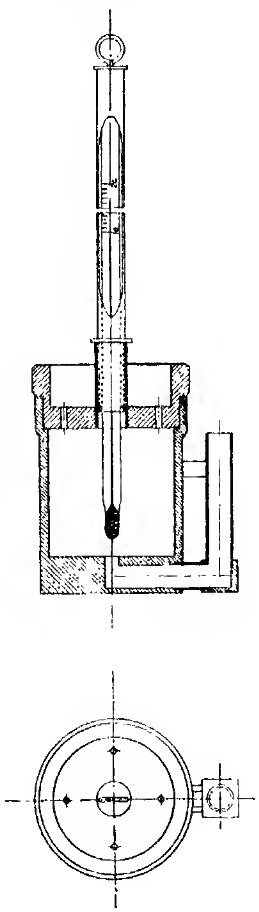
The failure of a filter occasionally to give a go product was attributed to the fact that a long peri of time had elapsed between the initial distillati

the filtration, *i.e.*, to the age of the kerosene. s, however, appears to be fallacious, as the follow- results show, the reason for the improved results bably being that agglomeration of coloured com- unds takes place which renders them easier of ention by the bauxite :—

TABLE VII.

Time after distillation. Days.	% Sulphur in filtrate.	Colour of filtrate (Saybolt).
—	0·116	14°
5	0·11	15°
10	0·086	16
21	0·083	19°
31	0·102	21°

One of the factors which determine the efficiency the bauxite process is the grade of bauxite. A igh-grade bauxite has a large proportion of pore pace, this being directly proportional to the efficiency



Ergometer.
(Half scale)

f the other conditions remain the same. The other esirable characteristic is hardness without brittleness. This is purely an economic desideratum, because a soft or brittle bauxite crumbles badly in the grinding and roasting and the dust formed is waste.

It must be emphasised at this point that it is impossible to find by chemical analysis whether a bauxite is high or low grade, as this appears to have no connexion whatever with its efficiency. Although the proportion of moisture in new unused bauxite is found to be roughly a measure of the pore space, this does not apply to used bauxite. In consequence, the method of testing new or recently activated bauxite for efficiency was a long and laborious task, involving actual filtration tests for colour and sulphur removal.

The length of time required for these tests prohibited their use except for consignments of new bauxite. It was impossible to test samples taken during the roasting of old bauxite to see whether it had received enough treatment or not, so the roasting was carried out empirically in the hope that it would "turn out all right."

It had been observed, however, that when kerosene is allowed to come into contact with activated baux- ite, a considerable rise of temperature occurs, and it was found that the greater the rise, the more efficient is the bauxite for removing colour, while the desul- phurising power is directly proportional to the rise in temperature. This fact has been made use of in practice to determine when the bauxite has been sufficiently roasted, the test being carried out as follows in an apparatus named an "ergometer," illustrated in the accompanying diagram

Sixty grams of freshly-roasted bauxite are cooled to the same temperature as the kerosene residue which is to be used in the test. The bauxite is then placed in the ergometer, which is a metal cylinder 1½ in. in height and 1½ in. in diameter, and holds about 50 grams 20/90 mesh, the temperature being observed by means of a thermometer fitted into a hole in the lid. 20 c.c. of the kerosene are poured into the cup-lid and flow through four small holes on to the bauxite, this quantity being just sufficient to wet the bauxite. The temperature soon com- mences to mount and the maximum rise is taken as the "ergometer number." A new bauxite of good quality which has been properly roasted will give a rise of about 16°. Regenerated bauxite should give 12°–14° rise; and if the rise is less than 10° faulty roasting is at once suspected. This temperature rise is reduced by a large percentage of fines. The total amount of time required for the test is about 10 minutes, so it is a rapid and convenient method of checking the efficacy of the roasting. Since the porous structure is created by the expulsion of water of hydration in the initial roasting, an alternative test for efficiency is available. It has been found that the activity of bauxite as a remover of sul- phur compounds from kerosene is directly propor- tional both to the temperature rise, as measured in the ergometer, and to the percentage of moisture that can be driven off by roasting at 400°–450°. With fresh bauxite therefore both of these phenomena can be used as a measure of activity, whilst in used bauxite the ergometer is the only test.

The following table shows that the maximum activity of various fresh bauxites obtained from

many different sources occurs when the material is roasted at 400° :—

TABLE VIII.

Temp of roasting.	Bauxite. I.	II	III.	IV.	V.	VI
0°	–	0 7°	—	1 1°	0·8°	0 8°
300	—	12 6	—	10 3	5·8	—
400	**18 8°**	**18 7**	**14 6°**	**12 8**	**9 3**	**8 1**
500	15 4	15 3	13 3	11 4	8 6	—
600	14 7	13 7	12 8	10 9	7 7	7 6
700	13	11 2		10 7	7 7	—
800	--	--	--	—	6 2	--
900	8 2	8 8	--	6 7	—	3 6

The following table shows the percentage of moisture removable by roasting at 400°, the ergometer rise (maximum) and the amount of total sulphur removed, all expressed in proportion with the worst sample of bauxite as unity. Direct proportionality—within experimental error– is seen to exist between these three sets of observations.

TABLE IX

Bauxite.	Water removed at 400° C	Ergometer rise.	Sulphur removed.	Colour of filtrate (Saybolt).
A	1	1°	1	18°
B	1 1	1 3	1	18 5
C	1 4	1 4	1 5	19
D	1 9	2	2	24
E	2 94	3	3	24
F	2 9	3 3	3	24
G	4 35	4 6	4	25
H	4 42	4 8	5	26
I	4 72	5 5	5	25

The colour of the filtrate improves progressively with the activity of the bauxite, but the exact relationship between the two has not yet been ascertained.

It is a well-known fact that to obtain the maximum efficiency from bauxite it should be cooled, after roasting, out of contact with air, and used as soon as possible. The reason for this is well shown by ergometer readings on samples exposed to the air for different periods, the decrease in efficiency, owing to adsorption of moisture, being clearly seen. Bauxite was roasted at 450° and divided into five parts :—

TABLE X.

	Ergometer reading.
(1) Cooled in desiccator for 1 hour	11 7°
(2) ,, ,, ,, ,, 17 hours	11 5
(3) ,, ,, open air ,, 1 hour	9 3
(4) ,, ,, ,, ,, 6 hours	8 0
(5) Roasted and kept for 2 years in corked bottle	1 1
(6) No. 5 re-roasted at 400°	12 8

Influence of liquids other than kerosene on the ergometer reading.

With a view to ascertain whether the ergometer could be employed to detect impurities in oil and thus be used as a means of finding out if kerosene had been properly refined, a variety of different fractions and mixtures were tested with a given grade of bauxite roasted under similar conditions. The test proved, however, that the instrument was not sensitive enough for such fine distinctions, though in the widely differing fractions such as petroleum ether and liquid paraffin (medicinal) and liquids such as benzol and xylol pronounced differences in readings were obtained from those observed with kerosene and petrol.

From the above results it can be seen that it is impossible to detect benzol in aviation spirit (Nos. 6 and 7)—although benzol alone gives a distinctly higher reading than straight petrol—and therefore small amounts of impurities in kerosene could h[...] be expected to make a noticeable difference i[...] reading. When testing the activity of bauxit[...] means of the ergometer, it therefore makes lit[...]

TABLE XI.

Material tested	Ergo[...] ri[...]
1. Crude untreated kerosene	1[...]
2. No. 1 after soda wash	1[...]
3 No. 1 after "bauxitising" at 50 lb./gal.	1[...]
4. Kerosene refined by hypochlorite	1[...]
5. No. 4 given further treatment of 2% C.O.V. and ½ lb. bauxite/gall.	1[...]
6. B.P. No 1 petrol	1[...]
7. Shell aviation spirit	1[...]
8. Petroleum ether, b p 40°-60°	1[...]
9. Cracked spirit from gas oil treated with hypochlorite and acid and redistilled to 175°	1[...]
10. Benzol	1[...]
11. Xylol	1[...]
12 Gas oil	1[...]
13. Amylene	1[...]
14. Medicinal liquid paraffin	

no difference whether crude or refined keros[...] used, and if a low figure is obtained it must b[...] to the poor condition of the bauxite and not t[...] liquid employed. Tests carried out to see if wa[...] bauxite produced similar evolution of heat to [...]sene gave results which showed that the actio[...] similar but not identical. The temperature obtained with water places different bauxites [...] same order as regards activity as with ker[...] but the heat evolved is much greater, and in [...]quence the experiments are less easily controll[...] more difficult to carry out satisfactorily. By pl[...] the water results against those given with ke[...] a straight line graph is obtained, thus proving proportionality between the two methods I[...] also noted that the maximum temperature rise in direct proportion to the percentage of wat[...] by roasting at 600°-700°. The maximum rise water is obtained by roasting at a higher tempe[...] than for kerosene, probably owing to direct hyd[...] being a contributory cause of evolution of hea[...] few examples of ergometer readings with wa[...] given below :—

TABLE XII.

Water value.

Material.	Temperatures of roasting. °	E[...] r[...]
New bauxite from Skewen	Unroasted	
,, ,, ,, ,,	400	
,, ,, ,, ,,	650	
,, ,, ,, ,,	900	
French bauxite from Douai	500	
Bauxite from Abadan	500	
Indian bauxite	500	
Bauxite from Hull, Blythe and Co.	500	

The mesh of the bauxite has a considerable [...] on its efficiency. For colour removal, the fi[...] mesh the better are the results—probably o[...] the longer time of contact. For sulphur r[...] efficiency increases with fineness of mesh to a[...]mum, after which increased fineness causes a d[...] in efficiency. The optimum mesh was foun[...] 30/60. This is not practicable on a works[...] because all bauxite finer than 60-mesh would [...] be rejected; thus much greater latitude is e[...] and 20/90-mesh is used. This latitude has adv[...] other than economic. One of the dangers wit[...] the refiner is faced when packing his filters wit[...] mesh bauxite is the formation of channels

ckets. These form a line of least resistance for the , which promptly follows the channels, with the ult that the kerosene merely washes the outside the coarse granules instead of percolating unirmly through the mass. This causes an immense s of efficiency, which is counteracted by the use a wider range of mesh, for then the small particles up the spaces between the larger ones and so tend eliminate channels and air pockets.

The shape and size of the filter does not appear be a vital factor. A convenient size to handle is e of 1 to 2 tons capacity, although there is no reason limit the capacity to this figure. So long as the igth is sufficient to ensure that the oil is in ntact with the bauxite for not less than 15 to 20 inutes, the shape is unimportant and is influenced ly by convenience in handling.

Shape of filters and rate of filtration.

In order to see if any advantage accrued from igthening a filter, equal weights of bauxite were it in filters having a ratio of length to diameter of :1, 4:1, 8:1, 50:1, and an equal volume of rosene was passed through at similar rates.

TABLE XIII.

Ratio l d.	Colour of filtrate (Saybolt).	% Sulphur in filtrate.
2 1	24°	0 206
4 1	24 5°	0 210
8 1	25°	0 205
50 1	25°	0 193

From this it is evident that the shape of the filter within reason) is of no importance, provided that he liquid is in contact with the bauxite for a suffiient time, on which of course depends the pernissible rate of filtration. Three equal filters were un at rates in the proportion of 1 : 10 : 50.

TABLE XIV.

Rate	Colour of filtrate (Saybolt).	% Sulphur in filtrate.
1	24 5°	0 18
10	25°	0 18
50	20 5°	0 18

These figures show that elimination of sulphur compounds is more rapid than the removal of colour, and that it is possible to surpass the critical speed or colour before sulphur removal is effected.

Filtration efficiency is influenced to some extent by the temperature of the bauxite, and the material should be allowed to cool sufficiently to avoid vaporisation or overheating of the kerosene, but not enough to allow the adsorption of moisture. The most appropriate temperature is about 120°.

The elimination of sulphur compounds is not directly proportional to the amount of bauxite used, the curve rising steeply at first but flattening out fairly rapidly.

After the bauxite is exhausted it is allowed to drain for about 1 hour and is then steamed out. Shortly after steam begins to issue from the bottom of the filter the extraction is stopped, and bauxite thus treated with superheated steam (150°) comes out dry to the touch, though still containing 7—12% of moisture and kerosene. Further steaming removes but little kerosene in proportion to the amount of steam used.

The bauxite is next roasted to remove moisture and burn out adsorbed impurities that are not removed by steam. This necessitates a temperature of about 550° in the presence of ample air.

Furnacing.

Any furnace to be successful must fulfil the following desiderata :—(1) Too much grinding and crushing should not take place. (2) Whilst maintaining the temperature required, ample air must be present so that sufficient oxidation may take place. (3) The roasting temperature of 550° must be maintained for a sufficiently long time.

A great number of experiments have been made on treating the bauxite after use by solvents or solutions of chemicals before roasting, but no results were ever obtained which were an improvement on the simple process of steaming out the adherent kerosene. The solvents tried include petrol, alcohol, acetone, benzol, ether, carbon tetrachloride, and mixtures of these, whilst the chemical washes were sodium carbonate, caustic soda, soap, hydrochloric acid, ammonium phosphate, and water and steam under high pressure. In no case, however, was it possible by the use of either hot or cold treatment to remove the whole of the contained impurities, which could only be completely eliminated by roasting in a good oxidising atmosphere. After draining a filter, 90% of the remaining adherent kerosene can be removed by steam, the major portion being expelled before steam issues from the bottom of the filter, and by using steam at 150°–180° the bauxite is left dry to the touch and easy to handle. Another advantage in the steaming process lies in the fact that expulsion of the evil-smelling sulphur compounds does not commence until most of the kerosene is already displaced, whereby it is possible to recover a large portion of the retained kerosene in a fit state for re-filtering.

Various theories have been put forward to account for the supposed "poisoning" of bauxite after prolonged use, such as the formation of sulphates or chlorides of aluminium or iron by the sulphur and chlorine compounds in the oil. Analyses, however, have proved that no accumulation of either sulphate or chloride takes place provided efficient roasting has been employed. The same sample of bauxite has been used and recovered over and over again with very little loss in efficiency and practically no change in chemical composition. Formation of dust due to repeated roasting and cooling brings about a slow, progressive, slight decrease in efficiency, but an occasional sieving will prevent this and maintain a regular standard of activity.

The following tables give examples of regeneration experiments carried out by steaming at 120° and roasting at 600°.

TABLE XV.

	Colour of filtrate. (Saybolt).	Sulphur of filtrate.
	°	%
Fresh bauxite	18	0 22
1st regeneration	17	0 20
2nd "	16	0 23
3rd. "	13	0 19
4th "	13	—
5th "	15	—
6th "	17	0 23
Fresh bauxite	20	0 18
1st regeneration	18 5	0 19
2nd "	18	0 10
3rd "	17	0 19
4th "	17 5	0 19
5th "	18 5	—

TABLE XVI.

Analysis	Fresh bauxite (ignited).	After use 20 times (ignited)
SiO_2	1 59%	1 57%
Al_2O_3, Fe_2O_3, TiO_2	97 26%	96 04%
SO_3	1 15%	1 19%
Fines passing 60-mesh	3%	28%
" " 90 "	0 5%	12%
Ergometer reading	14 5°	9 4°

TABLE XVII.

Experiment	Colour of filtrate (Saybolt).	% S removed.	Ergometer.
	°		°
1	21	40	11 5
2	22 5	43	—
3	25	50	11 5
4	25	41	—
5	25	45	13
7	25	53	—
11	25	48	10 5
12	25	50	
13	25	41	12
14	25	31	10 5
15	25	41	10

The above experiments were done with unhypochlorited naphtha residue, the following intermediate ones with hypochlorited naphtha residues :—

TABLE XVIII.

Experiment.	Colour of filtrate (Saybolt)	% S removed.	Ergometer.
	°		°
6	25	72	—
8	25	58	11
9	25	69	11 5
10	25	65	12 5
16	25	49	9 7
17		63	8 8
18	–	55	9 6
19	—	55	9 0
20	23 5	51	9 4

The increase in dust in the bauxite concurrently with a slight falling off in desulphurising efficiency and lowering of the ergometer reading is clearly shown. The bauxite was steamed *in situ* in the filter and roasted in an externally heated rotary furnace at about 550°, thus being well exposed to a good supply of air, which constitutes the principal feature of successful roasting.

The use of the ergometer in ascertaining the correct conditions for properly roasting used bauxite is clearly seen in the following table :—

TABLE XIX.

	Material.	Roasting Temperature	Roasting Time	Ergometer reading.
		°	hr.	°
	New bauxite	500	1	15 4
(1)	Used do	300	1½	12 9
(2)	" "	500	4	12 8
(3)	" "	600	½	12 7
(4)	" "	600	1¼	13 0
(5)	" "	600	3	14 6
(6)	" "	600	2½	15 1

In experiments 1—5 the bauxite was roasted in a dish in a muffle furnace in which there was not much circulation of air, but in experiment 6 a vc iron tube, heated externally, was employed in heated air was drawn through the mass o bauxite. The increased ergometer reading ind the extra efficiency obtained by thorough oxid of the material roasted. The deleterious e of chemical treatment as a means of assisti regenerating bauxite are also indicated by ergometer readings.

TABLE XX.

Material.	Treatment.	Roasting. ° hr.	r
New bauxite	None	500—1	
Used "	Dilute hydrochloric acid	550—1	
" "	Ammonium phosphate	450—1	
" "	" "	650—3	
" "	Caustic soda	600—1½	
" "	Caustic soda and washed in running water for 6 days	600—2	

The temperature at which fresh bauxite is roa has a very distinct bearing on its efficiency, as a decolorising and a desulphurising agent, in order to obtain the best results it is absol necessary that great care be taken to maintain temperature of the furnace at the proper degree The following table shows this point very tinctly :—

TABLE XXI.

Temp of roasting.	Ergometer rise.	% Moisture remaining.	Colour of filtrate (Saybolt).	% S removed.	Effect of 9 n sunlight on fi
°			°		
None	0	–	—	—	—
200	0 5	26	3	—	–
300	5	9 7	20 5	24	Brownish – gum at s and botto bottle.
400	14	4	23 5	48 5	Yellow, prac no gum.
500	9	1	22 5	58 6	Slightly than 300°,
600	7	0 68	21 5	65·0	
700	7	0 31	21 5	61 2	
800	6	0 22	20 5	—	Colour equ 400°. Gum equa 500°.
960	4 5	0 0	20	40 3	Brown heavy gu surface an tom of bo

The highest temperature attainable in the furn used was 900°, and this was taken as giving c pletely anhydrous bauxite. Other workers, howe employing temperatures of 1500°, as in the cera industry, have observed that bauxite shrinks about half its original volume and in this stat quite valueless as a filtering agent. This due to collapse of the capillary pores owing to par fusion of the bauxite, and it can be seen in the ab table that this phenomenon commences betw 700° and 800°. For all-round efficiency fr bauxite should be roasted at about 400°, at wh the maximum ergometer rise is obtained.

It is also to be noted that the filtrate from bau roasted at 400°—*i.e.*, where maximum ergome rise is obtained—withstood the effects of light a air better than any of the others, which is additio proof that the maximum ergometer figure is a t indication of the state of greatest efficiency of baux

The result of a study of the use of bauxite dust a filtering agent lends additional strength to the the that the principal action of adsorption takes pl

in the capillary pores in the interior of the grains not on the surface of the latter. This applies fly to the sulphur compounds, which are in solution, but in the case of colour where a large portion is probably in colloidal suspension, action of filtration appears to take place largely he surface of the grains. The proof of this is in the increased colour-removing power with ease in size of the grains, whereby the total rnal surface area of a given weight of material ressively increases. Experimental evidence of is shown in the following table :—

TABLE XXII.

ih of auxite.	% of total S removed. By agitation.	% of total S removed. By percolation.	Colour of filtrate (Saybolt). By agitation. °	Colour of filtrate (Saybolt). By percolation. °
0	25	—		—
	23	—	13	17
0	31	33	17	17
	31		—	—
0	33		–	—
	32	37	19	21
0	30	32	21	23
80	25	—	—	—
	24	—	22	—
ing 180	24	—	22¼	—

The maximum figure for removal of sulphur npounds occurring with 30-60 mesh bauxite is bably due to the diameter of the grains being he right order to give the most efficient length he capillary pores. Larger grains will contain s in the interior which have no opening to allow ance of the liquid, whilst in the smaller grains the s may be of a less efficient length.

he table also shows the superiority of the percolation method over that of agitation.

n making tests with the ergometer the effect of t and over-large particles must be taken into ount for two reasons : (a) the lower efficiency of se two extreme grades, and (b) the different ounts of liquid that can be held up by bauxite different mesh. Both these factors act in the same ection, *i.e.*, a lower ergometer reading, and consently bauxite that has been in use for some time l disintegrated to finer mesh by roasting and tion will show a slightly lower reading than the ginal, although it may be perfectly clean. The ct of mesh on the ergometer reading is shown in following table :—

TABLE XXIII.

Mesh of bauxite.	Ergometer rise. °
Held on 10	7 5
10–20	9 1
20 30	13·4
30 40	15 7
40–60	15 3
60–70	15 6
70–90	15 6
Passing 90	12 0

Filtration under pressure and in vacuo.

In order to see whether it was possible to produce tter desulphurising by forcing the kerosene into pores of the bauxite, experiments were carried t in two directions : (a) in which pressures varying om 100 to 240 lb. per sq. in. were applied to the uid above the bauxite, and (b) by evacuating the ntainer in which the bauxite was placed to empty the pores of air and thus allow easier entrance of the kerosene.

The pressure experiments were first conducted in a Mahler bomb, the bauxite and kerosene being introduced together and pressure applied by means of a nitrogen cylinder. No appreciable result, however, was obtained.

TABLE XXIV.

Pressure.	% S in filtrate.
None	0 05
140 lb. per sq in.	0 04
240 ,, ,, ,, ,,	0 04

In the next experiments a U-tube filled with kerosene was attached by one limb to a steam boiler working under 100 lb. pressure, and by the other to the filter containing bauxite. In this way direct filtration was obtained under 100 lb. pressure, the rate of filtration being regulated by a valve at the bottom of the filter. Direct comparisons were then made by using the same filter under atmospheric pressure in the ordinary way.

TABLE XXV.

	100 lb pressure.	Atmospheric pressure.
S in filtrate	0 15%	0 13%
Colour of filtrate	22° Saybolt	23°
S in filtrate	0 22%	0 19%
Colour of filtrate	22° Saybolt	23°

It is evident from these results that increased pressure is of no assistance.

In the vacuum experiment the bauxite was first roasted in air to remove moisture, then transferred to a silica tube attached to a vacuum pump and heating continued for 15 minutes under a pressure of 2—3 mm. The bauxite was then cooled while still *in vacuo*, and kerosene introduced through a tap-funnel without allowing air to enter the tube. After standing for 5 minutes the vacuum was released in order to force kerosene into the pores of the bauxite, and 15 minutes later the kerosene was filtered off under suction. The experiment was repeated using the same apparatus, but without vacuum, for comparison with ordinary filtration.

TABLE XXVI.

	Vacuum. %	Atmospheric pressure. %
Sulphur in filtrate	0 077	0 137
	0 07	0·135

The experiment was next conducted on a larger scale, but in this case the bauxite was roasted in open air and immediately transferred hot to an iron filter in which it was allowed to cool *in vacuo*, the roasting *in vacuo* being dispensed with. The kerosene was run in, and after releasing the vacuum, filtration was performed in the ordinary way.

TABLE XXVII.

	Vacuum. %	Atmospheric. %
Sulphur in 1st 50 c c. of filtrate	0 049	0 04
,, ,, 2nd ,, ,, ,,	0 067	0 077
,, ,, 3rd & 4th ,, ,,	0 132	0 14
Average of whole	0 095	0 099

It appears from this that actual roasting *in vacuo* is necessary in order to free the pores of air, and unless this is done no advantage results, either because the pores have never been really evacuated, or they absorb air extremely rapidly during the short time between removal from the furnace and applica-

tion of the vacuum. Of the two possibilities the former appears probable. It had been hoped that cooling *in vacuo* might have effected an increase in activity, but as roasting *in vacuo* is the deciding factor, this puts the method out of court as regards practical importance.

The increase in activity by roasting *in vacuo* was also apparent from the large amount of heat evolved when the kerosene was run on to the bauxite. The silica tube felt to the touch about 40°, whereas in the comparison experiment without vacuum hardly any increase in temperature could be felt, although from ergometer readings it was known that a rise of about 16° must have taken place. A great difference was also noticeable between the bauxite from the two experiments after filtering off the kerosene, the material from the comparison experiment being of the usual red colour, whilst that from the vacuum treatment was black and had a strong odour of cracked kerosene, the odour of the two filtrates also differing in the same way. No such results were observed in the second series of experiments where actual roasting *in vacuo* was omitted. The increased activity described above must have been very pronounced if the blackening of the bauxite was due to formation of carbon, as the "cracked" odour appears to indicate, but this point was not actually confirmed. Attempts to measure the temperature rise when kerosene was added were unsuccessful, owing to the difficulty of constructing a suitable apparatus, but it is hoped to be able to carry this out later and extend the investigation.

THE TECHNICAL USE OF BAUXITE IN CONNEXION WITH PETROLEUM REFINING.*

BY A. M. O'BRIEN, F.I.C.

Bauxite as a refining agent was first introduced into the petroleum industry by The Burmah Oil Company as far back as 1908, and the author has been associated with its use on the practical scale from the initial days to the present time.

Bauxite, up to date, has been used principally in the granular form, being ground by suitable machinery with the minimum production of dust or "fines" (material that will pass through 90 meshes per square inch).

The best results obtained by the author to date have given not less than 20—25% of fines, calculated on the original bauxite fed to the grinder. There is a limit also to the maximum size of the granules, and this has usually been set at "everything passing through 10 meshes per square inch."

Before use the granules must be incinerated to remove moisture and combined water. This is usually achieved by roasting in excess of air in a rotary kiln, similar to a cement kiln, at 400°—600°.

* Read at a meeting of the London Section on May 5, 1924.

The minimum temperature at which bauxite c heated to obtain efficient results in the subse refining process, is about 350°.

As a test of efficient recovery, or roastin Research department of The Anglo-Persia Company has established a method know the "ergometer test," described in the pre paper. Whilst once roasted bauxite shows a l ergometer test than the same bauxite on subse re-roastings, yet, from a petroleum refining of view, the regenerated bauxite is as efficient once roasted material. If a bauxite after use regeneration exhibits a satisfactory ergometer *i.e.*, 10° rise or over, other things being equal, i reproduce the same results as when in the roasted condition.

The bauxite, after preparation, whether in initial or regeneration stages, should be co preferably without exposure to the atmos Using a water-cooled conveyor of the push plate the bauxite can be delivered at the necessary perature to the vessel intended for its use. temperature depends upon the purpose for whicl bauxite is to be used; *e.g.*, if desulphurising wit regard to colour is intended, then the bauxite probably be delivered into the receiving vess a much higher temperature than when reducti colour only is the objective.

The following results of a filtration of kere clearly indicate the relation of temperature to co and sulphur. The oil fed to the filter was yellow in a Lovibond 18-in. cell, and conta 0·17% of sulphur :—

Temperature of filtration.	Filtrate. Colour (18 in. cell) Lovibond. *Yell.* + *Red.*	Filtrate. Sulphur.
10°	1·5 + 0·40	0·091%
20	2·2 + 0·00	0·087%
30	2·9 + 0·10	0·085%
40	4·0 + 0·58	0·084%
50	6·0 + 0·7	0·08%
60	6·9 + 0·60	0·077%
70	7·4 + 0·5	0·075%
80	8·0 + 0·90	0·072%
90	9·6 + 0·70	0·068%
100	10·4 + 1·0	0·065%

The vessels in which the bauxite is used may v in size up to a 50,000-lb. or 100,000-lb. filter, yield comparable results, irrespective of capac

The container for the bauxite is usually a cylindr vessel, the dimensions of which are ascertained preliminary experiment. The bottom of the c tainer or filter usually carries a perforated grid, which is placed wire gauze, surmounted by fine li or blanket cloth, to hold the bauxite in positi From the underside of the grid it is advantage to take a small pipe up to above the level of the of the container, to prevent air locks by permitt the escape of air occluded in the bauxite and d placed downwards in the column by the incom filtrate. If this air-vent is not used, the bottom out of the filter should be opened as soon as the liq to be filtered is passed on to the top of the bauxi at the same time keeping the top of the baux

ays covered with oil until the total air has been placed from the column.

The most efficient control of the filtrate is by prior asurement of the oil to be filtered, and the comte passage of the whole of the measured quantity. precise method of working will eliminate many ubles by doing away with the personal factor.

After the charge has been filtered through, the er should be allowed to drain. This can be pedited by attaching a vacuum pump to the filter, th the insertion of a receiver between the filter and e pump. By this method the time required for aining of a 4000-lb. filter can be shortened from hours to 2½ hours, and a drier product obtained. ll more liquid may be removed by blowing steam to the bauxite. For example, in the case of rosene, on simple draining some 22% of the oil is tained by the bauxite; after the application of cuum this quantity will be reduced to 18%, or even wer, and with the application of steam to as low as –5%. Furthermore, the time can be reduced from hours by vacuum draining, to 1 hour by vacuum us steam.

Before regenerating the bauxite it is advisable to dd a certain amount of fresh bauxite to make up for e amount lost as "fines" during the handling and sting.

Since bauxite is self-abrasive, transport through a ugh and continuous screw is not desirable. If a veyor with a central shaft is used, it should have ddles set tangentially instead of a continuous m or screw. It is preferable to make use of gies as much as possible, elevation being obtained lifts as and when necessary, and not by bucket vators.

Although for ordinary purposes the optimum size granule is from 10 to 90 meshes per sq. in., a much er grade (almost impalpable powder) can be used h liquids of an extremely low viscosity and high rmeability, such as petrols.

A recent development in the preparation of bauxite s been established on the practical scale by the thor, in which the ground bauxite is charged into the ntainer, and there heated by means of superated steam to a temperature not lower than 350°, er which it is cooled by passing dried air through The liquid to be refined is then passed through e filter, the quantity having been previously termined. The bauxite charge is afterwards subcted to steam, aided by the vacuum pump, and hen fully drained is again treated with superheated eam at a temperature of 350° for regeneration as reviously stated. These operations are carried on ternately.

This method of re-activation precludes a great eal of waste as compared with the method previously described. Furthermore, it minimises the amount of labour required on the plant; in fact, maintenance and running charges are reduced to a minimum.

The use of superheated steam might appear extravagant, but in view of the increased life of the bauxite it is a very economical proposition.

THE DYEING PROPERTIES OF SOME SCOTTISH LICHENS, AND OF A FEW OTHER MATERIALS.

BY T. S. PATTERSON, D.SC., PH.D.

At the instance of the Board of Agriculture for Scotland, Mr. E. J. A. Stewart, M.A., B.Sc., recently collected samples of a number of lichens in various districts of Scotland, and these were handed to me for a comparison of their tinctorial properties. In the majority of tests 5 g. of the specimen were used, but in some instances, where less than 5 g. was available, smaller quantities had to be worked with. Again since many of the samples amounted to little or no more than 5 g., there was small opportunity for variety of treatment, and only one experiment could be carried out. This, of course, rendered it necessary to adopt a uniform procedure such as appeared to be of widest application.

In the dyeing tests, therefore, the following general process was adopted:- 5 g. of the specimen were placed in a 600 c.c. beaker with 250 c.c. of water and 50 c.c. of concentrated ammonia solution. A piece of flannel, six inches long by three broad and weighing approximately 2·5 g., previously wrung out of hot water, was added, and the temperature gradually raised to near the boiling point and kept there for some four hours, another 100 c.c. of water and 50 c.c. of concentrated ammonia being added after about half that time had elapsed. The solution at the end of the four hours had generally evaporated down as far as was possible without risking the breaking of the beaker, so that the dyeing was forced in each case as far as it would go. The flannel was then removed from the solution, washed thoroughly with warm water, and dried. It is not possible to give a satisfactory account of these experiments as a whole without samples of the dyed material, but since it may be useful to others, a few of the results obtained may briefly be mentioned.

Samples of *Parmelia physodes*, Ach., *P. saxatilis*, Ach., and *P. omphalodes*, Ach., were supplied, but as they are already well known and in actual use in various parts of Scotland as the "Crottles," it is not necessary to refer to them. They serve, however, as a standard by which to judge some of the other lichens.

The dyeing properties of *Usnea hirta*, Hoffm., have been described by A. Edge (J. Soc. Dyers and Colourists, 1915, **31**, 3), who found it to give, without ammonia, after short treatment, a yellow colour, and on longer treatment, an orange-brown colour. Dyed from an ammonia solution I found it to give a brownish colour of a yellowish-green shade of no use except perhaps as a standard by which to judge some of the other lichens. Thus, *Evernia prunastri*, Ach., gives a somewhat similar shade to *Usnea hirta*, with rather more colouring matter, but a slightly greater tendency to greenness. *Lobaria pulmonaria*, Hoffm., gave a brownish colour with a little less green in it, and *Sphaerophorus coralloides*, Pers., gave a somewhat better brown. *Platysma glaucum*, Nyl., gave also a greenish-brown shade, although when dyed from an acid bath it gave a

more satisfactory warm fawn colour which might possibly be useful.

Ramalina farinacea, Ach., *Parmelia conspersa f. isidiata*, Leight., both also gave brown shades, the latter evidently containing more colouring matter. *Lobarina scrobiculata*, Nyl., also gave a brown shade of no very great value, but *Lecanora ventosa*, Ach., gave a good deep purple-brown colour which might be of distinct value and is, perhaps, worth further investigation.

Pertusaria dealbata, Nyl, was one of the best lichens examined for the production of a warm brown shade, being distinctly superior to the "Crottles." This is, however, a hard and stony lichen, very difficult to collect from the boulders upon which it grows.

Physcia parietina, De Not, *Stereocaulon coralloides*, Fr., *Cetraria aculeata*, Fr, and *Sphaerophorus fragilis*, Ach., gave delicate grey shades, perhaps better greys being produced by *Parmelia fuliginosa*, Nyl, *Gyrophora cylindrica*, Ach., and *Gyrophora proboscidea*, Ach.; *Ramalina subfarinacea*, Nyl., gives a fairly satisfactory brown shade

Additional experiments were carried out with some of the lichens available in greater quantity. Thus 30 g of a sample of *Parmelia saxatilis* were extracted with boiling water. Flannel dyed with this extract gave a good warm orange-brown. The solution after addition of ammonia dyed a much deeper warm chocolate-brown colour. Similar results were secured from *Parmelia omphalodes*. Another sample of flannel was first mordanted with potassium bichromate and dyed with an ammoniacal extract from *Parmelia omphalodes*, but the addition of the mordant seemed to make little difference in the colour obtained

Various samples of *Lecanora tartarea*, Ach, were submitted. They gave satisfactory results; but as this lichen is already well known they need not be referred to except to state that a portion of a sample from the rocks of Craigellachie, Aviemore, where the lichen is reported by Mr. Stewart to be very abundant, was extracted with absolute alcohol in a Soxhlet apparatus and the alcoholic extract evaporated to dryness From 79 g. of lichen 15·2 g. of extract were obtained This extract dyed, with ammonia, a fine purple colour, which seemed to be of a slightly bluer shade than that obtained from the lichen directly. This might possibly be due to ethylation of the hydroxyl group of the orcinol molecule, ethylation being known to produce this effect in certain other cases

A few other substances were submitted for examination in regard to their tinctorial properties. Of those the best was probably the root of Rhu (*Galium verum*, Linn, Lady's Bedstraw); the colouring matter is contained in the thin outer cover of the root, and dyes a fairly satisfactory terra-cotta colour. With this root the results obtained from aqueous solution without ammonia appear to be better than in presence of ammonia.

In the samples of *Lecanora tartarea* the quantity of orcinol present in the lichen was determined, since it is upon this that the value of the substance depends for the preparation of orchil. Fc purpose two methods somewhat similar in pr have been suggested. One of these is that orig proposed by Stenhouse (Phil. Trans., 184 and improved by H. E. Watt (J., 1908, 61 weighed quantity of the lichen is maceratec sodium carbonate solution, excess of hypoc solution is then added, and the excess titratec with arsenious acid. From the quantity of chlorite used, the quantity of orcinol present m determined. The second method is essentiall of Reymann (Ber., 1875, 8, 790). About 2·5 the powdered lichen are placed in a flask, 25 c $N/1$ caustic soda solution added, the solution up to 250 c.c., and the contents of the flask shaken. When the mixture has settled, 50 of the solution are withdrawn. To this are 5 c.c. of a solution of a mixture made up of of sodium bromide and 25 g. of sodium broma one litre of water. Some hydrochloric acid then some potassium iodide solution are a Bromine, liberated from the mixture of so bromide and sodium bromate, attacks the orc By titrating the iodine liberated by the exce bromine from the potassium iodide, the or content of the lichen can be calculated.

It appears that neither of these methods is gether reliable since they are based on the assum that there is nothing else in the lichen likely t acted upon by the two reagents mentioned. following table, however, gives the results of analyses which were carried out:—

Orcinol content of Lecanora tartarea.

Origin of specimen	Percentage of orcinol. Stenhouse-Watt I	II.	Mean		Reymann I.	II.	I
1. Boulders, Glen Nevis	3·18	3·47	3·32	.	—	—	
2. Crags and moss, Stob Garbh, Ben Laoigh	3·84	4·00	3·92	..	4·69	4·38	
3. Rocks Craigellachie, Aviemore (locally very abundant)	3·6	3·7	3·65	..	–	—	
4. Rocks, Aviemore	3·22	3·16	3·19	.	4·87	4·04	
5. Birch trees, Aviemore	1·15	—	--	.	2·21	1·94	
6. Trees, Glen Garry	2·08	2·10	2·09	..	3·38	3·23	

It will be seen that the analyses by the Stenhou Watt method are consistently higher than th by the bromine method, and since it appears proba that the bromine method is likely to give h rather than low results, the data given by the brom method are probably the more correct.

I am indebted to the Board of Agriculture Scotland for kindly consenting to the publicati of this paper.

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University of Glasgow.

THE INFLUENCE OF MICRO-ORGANISMS THE WEATHERING OF WOOL AND COTTON.

BY S. R. TROTMAN AND R. W. SUTTON.

In describing the properties of a textile fibr a high place is given to durability or permanen when exposed to air under ordinary condition Unless a fibre possesses this property to a marke

rce it is, naturally, of little use for textile pur-es. But no known fibre can be described as lly permanent, though cellulose acetate approaches s ideal very closely. Quite apart from the stresses d strains of ordinary wear, there is another factor ich causes the gradual disintegration of textile terials and which, for want of a better name, is med "weathering." Sensitiveness to the influence weathering is, thus, an important property, and ich work has been done with the object of deter-ning the causes which produce this effect. These

Langsdale (J., 1923, 12 T) showed that air containing small quantities of ozone attacked the epithelial scales, producing soluble sulphur and an increased percentage of soluble nitrogen. Oxidising agents such as persulphates produce a yellowish colour similar to that of weathered wool and cause rapid destruction of both epithelial scales and tensile strength. They proved also (*loc. cit.*) that effects similar to weathering could be produced by the action of bacteria such as *B. subtilis*. In fact it appears likely that bacteria play a considerable part

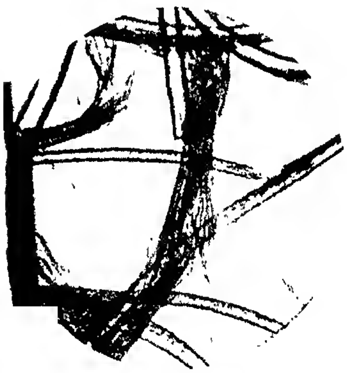

FIG. 2.

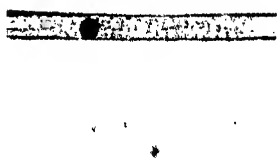

FIG. 1.

FIG. 3.

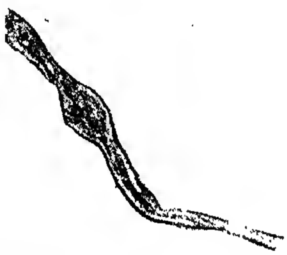

FIG. 4.

FIG. 5.

complex. The power of resistance to weathering y be diminished by faulty physical or chemical cesses in the preparation of the goods. Atmo-eric oxygen and actinic light appear to be among chief causes of natural weathering. Thus, in case of wool, Kertesz (J., 1919, 496A) concludes at all the effects of weathering could be produced y actinic light alone, and that while ozone produces nderness it does not give rise to the peculiar effects ssociated with weathering. Whitaker (J., 1914, 79) has suggested that weathering is accompanied by de-amination, whilst Fort and Lloyd (J., 1914, 306) arrived at an exactly contrary conclusion, namely, that free amino groups are produced. Trotman and

in the destruction of textile fibres by weathering. These experiments have now been confirmed.

Pieces of woollen fabric were sterilised by boiling with water, inoculated with a culture of *B. subtilis*, and incubated at 37·5°. The progressive damage can be followed easily by microscopical examination. At the end of 48 hours the epithelial scales had become faint in outline and in some cases had disappeared entirely. A fibre is shown in Fig. 1.

At this stage the fabric had a decreased shrinking power and an apparent increased affinity for acid dyestuffs. The shrinkage diminished in one case from 35·4% to 11·2%. Upon continued incubation, the fabric became gradually thinner and the scales

disappeared altogether. In about five days it was quite rotten and the fibres had become disintegrated with the liberation of the spindle-shaped cortical cells (Figs. 2 and 3).

The apparent affinity for both acid and basic dyestuffs was considerably greater than in the original material, but the fabric broke down altogether when boiled with water. The solution obtained contained sulphides, gave a precipitate with tannic acid, a strong biuret reaction, a turbidity with Acid Magenta and Methylene Blue, but no precipitate with ammonium sulphate. Similar results were obtained with *B. mesentericus*—another common aereal organism.

The action of B. subtilis on cotton.

The weathering of cotton has been investigated by Cross, Dorée, Turner, and others. Both Dorée and Turner arrived at the same conclusion, namely, that actinic rays were the chief disintegrating agent. Removal of the oxygen from the air surrounding the fibres reduced the destructive action of light but did not eliminate it entirely. The presence of small quantities of ozone accelerated the weathering effects. Dorée concluded that light has a twofold action on cotton. The ultraviolet rays exercise a physical disintegrating effect. If the cotton contains moisture, traces of ozone are also formed on the surface. Ozone attacks cellulose producing a cellulose peroxide, an acid derivative, and carbon dioxide. These effects are intensified by the presence of traces of metallic compounds which act as catalysts.

Micro-organisms constitute another factor in weathering, the importance of which is sometimes overlooked. Fleming and Thaysen (Biochem. J., 1920, 25; 1921, 407) found that good Indian raw cotton contained normally 1·4 million bacteria per gram. If less than 9% of moisture is present this number does not increase, but when the water content exceeds 9% growth is very rapid. They employed a swelling test, depending upon the presence of the cuticle to determine whether cotton hairs have been attacked by bacteria. When treated with a cellulose solvent such as Schweitzer solution, an undamaged hair shows the characteristic globular swellings, while if attacked by bacteria the cell walls swell up uniformly owing to the absence of cuticle.

When cotton is incubated with a culture of *B. subtilis* the first effect observed is a swelling up of the cell walls and loss of natural twist. This is accompanied by the formation of occasional globular swellings (Fig. 4) which sometimes cause rupture of the cuticle (Fig. 5). These swellings are not identical with those described by Denham (J. Textile Inst., 1923, T124), since they were not found in the original cotton. The tensile strength, in the case of cotton yarns, increased slightly at first, reaching a maximum in three days. After this it decreased, becoming less than that of the original cotton. The water content was in all cases the same when the samples were tested.

The following table illustrates the rise and fall in tensile strength:—

Time of incubation	Tensile strength.
Original cotton	15·0
After 24 hours	15·4
„ 48 „	16·5
„ 96 „	18·4
„ 7 days	12·0

The swelling is accompanied by a slight decrease in length. The tensile strength increases as the swelling proceeds, till the globular formations become marked. Loss of tensile strength seems to become apparent when the globular swellings are eviden[illegible] The incubated cotton appears also to have a sligh[illegible] increased affinity for Benzopurpurin. These poi[illegible] are summarised in the following table. Six lots [illegible] Egyptian cotton yarn, each exactly 60 yards [illegible] length, were inoculated with a culture of *B. sub*[illegible] and incubated at 37·5°. One lot was removed [illegible] the end of each three days, washed, and examined. At the end of the experiment the samples, togethe[r] with a control, were wetted with water and allowe[d] to dry at room temperature for several days to ensure the same "condition" with regard to moisture:—

No. exp.	Duration of exp. Days.	Length yd.	in.	Tensile strength	Micro[illegible] appearance
0	—	60	0	1·30	
1	4	60	0	1·34	Fibres sw[illegible] with little [illegible]
2	7	60	0	1·43	„
3	10	59	2	1·45	„
4	13	59	25	0·95	Increase in [illegible]age
5	16	59	25	0·97	„ „
6	19	59	2	1·00	„ „

Samples Nos. 4, 5, and 6 contained [m]ore of the globular swellings than the earlier on[es] and it will be noticed that this point corres[ponds] with the decrease in tensile strength. In all [case]s Schweitzer reagent gave very few charac[teri]stic globular swellings.

The use of *B. subtilis* has been [advocate]d for [the] removal of proteins from cotto[n]. The p[ercentage] of nitrogen present in the cotto[n was d]etermined [at] the beginning and end of the [experimen]t. Only [a] very small decrease was found [and this] has b[een] confirmed on other occasions, an[d it is] proba[ble] that *B. subtilis* is of little use for this [purp]ose. [Nor] does it remove starch nearly as rapidly as diast[ase], though the contrary has been maintai[ned] by ot[her] observers. The action of *B. mesenteri[cus]* [was] tes[ted] in a similar manner. As with wool, th[e] [res]ults w[ere] the same but the action was less marke[d]. A sim[ilar] swelling of the fibres was observed together with [the] formation of occasional globular swellings. [The] swelling is also accompanied by an initial incre[ase] in tensile strength rising to a maximum and [then] gradually falling. After four days' incuba[tion], [in] one example, the tensile strength increased from 9·66 to 10·88 and a small but distinct increase [in] affinity for Benzopurpurin was noticed. Prolonged incubation gradually produced a tensile stren[gth] below that of the original, as with *B. subtilis*.

Experiments with other types of bacteria a[re] in progress.

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THE SUBMERGED CORROSION OF IRON.*

BY W. G. WHITMAN AND R. P. RUSSELL.

The electrochemical explanation of corrosive action as quite generally accepted soon after its formulation by Whitney[1] and its early development by Walker and other investigators. In more recent years this concept has been severely attacked by proponents of other theories, notably those of direct oxidation[2] and of catalytic colloidal action.[3] The weight of experimental evidence, however, strongly indicates that corrosion is fundamentally electrochemical in nature and that the processes can best explained along electrochemical lines. Certain modifications of the earlier ideas are necessary, and investigations of men who have attacked the electrochemical theory have assisted in clearing up many points and in bringing out the picture which have at present.

Experimental foundation.

Our present knowledge of the facts in submerged corrosion must serve as the basis for any theoretical discussion. Any valid theory of corrosion must adequately explain all the facts given in the numbered paragraphs below. The paragraphs are divided three groups—(1) Natural waters; (2) Alkaline waters; (3) Acids. In Class A of each group are observations which have been repeatedly checked by many investigators, and are matters of common knowledge. In Class B of each group are a series of facts which have recently been observed in this laboratory and in the laboratories of the National Tube Company. These latter observations, although not widely known, have an important bearing on the theory of corrosion.

1. *Ordinary natural waters.*

(1) Dissolved oxygen is necessary for appreciable corrosion of iron or steel at ordinary temperatures, and hydrogen is not evolved except in minute quantities.

The amount of corrosion in a given natural water is proportional to the dissolved oxygen concentration. The rate of corrosion increases with temperature.

Rust formed by the corrosion process is a mixture of ferrous and ferric compounds, the ferrous being adjacent to the metal, and the ferric in the outer layers of the rust film.

The rate of corrosion over long periods of time is different in different natural waters.

(5) The composition or surface condition of the metal has practically no effect on the ultimate rate of corrosion.

(6) Dissimilar metals in contact cause accelerated corrosion on the metal which acts as anode.

B. (1) The amount of corrosion when dissimilar metals are in contact is proportional to the extra surface due to the second metal. That is, if copper is in contact with steel, the total corrosion, though localised on the steel, is the same as if the entire effective area were steel.

(2) Corrosion increases with velocity.

(3) The same initial corrosion rate is obtained in different natural waters, although the ultimate rates are widely different. The rate decreases with time.

(4) Between p_H 4·5 and 9·5 at ordinary oxygen concentrations, the corrosion rate in a given water is constant, and the addition of mineral acid or alkali between these limits has no effect.

(5) The final corrosion rate in natural waters is not influenced by the thickness of the rust film within wide limits.

2. *Alkaline waters.*

A. (1) Corrosion is decreased by increasing the alkalinity.

B. (1) In solutions more alkaline than p_H 9·5 the initial rate of corrosion is the same as in neutral water; this corrosion rate decreases with time to a constant value depending on the p_H.

(2) After a constant low corrosion rate is obtained in alkaline water, if the corroding metal is reimmersed in neutral water, the rate of corrosion increases gradually with time until finally the normal rate for neutral water is obtained.

(3) There is no "critical concentration" of increased corrosion with increasing alkalinity.

3. *Non-oxidising acids.*

A. (1) Corrosion in acids is accompanied by the evolution of gaseous hydrogen.

(2) Increase in acidity (p_H) increases the corrosion.

(3) In contradistinction to natural waters, the composition has a marked effect on corrosion by acids.

(4) The presence of dissolved oxygen increases the rate of corrosion, particularly at high velocities.

(5) Corrosion may be greatly accelerated by dissimilar metals in contact. The acceleration may be much more than proportional to the extra surface.

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* At a meeting of the American Section on April 18, 1924.

[1] J. Amer. Chem Soc., 1903 25, 394.

[2] ...gh, 6th Rept. Corrosion Res. Comm. Inst. of Metals, 1922.

[3] Carnegie Memoirs, Iron and Steel Inst., 1922, 11.

B. (1) At ordinary oxygen concentrations, the addition of mineral acid does not cause the evolution of hydrogen gas in appreciable quantities until the solution is made more acid than p_H 4·5. With lowered oxygen concentration, however, hydrogen can be evolved at a p_H at least as high as 6.

(2) When the p_H is more acid than 4, corrosion by dissolved oxygen is more rapid than in neutral water.

We believe that these facts are most logically explained along electrochemical lines, as brought out in the following discussion.

General theory

The initial reaction in the submerged corrosion of iron is electrochemical and operates through a corrosion cell. At the anodic electrode of this cell the corroded metal sends ferrous ions into solution according to the reaction $Fe + 2\oplus = Fe^{\cdot\cdot}$ (1). A corresponding reduction* occurs at the cathode area, usually the deposition of hydrogen ions as atomic hydrogen or the solution of dissolved oxygen to form hydroxide ions. The cathode reaction for hydrogen deposition† may be expressed as $2H^{\cdot} = 2H + 2\oplus$ (2), and for oxygen solution as $\frac{1}{2}O_2 + H_2O = 2OH' + 2\oplus$ (3).

Films of corrosion products exert a protective action which depends primarily upon the conditions attending their formation. Even the ordinary rust formed on iron by natural waters exhibits some degree of protectiveness, and certain waters build up more resistant layers than do others. The solubility, density and adherence of the rust film to the metal are vital characteristics. In alkaline solutions, the reason for reduced corrosion is the greater film protectiveness due to decreased solubility of the rust. The effect of neutral salts in the water, while not yet fully understood, is undoubtedly attributable to their action on protective films.

The electrochemical theory is fundamentally based on the conception that the corrosion reactions take place simultaneously at two electrodes. This is in contradiction to the direct oxidation theory, which considers that the oxygen reacts only at the point where the metal is corroding. The latter theory cannot, however, explain the action of other metals, such as copper, in contact with the steel. The advocates of the theory of direct oxidation have failed to appreciate the fact that, although the anode and cathode areas may be widely separated in some cases, in others they may be very closely adjacent as in the corrosion of a single piece of metal. It is entirely possible for a single area to act both as cathode and anode, being cathodic towards another area of higher solution pressure and anodic towards one of lower solution pressure. Furthermore, the products of corrosion or an area protected by a film often act cathodically towards the corroding metal.

With these general considerations, we can proceed to the discussion of the corrosion of iron under different sets of conditions. To assist in this discussion, Fig. 1 has been drawn to show the effect of hydrogen-ion concentration, velocity, and oxygen concentration on the submerged corrosion of iron and steel.

Corrosion of steel vs. hydrogen-ion concentration of solution with varying oxygen concentration and velocity.

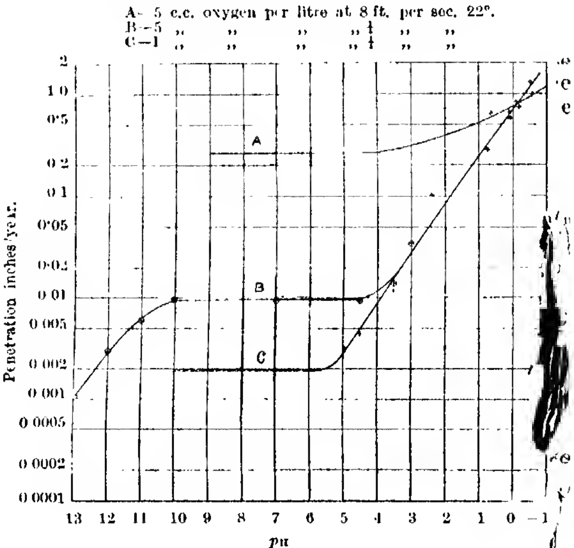

FIG. 1.

The data for this plot have been obtained from the following sources:—Acid corrosion below p_H 2⅟₂ from Whitman, Russell, Welling, and Cochrane.[5] Corrosion at p_H 8, from Speller and Kendall.[6] All other data from Whitman, Russell, and Altieri.[7]

* While these two are the most common cathode reactions there are a number of other reactions possible under very special conditions, such as the deposition of copper, the solution of dissolved chlorine to form chloride ions, and the reduction of nitric acid.

† It should be noted that the oxygen effect has usually been expressed as an oxidation (depolarisation) of the atomic hydrogen formed by reaction (2). Thus Wilson[4] gives the process in the following reactions:— $2H^{\cdot} = 2H + 2\oplus$; $2H + \frac{1}{2}O_2 = H_2O$. If these reactions are written in full showing the hydrogen ion coming from the dissociation of water, they would have the form

$$2H_2O = 2H^{\cdot} + 2OH' = 2H + 2\oplus + 2OH'$$
$$2H + 2\oplus + 2OH' + \frac{1}{2}O_2 = H_2O + 2\oplus + 2OH'$$

By adding the two equations and cancelling 1 mol. of water the reactions reduce to the form

$$H_2O + \frac{1}{2}O_2 = 2OH' + 2\oplus,$$

which is identical with reaction (3) given above. It is thus evident that the net result of Wilson's series reactions is the same as is obtained when oxygen is considered to react directly at the cathode. The authors themselves have used Wilson's equations in earlier papers, but now believe that reaction (3) expresses the facts in a more direct and convenient form, and also allows the direct computation of the electrode potential at the cathode. Furthermore, the corrosion of a metal like copper, which is below hydrogen in the electromotive series, can be more readily visualised on the basis of a direct oxygen electrode reaction than by considering that hydrogen must first be deposited. The situation closely parallels the controversy about the true cathode reaction in the electrolysis of sodium chloride, *i.e.*, does sodium deposit first and then decompose water to form sodium hydroxide and hydrogen, or is hydrogen deposition the primary electrode reaction? This question has been decided in favour of direct hydrogen deposition since the electrolysis of salt can be carried out with less voltage than would be necessary for sodium deposition. Similarly, in the case of oxygen corrosion, the direct oxygen electrode reaction can occur under conditions where atomic hydrogen would not theoretically be deposited unless a depolariser were present.

[4] Wilson, Ind. Eng. Chem., 1923, 15, 127.

[5] Ind. Eng. Chem., 1923, 15, 672.
[6] *Ibid.*, 1923, 15, 134.
[7] To appear in Ind. Eng. Chem.

Corrosion by natural water.

The corrosion of steel by natural waters is almost entirely a question of action by the dissolved oxygen in the water, opposed by the protective action of rust films.

The potential for corrosion of iron by oxygen is so high‡ that it is never the controlling feature in the process. The actual rate of corrosion is limited primarily by two factors: (1) The rate at which dissolved oxygen diffuses into the cathode surface, and (2) the formation of protective films.

The rate of oxygen diffusion is determined by the oxygen concentration, by the distance through which it must diffuse from the main solution to the cathode area, and by the specific resistance of this layer where diffusion occurs. The authors have compared Speller's data (*loc. cit.*) on the corrosion of steel pipe by natural waters and further data of their own with the figures for heat transfer from water to pipe under the same conditions of temperature and velocity. They find that the rate of oxygen diffusion (and hence the rate of corrosion) corresponds to diffusion through a film of quiet water about 0·3 mm. in thickness when the velocity is 0·15 ft. per sec. in a ½-in. pipe at room temperature. It is rather surprising to find that the corrosion rate is fairly independent of the amount of rust on the iron after the initial rust film has been formed. For example, in Cambridge water at 8° C. with a very thin rust film (approximately 1 mm. thick), the corrosion rate was found to be 0·00061 in. per yr. per c.c. of oxygen per litre: after corrosion had continued for three months and the rust film had grown to about 5 mm. thick, the corrosion rate was the same. Now since this rust film may be 5 mm. thick, it must be true that the oxygen does not have to diffuse into the metal but reacts on or just inside the surface of the rust. This would indicate that the rust is itself the cathode surface where oxygen is deposited and OH′ ions are formed.

With this concept the action of protective films (which differs for different waters) may be visualised as follows. The protective film prevents effective electrolytic action between the outside of the rust and the metal, and as a result oxygen must diffuse underneath the surface of the rust film before electrolytic contact is established. Thus the oxygen diffusion is slower when a more protective film is formed, because the path of diffusion to the cathode has been lengthened.*

The corrosion of steel by natural waters containing dissolved oxygen is independent of the hydrogen-ion concentration over a considerable range. Thus if the p_H value of a given natural water saturated with oxygen is varied from about 10 to 4·5 at room temperature by adding sodium hydroxide or hydrochloric acid, the corrosion rate will be unchanged (see Fig. 1). The constancy of corrosion rate with varying p_H is explained by considering the composition of the liquid in direct contact with the metal over this range.

The possibility of a difference in the compositions of the solution in direct contact with the surface of the corroding metal and the main solution itself is a factor which has not received proper appreciation in corrosion studies. Thus, the corrosion of iron in natural water results in the formation of a rust which is highly oxidised to the ferric state on the outside, but which consists of ferrous hydroxide in the inside layers adjacent to the metal. Now ferrous hydroxide is slightly soluble, and because of this solubility, a saturated solution of ferrous hydroxide is somewhat alkaline and has a p_H value of about 9·5. From the solubility product $(Fe^{\cdot\cdot}) \times (OH')^2 = 1{\cdot}6 \times 10^{-14}$, it can be calculated that if the solution against the metal had p_H 7, *i.e.*, if it were absolutely neutral, the ferrous-ion concentration would have to be 1·6 molal before ferrous hydroxide would be precipitated. Similarly, at p_H 6, the saturation value would be 160 molal. We know, however, that ferrous rust is formed in the corrosion of iron by neutral water (containing oxygen) and even by water of p_H 5. It is therefore evident that the solution around the ferrous hydroxide rust cannot have a p_H 5, or even one of 7, since the rust does not dissolve. Hence the p_H of the film liquid must be on the alkaline side as long as any rust is present, even though the main solution may be somewhat acidic.

While the process of intermixing between the main solution and this alkaline film tends to neutralise the film, a fresh supply of ferrous hydroxide is being constantly produced by the process of corrosion. The main solution can therefore effectively neutralise the film only when sufficient acid is diffusing in to equal the production of OH′ ions by corrosion. Now the hydrogen-ion concentration of a neutral solution (p_H 7) is so low that it cannot neutralise the alkaline ferrous hydroxide liquor. Such neutralisation can be effected only by a main solution, the acidity of which is approximately equal to or greater than the alkalinity due to the ferrous hydroxide. This acidity is realised by a hydrochloric acid solution with p_H 4·5, and we find by experiment that this p_H actually marks the limit of the constant natural water range of corrosion, and that hydrogen evolution commences at this point in waters at room temperature which are saturated with oxygen. Solutions of lower oxygen concentration will evolve hydrogen with less acidity, as is shown in Fig. 1, because the rate of ferrous hydroxide production is cut down and it becomes easier to neutralise and dissolve the film. In this connexion solutions of a weak acid, such as carbonic acid, will

‡ The potential of the oxygen reaction at room temperature can be calculated from the normal potentials of oxygen and iron when the ferrous- (or hydroxide- (or hydrogen-)ion concentrations are known, using the ... equation. This method is presented in more detail later for the ... reaction under "Acid corrosion" Fig. 2 shows the oxygen ... plotted against the p_H of the solution for several ferrous-ion concentrations. It will be seen that in saturated ferrous hydroxide solution ... potential is about 1·74 volts, whereas that for the hydrogen evolution ... 0·030 volt (see Fig. 3), thus justifying the assumption that oxygen ... part in the direct cathode reaction rather than acting as a depolariser ... atomic hydrogen. *It should be emphasised that the potential of this reaction is constant, regardless of the alkalinity so long as a saturated hydrogen solution is in contact with the metal.*

* The assumption that corrosion proceeds by the oxidation of ferrous to ferric with the subsequent reaction of this ferric iron with metal to form ferrous, may be the actual mechanism. This is, however, a ... point since zinc apparently corrodes in a similar manner, whereas ... stage of oxidation can exist in its rust film. The correct explanation ... should therefore be general and not specific to iron.

neutralise the film at a lower hydrogen-ion concentration than is required by a strong acid such as hydrochloric acid. The weak acid has a greater total acidity at the same p_H and therefore has a greater neutralising power.[7]

Factors affecting oxygen diffusion.

Since the film protectiveness is maintained constant over the entire natural water range, the rate of corrosion in any given natural water is determined by the rate of oxygen diffusion alone. The composition and surface structure of the iron or steel are of practically no importance, and all commercial steels corrode at the same rate. The work of Hadfield,[8] Richardson,[9] and others has experimentally demonstrated this point.

The factors controlling oxygen diffusion in any given water (*i.e.*, the film protectiveness being constant) are oxygen concentration, velocity, and temperature. The diffusion rate is directly proportional to the oxygen concentration and this is therefore the most important factor in the problem.

The effect of velocity in natural water corrosion is to increase the rate of oxygen diffusion by thinning down the layer of fairly quiet liquid against the surface through which the oxygen must diffuse. Speller's data (*loc. cit.*) on this point are in fair agreement with data on the effect of velocity in heat transfer. In the latter case, it is found that the heat transfer coefficient increases as about the 0·8 power of the velocity of the fluid. The pipe corrosion observed by Speller also increased with velocity at about the same rate. The effect of increased temperature on corrosion by oxygen diffusion is primarily to make diffusion easier because the liquid is more fluid. We find that the temperature effect in heat transfer can be approximated by stating that the rate increases with the 0·8 power of the fluidity of the liquid. It seems probable that a similar relationship holds in the case of corrosion by natural waters, although the data are not yet conclusive.

Alkaline corrosion.

On the alkaline side of p_H 9·5, increased OH′ concentration makes the film liquid more alkaline. The relationship between the concentrations in the film liquid and the main solution is shown in Fig. 3. Solutions which are more alkaline than p_H 9·5 or more acid than 4·5, have a higher ion concentration (OH′ or H˙) than exists in a saturated ferrous hydroxide solution. They, therefore, overbalance the effect of the ferrous hydroxide, and maintain the film liquid at practically the same concentration as exists in the main solution. In the range between p_H 4·5 and 9·5, however, the concentration of either OH′ or H˙ is so low that the main liquor has very little effect on the film and the latter maintains its p_H of 9·5.

The films formed in alkaline solutions beyond p_H 9·5 will therefore be less soluble than those formed in natural water, and the solubility will decrease as the alkalinity increases. From the solubility product of ferrous hydroxide we see that a tenfold increase in OH′ concentration means a 100-fold decrease in the ferrous ion. Films formed in these alkaline liquids will therefore be precipitated more directly and protectively upon the metal surface and the corrosion rate will be reduced. Wilson (*loc. cit.*) and others have attributed the decreased corrosion in alkalis to the very small concentration of hydrogen ions in the solution, using the concept that hydrogen deposition is the first stage in the oxygen reaction. This viewpoint appears entirely untenable on two grounds. In the first place, the potential for either the oxygen or the hydrogen reaction is independent of the alkalinity and the depletion of hydrogen ions cannot be the controlling factor *per se*. In the second place, the type of corrosion result obtained by Speller and Texter[10] and by the authors strongly indicates that the action is one of protective films. Speller and Texter carried out experiments running alkaline solutions through pipes, which have been paralleled by the authors under different conditions. In both cases, it was found that the rate of corrosion in an alkaline solution was initially as high as if the solution were neutral, but that the rate progressively decreased with time, corresponding to the building up of a protective film. Furthermore the authors found that this protective film was readily destroyed when neutral water was substituted for the alkaline solution, and that a considerable time was required before the corrosion rate increased to its normal value for a neutral solution. The character of the corrosion curve with increasing alkali is shown in Fig. 1.

The presence of other film-forming compounds such as sodium silicate gives considerable protection against corrosion at much lower concentration than are required with sodium hydroxide. These materials are finding commercial use as corrosion preventatives.

[7] Whitman, Russell and Altieri *loc. cit.*
[8] Engineer, 1922, **133**, 414.
[9] Trans. Amer. Inst. Chem. Eng., 1920, **13**, Part 1., 64.
[10] Ind. Eng. Chem., 1924, **16**, 393.

(*To be continued.*)

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HE SUBMERGED CORROSION OF IRON.

BY W. G. WHITMAN AND R. P. RUSSELL.

(*Continued from page* 196 T.)

Acid corrosion.

he corrosion of steel in non-oxidising acids inarily occurs with the evolution of hydrogen gas. oxidising acids the cathode reaction is usually duction of the oxidising material, and no hydrogen volved. Corrosion by dissolved oxygen may be important factor in non-oxidising acids, but in hly oxidising solutions its effect is submerged by t of the other oxidising agent. A discussion of hydrogen gas reaction is logically introduced at s point.

he theoretical potential of corrosion with hydrogen lution* is not realised in practice primarily because overvoltage effects which retard and often com-tely prevent the corrosion reaction. The true ure of overvoltage is not fully understood, but ffect is to reduce the available potential. Over-ge varies with a number of factors and is pro-ly influenced by the composition and character metal surface and by the rate of gas evolution. ery[12] gives a value of 0·27 volt for the over-ge on iron in $N/1$ sulphuric acid, but this figure s on commercial steels and must be lower in dilute acids. The latter point is illustrated by act that hydrogen gas can be evolved at atmos-ic pressure and at room temperature in the osion of iron by oxygen-free solutions where p_H is 6 or even greater. Under these conditions theoretical potential would be about 0·2 volt, the overvoltage must therefore be less than this unt.

ydrogen gas is not evolved in detectable amounts the corrosion of steel by neutral waters at room mperature when oxygen is present. Under these nditions the solution next to the metal is saturated ith ferrous hydroxide, the theoretical corrosion tential is 0·030 volt, and the overvoltage is high enough to prevent the formation of hydrogen gas bubbles. It is, however, possible to obtain a very slow evolution of hydrogen under these conditions in the absence of oxygen, since the corrosion rate is too slow to produce enough ferrous hydroxide to maintain a saturated solution against the metal: the theoretical potential therefore is increased. It should be mentioned that hydrogen may be evolved and dissolved directly in the water at pressures much lower than atmospheric, but the rate of such a reaction is necessarily very slow.

The effect of velocity between the metal and the solution on overvoltage is not known with any great accuracy. Velocity certainly does increase overvoltage, as is shown by experiments by the authors[5] where hydrogen gas evolution was decreased by increase in velocity using a steel shaft rotating in sulphuric acid. A probable explanation of this effect is that the gas bubbles are smaller when they are evolved from the rotating electrode and that therefore more energy is required for their formation.

The following data were obtained in experiments[13] to show the effect of oxygen in acid corrosion. Specimens of cold-rolled steel were suspended by glass hooks in bottles containing the corroding agent through which gas was bubbled. Parallel experiments over five-hour periods were made, using oxygen and hydrogen for the comparison. The results are given in Table I.

TABLE I.

Acid.	Conc. % by wt.	Av. penetration, in. per year under O_2.	H_2.	Added corr. due to O_2.	Ratio of $O_2 : H_2$.
H_2SO_4	96	0·079	0·082	−0·003	0·96
H_2SO_4	50	0·262	0·192	0·070	1·36
H_2SO_4	6	0·360	0·031	0·329	11·6
HCl	4	0·482	0·031	0·451	15·5
HCl	0·4	0·388	0·0055	0·383	70·5
HNO_3	1·2	1·82	1·57	0·25	1·16
$CH_3 \cdot CO_2H$	6	0·545	0·0063	0·539	86·5

The last two columns show the added corrosion due to oxygen and the ratio of the corrosions obtained with oxygen and hydrogen. The added oxygen effect is seen to be of the same order of magnitude for all the weaker acids, and the ratio of corrosiveness is very pronounced for the weak hydrochloric and the 6% acetic acids. In the last case corrosion is increased nearly 100-fold by the presence of oxygen. The oxygen effect is slight with the strong sulphuric acid, and is somewhat obscured by the high oxidising power of the nitric acid. Similar data on other metals will be presented in a later paper.

The oxygen effect in acids is greatly increased by velocity due to the increased rate of diffusion. The authors have shown that a rotating steel shaft with a peripheral speed of 10 ft. per sec. will corrode just as

* The corrosion potential of the reaction when hydrogen gas is evolved n be calculated from the normal potentials of iron and hydrogen, recting for ionic concentrations by means of the Nernst equation. The de and cathode reactions in this case are:—$Fe + 2\ominus = Fe^{\cdot\cdot}$; $2H^{\cdot} = 2H + 2\ominus$. is and Randall[11] give the potential of iron against $N/1$ ferrous ion as $Fe^{\cdot\cdot} = 0·441$ volt, using the potential of $N/1$ hydrogen ion against rogen gas (at 1 atmosphere and on platinum) as zero. The Nernst ula for correcting for the ionic concentrations states that a ten-fold ase in ion concentration increases the potential of the metal against olution by 0·058 volt for a univalent ion such as $H^{\cdot}$ and by one-half t amount (0·029 volt) for a bivalent ion such as $Fe^{\cdot\cdot}$. The theoretical otentials of the reaction have been calculated and are shown in Fig. 4, here the potential is plotted against the p_H of the solution for several rrous-ion concentrations. It will be noted that this potential has a onstant value of 0·030 volt for any solution which is saturated with ferrous droxide, *i.e.*, which contains ferrous rust. This must be true, since the e energy of ferrous hydroxide in saturated solution is constant and dependent of the actual concentration.

[11] Lewis and Randall, "Thermodynamics," 1923.
[12] Mem. Manchester Lit. Phil. Soc., 1917, 61, No. 9.
[13] W. A. Wilson, Unpublished Thesis, S.B., Mass. Inst. Tech., 1924.

rapidly in 0·004N sulphuric acid as in 5N acid, provided dissolved oxygen is present, whereas at rest the stronger acid was over ten times as corrosive as the weaker.

Anode and cathode areas.

The conditions which determine whether an area will be initially anodic or cathodic are somewhat indefinite, although the effect of mechanical working is well recognised. On the other hand, the factors determining the anodic or cathodic tendency after corrosion has proceeded are fairly definite. Any area which becomes coated or partially coated with a protective film will tend to become cathodic, and in this same connexion the presence of hydroxide ions is a factor tending toward the formation of protective films.

Theoretical corrosion potential for direct O_2 reaction at 1 atmosphere.

A—Fe''=10^{-6}M. B—Fe''=10^{-1}M.

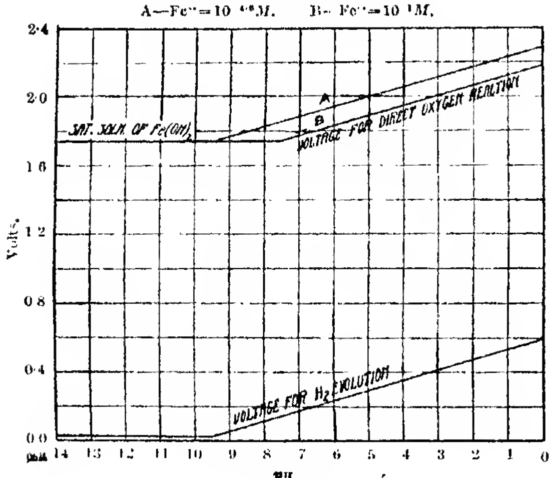

FIG. 2.

Evans'[14] experiments, in which one or the other electrode of a corrosion cell is aerated, are very interesting on this point. He shows that when two pieces of zinc, externally connected, are immersed in a salt solution, either one may act as anode or cathode at the start. If, however, one of the electrodes is removed from the solution, and then re-immersed, it acts cathodically toward the other, and the electrode which has not been removed bears the brunt of the corrosion. The corrosion current can be reversed by aerating the anodic electrode and it, in turn, becomes cathodic. Evans carried out somewhat similar experiments by placing one zinc electrode below the other in the solution. The upper electrode, which was subject to action by dissolved oxygen, became cathodic, while corrosion was mainly located on the lower anode. Furthermore, in this experiment, hydroxide was produced at the upper electrode and soluble zinc salt at the lower. The point at which these two solutions mixed was marked by a screen of precipitated zinc hydroxide. Evans then separated two electrodes by a diaphragm and aerated one of them by a stream of oxygen bubbling through the solution. The oxygenated electrc acted cathodically, and the current set up by t cell was electrochemically equivalent to about 7C of the total corrosion of the two zinc electrodes.

These results are explainable on the basis of t selective formation of protective films at the catho area. The oxygen electrode reaction forms OH' ioı At the same time, a slight amount of corrosion occı on closely adjacent areas and zinc ions are forme These zinc ions precipitate in the alkaline solutic forming a protective coating of zinc hydroxide. the unaerated electrode where no alkali is bei formed, the zinc ions go into solution to form solul zinc salt and no protective film is built up. It important to note, however, that some corrosion do occur at the cathode, and that the action is not 100 corrosion at the anode except under very speci circumstances. Corrosion on the aerated electro occurs because the film protectiveness on the cathoc is not perfect, and short-circuited corrosion cells a set up between points of different potential on tl cathode itself.

In experiments at this laboratory, two externall connected iron electrodes, separated by a diaphragı were immersed in a 5% sodium chloride solutio and oxygen was bubbled past one electrode; it wa found that the oxygenated electrode always reac cathodically under these circumstances, but that ove a 16-hour test, the cathode actually loses twice a much weight as does the anode, showing that twice a much of the corrosion is occurring by means of short-circuited cells on the cathode itself as occurred by cell action between the two separate electrodes. If enough caustic is added to the solution around the unaerated electrode to make it slightly more alkaline than corresponds to a saturated solution of ferrous hydroxide, this electrode then becomes the cathode,

Comparative H' concentrations of main solution and of liqui against corroding metal.

A—Low oxygen concentration.
B—High „ „

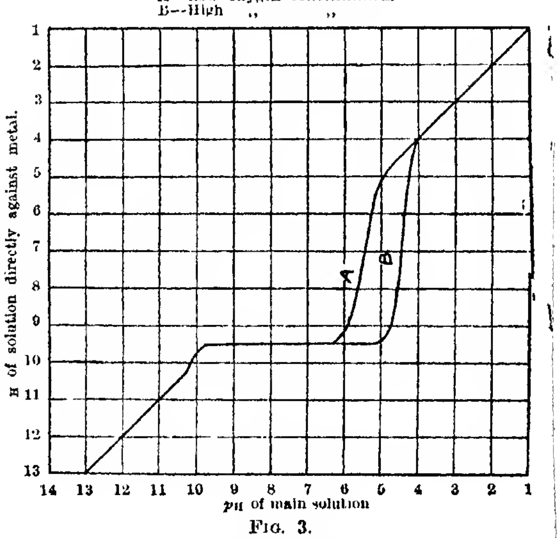

FIG. 3.

[14] U. R. Evans, Chem. and Ind., 1924, 222.

[15] Whitman and Russell, Ind. Eng. Chem., 1924, 16, 276.

and is practically uncorroded in the test. This would be expected since the alkalinity permits the formation of a protective hydroxide film on the unaerated electrode and hence makes it cathodic. This whole argument may be summed up by the general statement that protective films formed by the corrosion reaction tend to make a given area cathodic and prevent corrosion at that point, whilst the absence of such protective film allows an area to remain anodic.

Theoretical corrosion potential when H_2 gas is evolved at 1 atmosphere.

$E = 0{\cdot}441 - 0{\cdot}029 \log (Fe^{\cdot\cdot})/(H^{\cdot})^2.$
A. $Fe^{\cdot\cdot} = 10^{-4{\cdot}5}$ *M.* B. $Fe^{\cdot\cdot} = 10^{-5}$ *M.*
C. $Fe^{\cdot\cdot} = 10^{-1}$ *M.*

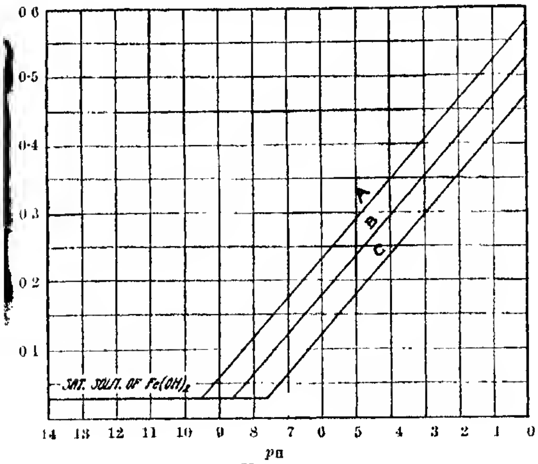

FIG. 4.

Contact of iron with a metal of lower solution pressure, such as copper, increases the corrosion of the iron since the other metal reacts cathodically. In natural waters the effect of copper[15] is to form additional cathode surface to which oxygen can diffuse and react, so the increased corrosion due to the copper is directly proportional to the increase in effective cathode surface and is not the result of any hypothetical catalytic effect. Similar effects are caused by the presence of mill scale, local protective films (such as are formed in very dilute alkali), or other cathodic impurities on steel. These are known to cause severe pitting because the total corrosive action is localised on the unprotected metal, but the results have previously been explained on the basis of catalytic action. In acids, if the metal in contact has a lower overvoltage than that of iron, it makes hydrogen gas evolution much easier and will greatly accelerate corrosion.

If the metal in contact has a higher solution pressure than that of iron, the same considerations are true except that the iron then reacts cathodically and is protected at the expense of the second metal. An exception to this rule occurs when the second metal is non-corroding because of a protective film (as in the case of aluminium).

Summary.

1. The phenomena observed in the corrosion of iron and steel under natural waters and solutions of alkali and non-oxidising acids can be adequately explained along electrochemical lines. Earlier concepts must, however, be modified in the light of our present knowledge.

2. Dissolved oxygen takes part in the direct cathode reaction, rather than serving as a depolariser for atomic hydrogen as postulated by Wilson and others.

3. The rate of corrosion under natural waters is determined by the rate of oxygen diffusion to an effective cathode surface and by the protectiveness of the film formed on the metal. The composition and surface condition of the metal are unimportant factors in the corrosion of ordinary steels and irons. Changes in hydrogen-ion concentration of a given water between approximate limits of p_H 10 and 4·5 do not change the corrosion rate, since the liquid against the metal maintains a constant alkalinity because of the solubility of ferrous hydroxide. The differences in corrosiveness between various natural waters are due to differences in their film-forming tendencies.

4. Under alkalis the rate of corrosion decreases because the rust is more insoluble and hence forms a more protective film. The depletion of hydrogen ions in alkaline solutions, which is given by some writers as the reason for decreased corrosion, is not a factor in the problem.

5. In non-oxidising acids hydrogen gas is evolved and the rate of corrosion by this means is largely affected by overvoltage. For this reason, the composition and surface condition of the metal are important factors. Corrosion by dissolved oxygen in acids is limited by the rate of oxygen diffusion to the surface, as in natural waters. The oxygen effect becomes pronounced in weak non-oxidising acids and at high velocities.

6. The anode and cathode areas may be widely separated or closely adjacent, and any inert area (including rust) in electrical circuit with the corroding anode may act as cathode. Contact with additional cathode area increases the corrosion of iron under natural waters by increasing the area to which oxygen can diffuse. Pitting effects are due to localised corrosion where the unattacked areas have been partially protected (usually by films), and have therefore acted as cathodes towards the corroding pits.

7. The theories of direct oxidation or of colloidal catalytic activity can cover only a part of the phenomena observed in the submerged corrosion of steel. Each is contradicted by certain experimental facts, of which two of the more important are the action of copper in contact with steel under natural waters, and the similarity in the action of oxygen in natural waters and in acids.

Acknowledgment.

Much of the experimental work referred to in this paper was carried out under a fellowship from The National Tube Company, directed by Mr. F. N. Speller. The authors wish to acknowledge the valuable assistance and co-operation afforded by this arrangement.

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PROPERTIES OF FUSIBLE ALLOYS.

BY N. F. BUDGEN, M.SC., PH.D.

Previous work on binary, ternary, and quaternary fusible alloys. The expression "fusible metal" is applied to alloys having melting points below that of tin*, so that the alloys falling within this group include binary, ternary, and quaternary mixtures of lead, bismuth, tin, and cadmium. A quinternary alloy, containing in addition mercury, is also classed as a fusible metal. These alloys are used principally in the preparation of readily fusible plugs for use in automatic fire extinguisher systems, but they are also employed for the manufacture of small statuettes and for taking casts of the human body. An important application arose during the war years, when petrol tanks of complicated form were required free from joins and seams for aeronautical work. These were made by electrodepositing copper upon a casting of fusible metal, and then by placing the whole finished article in hot water the fusible alloy was run out, leaving a copper shell intact. Fusible metals used for boiler plugs† are usually of pure tin, since they must have a melting point of not less than 232°.

The melting or freezing point of an eutectic alloy, consisting wholly of eutectic, does not occur over a solidification range, but at some definite temperature, as in the case of a pure metal; nevertheless, owing to surfusion phenomena, the melting and freezing points of such an alloy are not necessarily identical—they are in fact frequently widely different.

If eutectic alloys which alone have a definite freezing and melting point be considered, there are among the fusible metals six possible binary eutectics, four ternary eutectics, and at least one quaternary eutectic alloy.

The eutectie compositions and freezing points of binary fusible alloys are as follows :—

TABLE 1.

Atomic composition % at eutectic.							Freezing point.
Bi	43 0	..	Sn	57 0	..		137 0°
Bi	56 5	..	Pb	43 5	..		125·0°
Bi	55·5	..	Cd	44 5	..		146 0°
Sn	75·0	..	Pb	25·0	..		180 0°
Sn	67·6	..	Cd	32·4	..		177·0°
Pb	63·0	..	Cd	37·0	..		249·0°

The four possible ternary eutectics are given in Table II. :—

TABLE II.

Composition % at eutectic.										Freezing point.
Bi	27·5	..	Sn	33·2	..	Cd	39·3 (atomic)	..		103 0°
Bi	51·65	..	Pb	40·2	..	Cd	8 15(weight)	.		91 5°
Pb	21·0	..	Sn	57·0	..	Cd	22·0 (atomic)	.		145 0°
Bi	52 0	..	Pb	32·0	..	Sn	16·0 (weight)	..		94·0°

Four well-known ternary mixtures, which, however, are not entirely eutectic alloys, are given in Table III :—

TABLE III.

Weight %. Bi.	Pb.	Sn.		Melting point.		Name.
50	31·25	18·75	..	95 0°	..	Newton's alloy
50	28·0	22·0	..	100 0°	..	Rose's alloy
50	25·0	25·0	..	93 0°	..	Darcet's alloy
50	30·0	20·0	..	91·6°	..	Lichtenberg's alloy

Charpy's‡ work on the ternary alloys of lead, tin, and bismuth has shown that all mixtures of the fusible metal group form simple alloys with one another, *i.e.*, they form neither compounds nor solid solutions, but consist of practically pure metals and eutectics. Rose's alloy and Newton's alloy both approximate closely to the composition of the ternary eutectic and melt at about 94°; such alloys are used as soft solder by pewterers. The eutectic alloy of lead, tin, and bismuth possesses the property of expanding on cooling and is therefore used for taking impressions, as the finest details are faithfully reproduced. Bismuth is the component which causes expansion of the alloys on solidification. Other mixtures such as Pb 9, Sb 2, Bi 2, or Pb 10, Sb 1, Bi 1, are often used for stereotype plates, also for casting delicate objects, and for taking impressions from dies, medals, etc. Lastly there are the quaternary bismuth-lead-tin-cadmium alloys and the quinternary mixtures wi mercury, both of which may have an infinite variet of compositions. Two well-known examples a Lipowitz' metal, Bi 15, Pb 8, Sn 4. Cd 3, and Wood alloy, Bi 4, Pb 2, Sn 1, Cd 1, having respective melting points of 70·0° and 60·5°.

Quaternary systems are represented graphically l means of a regular tetrahedron, of which the fo component ternary systems occupy the faces. Th constitutional properties of some part of the quate nary bismuth-cadmium-lead-tin system have bee investigated by Parravano and Sirovich,* who hav discussed the methods of constructing such a figure and of representing the results of thermal analysis i space or on a series of plane sections. These author predicted from mathematical considerations certai of the constitutional conditions which could b expected in an alloy system of this class, and subse quently experimentally verified their results.

The temperatures of solidification of 400 differen alloy compositions were determined and 50 plan sections through the tetrahedral space model we constructed. It seems that the solid solution which are formed at first are completely resolve into their components on cooling, and the observa tions indicate that the solid phases present at th quaternary eutectic temperature are the almos pure metals.

The quaternary eutectic alloy has m.p. 70°, an contains Cd 10·10, Sn 13·13, Pb 27·27, and Bi 49·50 by weight. This composition differs from th assigned to the eutectic alloy by Guthrie,† but a examination of Guthrie's alloy shows it to contai crystals of primary bismuth. It is unlikely that an ternary or quaternary compound is formed, an the development of heat observed in many of th alloys at 95°—100° or 110°—115° is to be attribut entirely to changes in the binary solid solutions, it always diminishes towards the interior of t tetrahedron. A number of typical alloys of low melting and freezing point are given in Table IV and it is seen that several of these have a somewh lower point of initial melting than has the quaterna eutectic alloy. This difference may be due either inaccuracies of temperature measurement or to t influence of surfusion phenomena.

* Law, "Alloys and their Industrial Application."
[illegible] World, [illegible] 106.

* Gazzetta, 1912, 42, 630.
† Phil. Mag., 1884, 17, 462.

TABLE IV.

Fusible alloys.

Comp'n by weight, %.					Temperatures of arrests on cooling.			
Cd.	Pb.	Sn.	Bi.		1.	2.	3.	4.
1·5	34·0	4·5	60·0	..	98°	92°	80°	—
12·9	21·4	5·7	60·0	..	101°	85°	71°	—
11·8	19·6	8·6	60·0	..	100°	—	—	70°
10·7	17·9	11·4	60·0	..	100°	—	78°	70°
12·5	30·0	7·5	50·0	..	100°	90°	70°	—
9·4	31·0	5·6	53·1	..	100°	80°	75°	—
13·1	24·4	21·9	40·6	..	100°	87°	—	69°
11 25	26·25	18·75	43·75	..	85°	68°	—	65°
9·4	28·1	15·6	46·9	..	75°	—	68°	66°
7·5	30·0	12·5	50·0	..	73°	—	68°	66°
5 6	31·9	9·4	53·1	..	77°	—	70°	68°
3·75	33·75	6·25	56·25	..	90°	—	72°	68°

EXPERIMENTAL.

esearch on typical quaternary and quinternary alloys for properties of industrial value.

(*a*) *Temperatures of complete liquefaction and solidification of quaternary alloys.*—For practical purposes, ro definite temperatures are required with regard to sible alloys: the point at which the alloy is first itirely solidified, and that at which it is all quite iid; these temperatures do not therefore corre- ond to the true melting and freezing points.

A series of typical quaternary fusible alloys, with eir supposed melting points, taken from writings Heine, Law, Lassieur and others, are given in ıble V.

TABLE V.

Quaternary fusible alloys.

No.	% Weight of Pb.	Sn.	Bi.	Cd.		Supposed melting point (Heine).	(Lassieur).
1	25·0	12·5	50 0	12·5	..	65 55°	74°–75°
2	26·7	13·3	50·0	10·0	..	60°–68°	75°–76°
3	26·0	14·8	52 2	7 0	..	68·5°	
4	28·6	14 3	50·0	7·1	..	70 0°	
5	27·6	10 3	27·6	34·5	..	75·0°	
6	35 1	20·05	35 35	9·5	..	80·0°	
7	27·27	13·13	49·5	10·10	..	70·0°	
8	33·1	19·0	33·6	14·3	..		94°–95°
9	22·85	11·45	57·1	8·6	..		74°–75°
10	23·5	23·5	44 15	8·85	..		75·0°
11	15·4	15·4	57 65	11·55	..		80 8°
12	30·8	15·4	38·4	15·4	..		80 0°

ıch of these has been examined with regard to oints of solidification and liquefaction.

The metals used were the commercially pure oducts and contained no appreciable quantities of her elements.

The apparatus employed consisted of a sensitive ermometer reading to 120° and accurate at 100° ıd 0° to within 0·1°; this was surrounded by a otective sheath and entirely immersed in a thin, ırrow-bore test-tube, the intervening space being led with water. The test tube containing the water ıd thermometer was placed inside another test ibe of considerably greater internal diameter, and e space between the large-bore and small-bore tubes ntained the fusible alloy under examination. Each these tubes was of the same length as the thermometer, and when necessary the thermometer was ted partially out of the central tube for examination. he tubes were supported in a large glass beaker led with water. This arrangement allowed for e complete immersion of the thermometer stem, ıus eliminating stem-error and the necessity for lculation of the true value of each reading. The mperature was raised by heating the water in the eaker and lowered by allowing it to cool "naturally." In the neighbourhood of the complete fusion point the temperature of the water bath was raised very slowly so as to ensure obtainment of a true figure. Cooling curves were not taken, but with the thermometer bulb, the alloy in its container was thoroughly and continuously stirred when liquid, until it became entirely solid and no liquid whatever remained. On gradual heating, the point at which the last solid crystals of alloy became liquid was noted, so that at this temperature the alloy was perfectly fluid. By observation and by continuous careful feeling with the thermometer, these definite points could be determined with great accuracy.

The observations made, have established the following thermal data:—

TABLE VI.

Liquefaction and solidification points of fusible alloys.

Alloy no.		Temp. of complete liquefaction.		Temp of complete solidification.
1*	..	73 0°	..	68 5°
2†	..	74·5°	..	68·0°
3	..	73·5°	..	68 0°
4	..	74·0°	.	67·5°
5	..	120·0°	..	71·0°
6	..	90·0°	.	67·0°
7	..	73·5°	.	65·5°
8	..	93·0°	.	70·0°
9	..	73 0°	.	67·0°
10	.	75 0°	.	66 0°
11	..	82 0°	..	68·5°
12	..	85 0°	..	68 0°

* Wood's alloy. † Lipowitz' alloy.

The alloys of lowest complete liquefaction point (73·0°) are seen from the table to be nos. 1 and 9, whilst the mixture of lowest complete solidification point (65·5°) is no. 7.

Most of these fusible alloys have a freezing range, that is, they do not entirely solidify or liquefy at one definite temperature, so that although no members of the series here examined are entirely liquid until 73·0° is reached, certain of them are pasty at a temperature only a degree or two above that of the complete solidification point. It is noticeable that no alloy has been found which melts and freezes at the same temperature, from which it might be inferred that no alloy consisting wholly of eutectic had been examined. This, however, is not necessarily the case, because surfusion phenomena are frequently observed at the solidification of an eutectic; by the simple noting, therefore, of the point of complete liquefaction and solidification, if undercooling has occurred, an eutectic alloy might easily be mistaken for an alloy having a freezing range.

It is well known that during cooling and solidification of an alloy, those portions which have the highest melting point are the first to freeze out, leaving the more fusible constituents until last. This fact was utilised to ascertain whether or not any alloy of lower melting point than those given in the above table could be obtained. Equal proportions of the twelve alloys were melted together in a cylinder with plunger. The mass was allowed to solidify partially, and when only very little liquid remained, this was expressed by means of the plunger. This most fusible constituent of the whole mixture was tested as before, and found to become entirely liquid at 73° and quite solid at 66°, *i.e.*, at no lower point than is shown in the above table.

(*b*) *Temperatures of complete liquefaction and solidification of quinternary fusible alloys.*

The effect of mercury upon the melting points of several fusible alloys has already been studied by earlier workers; for example, Lassieur noted that a mixture Pb 4, Sn 4, Bi 7·5, Cd 1·5, Hg 2, melts at 66°—67°. In the present work the effect has been more thoroughly studied, and to each of the alloys of Table V., 16·6% by weight of mercury was added and the liquefaction and solidification points redetermined as before. The results are tabulated below:—

Mercury fusible alloys.

TABLE VII.

Alloy no.	Temp. of complete liquefaction.	Temp. of complete solidification.
1	68°	56°
2	120°	56°
3	not det.	not det.
4	63°	53°
5	73°	62°
6	70°	56°
7	65°	55°
8	73°	60°
9	63°	50°
10	65°	55°
11	74°	58°
12	68°	61°

Thus it is seen that by the addition of mercury, there is, in general, a lowering of both melting and freezing point, of anything from 5° to 20°.

By adding more mercury the melting points of these alloys can be lowered to any desired degree until the alloy remains pasty or even liquid at room temperature, approximately 50% of mercury being required to bring this about.

Mechanical properties of quaternary alloys.

So far as the author is aware, the mechanical properties of fusible alloys have never before been scientifically determined; figures for hardness, tensile strength, etc. should therefore be of value from the point of view of the manufacture of small casts and statuettes for which fusible alloys are often employed.

Tensile properties of mercury-free alloys.—Specimens of the alloy compositions shown in Table V. were prepared in the form of round rods for tensile testing by drawing the molten metal up into evacuated glass tubing. The metal flowed freely up and quickly solidified, so that in effect chill-castings were obtained. The metal rod was subsequently slipped out of the tube or, in the case of those alloys which expand on solidification, the glass partially cracked of itself and was subsequently removed. The specimens were cut to standard 4-inch lengths and turned in a delicate lathe to 0·188 inch diameter over a 1 inch parallel length. After careful measurement the bars were subjected to tension testing in a Dixon and Hummel wire testing machine; elongation was taken from the 1 inch parallel length. The tests were conducted in duplicate and the average figures are given in Table VIII.

From the table it is seen that the strongest alloy is no. 10, which also shows an elongation of 16% on a 1 inch parallel length; the weakest alloys are nos. 1 and 4.

Alloy no. 1 has a strength of 4422 lb. per square inch, and no member of the series will withstand more than about 3 tons per sq. in. Several of the specimens after tensile testing are shown in Fig. 1.

TABLE VIII.

Alloy no.	Maximum load, lb.	Elongation, %.
1	125	3
2	170	6
3	145	20
4	125	40
5	175	15
6	165	15
7	145	20
8	185	5
9	135	10
10	190	16
11	185	1
12	180	9

FIG. 1.

The alloys containing mercury were not tested i tension but were noticed to be much weaker than th above series.

Hardness.—Brinell hardness numbers, obtaine with a load of 500 kg. and 10-mm. ball applied fc 1 minute, are given in Table IX. For the test small cylindrical specimens 1 inch diam. and inch thick were employed; these were chill cast i a metal mould and afterwards polished on opposit faces. The figures are given for both the alloy without and with 16·6% of mercury added; the is seen to be a marked softening by the addition c mercury except in the case of no. 12.

TABLE IX.

Alloy no.	Brinell hardness number. Without mercury added.	With mercury added.
1	25	5
2	20	1
3	30	not det.
4	25	1
5	23	1
6	18	1
7	18	1
8	16	2
9	12	8
10	20	broke up
11	29	20
12	1	12

These Brinell figures show a maximum value the cases of those alloys which contain the greate proportion of bismuth.

Flexibility.—Nearly all of these fusible allo are extremely brittle under sudden shock loadi yet very flexible and plastic under gradual loadin In both tensile and hardness testing this proper was very marked, for in the tensile testing the res for elongation depended almost entirely upon t

rate of loading and hence upon the rate of straining. The elongation could be made to assume almost any figure by altering the speed of loading, so that to obtain concordant results it was necessary to employ a uniform slow rate of loading for all the specimens.

For instance, in the case of alloy no. 4, by loading in tension a little more quickly than usual, the specimen snapped off like chalk, showing an elongation of about 10%, while by loading somewhat more slowly a value as high as 65% was obtained. Similarly with the Brinell hardness testing, as soon the load had been applied, the lever carrying the ght would begin steadily to sink until resting inst the stop; the load would be then re-applied the sinking continued. In this case also, there-, the time factor was most important if con-lant results were to be obtained. Simple bending s gave further illustration of this remarkable perty: by bending thin rods (¼ in. diam.) very vly they could be formed into any desired shape, by a sharp, quick bending motion the bars would p off short; the alloys indeed behave in this ect exactly like pitch, which is plastic or tle according to the rate of loading. Alloys . 9 and 11 were exceptions and would only bend ough an arc of about 10°.

All of the alloys split on gentle hammering or on ld rolling. Alloys containing mercury exhibited e property of flexibility to a much lesser degree.

Grain size, microstructure, and corrodibility.—Of the loys (Table V.) which contain no mercury, nos. 9, and 11 have the coarsest grain as revealed by a acture; the remainder exhibit a very fine-grained, rey-coloured fracture (see Fig. 2).

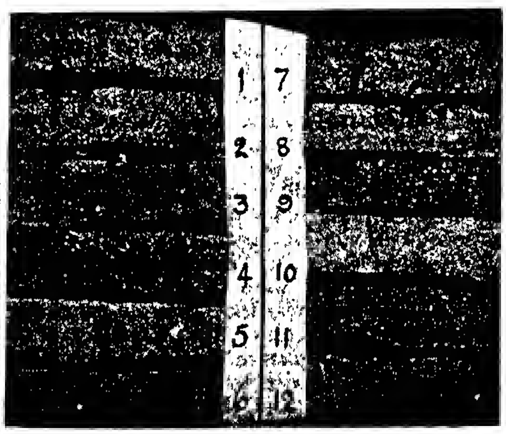

FIG. 2.

The grain size of all specimens containing mercury very fine and close and the fractures are all similar. Micro-examination of representative samples in-icates the existence (in the case of alloys nos. 1 nd 2) of at least four structural constituents, but ese are not easily reproduced photographically. he structure as revealed by casting on glass and ching without polishing is not the true structure of the alloy but represents the form of dendritic growths in contact with the cold glass plate.

The tendency of the alloys to corrode was noted by retaining them molten under water and also under liquid paraffin. After half-an-hour in this state all of the alloys of Table V. formed a quantity of black powdery residue which when stirred would settle rapidly from the liquid, being evidently very heavy. In the case of each alloy, this black residue formed to about the same extent except from nos. 1 and 6, where the amount formed was much greater.

The tendency to corrosion of the same alloys each containing 16·6% of mercury was not more marked.

Summary.

None of the twelve quaternary fusible alloys is entirely liquid until a temperature of 73° is reached, nor is any of them entirely solid above 65·5°. The addition of 16·6% of mercury lowers these points to 63° and 50° respectively, and by further additions the melting point can be reduced so that the alloys are liquid at room temperature.

The tensile strength of the alloys is in no case greater than 3·5 tons per sq. in.; by the addition of mercury this value is much reduced. The elongation can be considerably altered by variations in the rate of loading, and most of the alloys exhibit the property of brittleness under sudden shock and plasticity under gradual loading to a most remarkable degree.

Brinell hardness figures show a maximum value in the cases of those alloys containing the greatest proportion of bismuth.

Grain size, microstructure, and corrodibility have also been studied.

In conclusion, the author wishes to acknowledge his indebtedness to Professor T. Turner, for granting facilities for carrying out the investigation in his laboratories and for his continued interest and advice.

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THE REMOVAL OF GUMMY, OILY, AND WAXY MATTERS FROM RAW CANE SUGAR.

BY C. M. KEYWORTH, M.SC., A.I.C., AND R. B. FORSTER, D.SC., PH.D., F.I.C.

In the filtration of liquors and syrups derived from raw cane sugar considerable difficulty is generally experienced with the gummy, oily, and waxy matters introduced in the raw sugar. Especially is this noticeable when decolorising carbons are used, which are usually indifferent filtering aids. The gums form an impenetrable layer on the face of the filter-cloth, with the result that the filtration efficiency rapidly decreases, the pressure becomes excessive, and the outflow from the press almost negligible.

As is well known, these gums are secretions of the cane plant which protect the stems from the attacks of parasitic insects. The late cane crops contain more gummy matters than the early cane crops, and some types of cane contain much more gummy matters than others, the Uba variety being particularly bad in this respect. Cane wax is also usually present along with the gummy matters. In the process of refining, these gums must be removed, and they cause more or less trouble during filtration.

The gummy matters can be completely removed by the carbonatation process, but this is somewhat costly and cannot always be used economically. There is a growing tendency to try to replace bone-charcoal with activated vegetable charcoal or other activated charcoal, which, although 10–20 times as active as bone-charcoal, yet removes gummy matters very incompletely unless used in excessive amounts, and soon, therefore, causes the rate of filtration to become poor. Filter aids such as kieselguhr ("filter-cel") greatly accelerate the filtering of sugar liquors, but remove little or none of the colour.

It was known to one of us that when steam is blown through a spent filter press which has for some time been used for filtering raw sugar liquors containing decolorising carbons, the press can then be restarted to advantage without stripping. Investigations were made as to the cause of this, and it was found that the gummy, oily, and waxy matters were to a large extent volatile in steam. Hence when a filter press was steamed, the oily film on the cloth was at least partially removed, and the power of filtration restored. The process cannot be repeated indefinitely, as it becomes less effective each time; and, moreover, the steam has a scorching action on the filter cloths.

A sample of raw sugar was dissolved in an equal weight of water in the laboratory, and the solution heated to boiling point *in vacuo* while steam, generated in another flask, was passed through the solution. It was found that the bulk of the gummy matters passed over in the distillate. The residual liquor was then reduced to the same density as the original solution and their rates of filtration were compared. It was found that the rate of filtration of the steam-treated liquor was approximately twice that of the original liquor. Further experiments with raw Peru and Java sugar confirmed this. The gums were not removed quantitatively, but the amount could not be determined, as no completely satisfactory method for this purpose appears yet to have been devised.

The time required to remove the maximum amount of gums naturally depends on the quality of the sugar. Generally speaking, steam was passed through the solution for about half-an-hour, the liquor being maintained at a temperature of 50°–65°, and a vacuum of about 650 mm. used. The density of the liquors was kept at about 60° Brix. To compare the filtration efficiencies, decolorising carbons such as norit and klarit were used, and also filter-cel. In the laboratory trials the increase in efficiency varied from 70 to 100% with most sugars. The decolorising power of an active carbon is greater with a steam-treated sugar liquor, presumably because the pores of the carbon do not become clogged with gummy particles.

By permission of Messrs. Macfie and Sons, Ltd., of Liverpool, experiments were carried out on a large scale in their refinery, and the authors are indebted to them for permission to publish the results. The experiments were made on a sample of raw Peru sugar and washed raw Peru sugar which, though of fair quality, was yet difficult to filter with decolorising carbons. The decolorising carbon used was "klarit," and the filter press a 40-in. washing type plate and frame press.

Four experimental filtrations were carried out: (1) on untreated raw Peru sugar liquor; (2) on treated raw Peru sugar liquor; (3) on untreated washed Peru sugar liquor, and (4) on treated wash[ed] Peru sugar liquor.

Filtration of untreated raw Peru sugar liquor.

Five tons of raw Peru sugar were dissolved to [a] density of 52½° Brix at 66° and 2 cwt. of klarit we[re] added. This liquor was then pumped through t[he] filter-press, and the results recorded in Table I. we[re] obtained. The rate of flow through the press w[as] calculated from the time taken to fill the outfl[ow] trough. After 1 hr. 25 min., since the liquor w[as] trickling very slowly, the flow negligible and t[he] pressure excessive, the press was stopped. The tot[al] amount of liquor run through the press was 6[..] gallons.

TABLE I.

Time in min. after starting press.	Pressure, lb. sq. in.	Rate of flow through press, gall. per min.	Remarks.
4	15–20	—	Frothing badly
6	17–25	—	All taps clear
8	20–27	25·7	—
17	25–35	20·0	—
37	27–42	12·0	—
85	50–60	6·0	—

Treatment of raw Peru sugar by steam in vacuum.—The plant used for subjecting the liquor to treatmen[t] with live steam was a Claassen type vacuum pan. This pan was heated by means of a calandria operate[d] by low-pressure steam, and had a small perforate[d] coil round the inside through which live steam [at] 50–60 lb. pressure could be introduced. This arrang[e]ment was not ideal, but a pan with a larger coil a[nd] low-pressure steam was not available.

Ten tons of the same Peru sugar as used in t[he] previous experiment were dissolved in water a[nd] drawn by vacuum into the Claassen pan. At t[he] beginning of the operation the barometer stood [at] 738 mm and the pressure in the pan at 625 m[m]. The charging of the pan took 29 min., the pressu[re] then being 610 mm. and the temperature and t[he] density of the liquor being 59° and 59° Brix, resp[ec]tively. Steam was then passed in for 90 min., dur[ing] which time the pressure became 635 mm., the te[m]perature 54°, and the density 62½° Brix. The liquo[r] was then diluted to 54° Brix, and pumped to th[e] filtration department.

Filtration of treated raw Peru sugar liquor.

Klarit (2% calculated on the weight of sugar) wa[s] added and the same pumps and press were used a[s] in the previous trial. The pressure rose fairly rapidly

but the flow continued to be very good, and was much greater than in the previous experiment with untreated Peru sugar. After the press had been running for some time, however, it was noticed that the density of the liquor had decreased, owing to the contents of another vessel siphoning through a leaky valve. This vessel was used for washing spent klarit and also contained washings from dirty filter cloths, so that the water therefrom contained a considerable proportion of non-sugars and was difficult to filter. Unfortunately, it was impossible to repeat this xperiment.

The results obtained are recorded in Table II. 'he amount filtered through the press was 1033 gal- ons of liquor, plus the unknown amounts of liquor nd sweet water accidentally introduced as above entioned.

TABLE II.

ime from starting of press, min.	Pressure, lb./sq. in.	Temp. of effluent,	Brix.	Level of liquor from top of tank, in.	Rate of flow, gall. per min.	Remarks.
5	—	77°	54°	15	—	Press full
10	15	—	—	—	—	—
15	25	—	—	—	28·6	—
30	40–50	—	—	—	30·0	—
40	45–55	—	48°	26	24·7	—
70	55–65	—	—	39	20·5	—
90	55–75	—	38°	42	—	Shows water leakage
95	55–75	—	—	46	19·3	
105	55–75	—	—	46	17 1	
120	55–75	—	—	44	—	

Filtration of washed Peru untreated sugar liquor.

The same filter press was used, and similar sugar s in the previous experiments, but this sugar was vashed in centrifugals before solution. Klarit (2% n weight of sugar) was added to the liquor. The esults obtained are given in Table III. :—

TABLE III.

ime from starting of press, min.	Pressure, lb./sq. in.	Temp. of effluent,	Brix.	Rate of flow, gall. per min.	Remarks.
5	—	75°	41°	—	Press full
8	10	80°	47°	32·7	—
18	18–20	—	46°	22·5	—
23	20–22	—	46°	22·5	—
31	27–30	—	46°	22·5	—
40	30–40	80°	45·5°	20·0	—
50	35–40	80°	44 5°	17·7	—
60	40–55	—	44 5°	15 3	—
67	40–50	—	44·5°	11·2	—
87	45–55	—	45°	9·0	—

The amount of liquor put through the press was 050 gallons less 175 gallons remaining in the press, hat is to say, 875 gallons.

Treatment of washed Peru sugar by steam in vacuum.
-10 tons of the same washed Peru sugar as used in e previous experiment were then dissolved in water d drawn into the Claassen pan. Steam was passed rough the liquor for a little more than an hour, it owing to the slow rate at which the liquor entered e pan some of the liquor did not get more than minutes' treatment. The final temperature was 5°, and the pressure 635 mm. Water was then lded to bring the density down to 54° Brix. Klarit ·66% on weight of sugar) was added and the quor pumped through the filter-press.

The pump took a long time to fill the press, but fterwards worked satisfactorily. The outflow was uch greater than in the case of the untreated washed 'eru sugar, and the amount put through the press as 1800 gallons.

TABLE IVA.

Time from starting of press, min.	Pressure, lb./sq. in.	Temp. of effluent.	Brix.	Level of liquor from top of tank. in.	Rate of flow, gall. per min.	Remarks.
20	10	77°	44°	—	—	Press full
27	15	—	48°	—	34 0	—
38	22	—	46·5°	—	30 0	—
43	25	—	46·5°	—	27·7	—
49	27	—	46·5°	—	27 3	—
62	32	80°	46°	40	22 2	—
70	30–40	—	46°	—	20 2	Tank almost empty
88	30–40	—	47·5°	54	18·0	

The press was then steamed off, the percentage of klarit brought up to 2%, and a further quantity of liquor run through the press. The results are given in Table IVB.

TABLE IVB.

Time from starting of press, min.	Pressure, lb./sq. in.	Temp. of effluent.	Brix.	Level of liquor from top of tank, in.	Rate of flow, gall. per min.	Remarks.
3	15	71°	48°	—	—	Press full
7	25	—	48°	—	27·7	—
11	25–35	—	47 5°	—	22·8	—
17	30–40	—	47 5°	—	19 8	—
62	35–40	—	47°	32	9·8	—

The amount of liquor run through the press was 1075 gallons, less 175 gallons remaining in the press. Hence the total amount run through the press was 1800, plus 900 gallons = 2700 gallons, compared with 875 gallons with the untreated liquor.

Laboratory control tests were carried out. In the first experiment with raw Peru sugar it was found that inversion occurred to a slight extent during the steam distillation. Thus after one hour's distillation the apparent purity as indicated by the quotient had dropped from 96·76 to 96·71, and when the liquor left the vacuum pan the quotient was 96·45. The acidity per 10 c.c. of the liquor was 2·2 c.c. $N/100$ sodium hydroxide, using litmus as indicator.

In the second experiment with washed Peru sugar the acidity was reduced by the addition of lime to neutrality against litmus, but it was acid to phenolphthalein. Similar inversion, however, occurred, the quotient dropping from 98·59 to 98·26 during the time the liquor was in the pan. It is possible that low-pressure steam would have reduced this inversion to a negligible quantity.

Throughout the steam treatment in the Claassen pan no loss of sugar through entrainment was noticeable.

Conclusions.

The optimum time required for distillation naturally varies with the sugar to be treated, but from 30 to 60 minutes is usually sufficient if the live steam-coil is of suitable proportions. Longer time than this was taken in the large-scale experiments on account of the unsuitability of the steam-coil, and also to ensure that the optimum time had been exceeded, for it would not have been possible to repeat the experiments then. The increase in filtration efficiency is usually about 100%. A more exact statement is impossible, because it is difficult to obtain satisfactory methods of comparing rates of filtration in the laboratory. The viscosity of a sugar solution rapidly decreases as the temperature rises, and it is almost impossible to filter two solutions and keep them at the same temperature. The best

method is to use two suction filters heated in a steam oven and connected to the same filter-pump. Ordinary conical funnels in a steam-oven will, however, give a fair idea of filtration values, though, of course, the amount filtered is small.

The advantages of the method on a commercial scale are numerous and very obvious. Either raw sugar liquors or the partly exhausted syrups—even affination syrups—can be advantageously so treated before filtration. As mentioned above, the decolorising power of a given carbon is increased, because the carbon is not obliged to absorb so large a quantity of gums; but the authors have not yet carried out any quantitative experiments. After treatment by their process the amount of the decolorising carbon required to filter efficiently any sugar-liquor is smaller if the carbon is added for the purpose of filtration, and not for the sake of decolorisation only.

The process is covered by British Patent Application 30,977 of 1923.

α-NAPHTHOLAURIN. A METHOD FOR DETECTING SMALL QUANTITIES OF α-NAPHTHOL IN THE PRESENCE OF β-NAPHTHOL.

BY JOHN EDMUND DRIVER, B.SC., A.I.C.

The preparation of a blue dyestuff by the action of carbon tetrachloride on α-naphthol in alkaline solution is described in British Patent 172,177.

It has been shown (Baines and Driver, Chem. Soc. Trans., 1923, **123**, 1214) that the action of carbon tetrachloride on metallic derivatives of phenol, and of the cresols, results in the formation of aurin or of the corresponding trimethylaurin. In continuing this work the present author has investigated the action of dry carbon tetrachloride on the sodium and potassium derivatives of the naphthols. In the case of α-naphthol, an acid dye is formed. It dissolves in aqueous sodium hydroxide to form a beautiful deep blue solution, from which it is precipitated in flocks on addition of excess of hydrochloric acid. All attempts to crystallise the substance have been unsuccessful, and therefore a sample has not been obtained pure for analysis. However, from previous work (Baines and Driver, *loc. cit.*), there is little doubt that the dye consists chiefly of α-naphtholaurin, $(HO.C_{10}H_6)_2C:C_{10}H_6:O$.

The change in colour from red to blue in passing from the simpler benzenoid aurins to the corresponding naphthol compound is in agreement with common experience in the study of other types of coloured compounds. In confirmation of these views, it is found that β-naphthol, in which the para-position to the central carbon atom is occupied, gives no such dyestuff.

These facts provide a simple method for distinguishing between the naphthols, and also for detecting small quantities of α-naphthol present as impurity in samples of β-naphthol. For pharmaceutical [illegible] other purposes it is essential that β-naphthol should be free from the α-compound, but the usual methods of detection leave much to be desired. The official test of the British Pharmacopœia consists in treating the sample, in boiling aqueous solution, with [illegible] chloride. The precipitate formed should be white changing to brown, and should have no violet tinge showing the absence of α-naphthol (*cf.* Schaeffer Annalen, **152**, 281). This test has the advantage of simplicity, but does not give satisfactory indication of the presence of α-naphthol when the proportion of the latter is very small.

Procedure.—In order to distinguish between the naphthols, 2—3 c.c. of carbon tetrachloride are added to a few milligrams of the sample dissolved in aqueous caustic soda. The mixture is heated on the water bath for ten minutes, preferably with the addition of a little copper powder as catalyst. α-Naphthol gives a pure, deep blue solution, which on exposure to air slowly changes to green. In the case of β-naphthol the solution is pale yellow.

To detect small quantities of α-naphthol in the presence of the β-compound, 0·5 g. of the sample is dissolved in 20 c.c. of 10% caustic soda. 10 c.c. of carbon tetrachloride and a little copper powder are added, and the mixture is heated to boiling for 30 minutes. A blank experiment is carried out with an equal quantity of pure β-naphthol. The two liquids are then filtered through glass wool, and the colours compared in Nessler glasses. The presence of less than 0·005 g. of α-naphthol in 0·5 [illegible] β is sufficient to give the solution a distinct green tinge.

It is essential that the carbon tetrachloride used in these tests should be free from chloroform, since both the naphthols give blue solutions when boiled with chloroform in alkaline solution (Lustgarten Monatsh., **3**, 720).

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A NEGLECTED CHAPTER IN CHEMISTRY: THE FATS.*

BY E. FRANKLAND ARMSTRONG AND JOHN ALLAN.

This account of our knowledge of the fats and of some of the many problems needing study, particularly in the organic branch of chemistry, is mainly written with the hope of reviving interest in them as, part from physical and analytical investigation, no ther province of chemistry has been so little studied ring recent years. This is, no doubt, almost tirely due to the considerable experimental difficules which confront the worker and to the need for aking a mass attack on the subject by the whole aff of a research school during a number of years fore any measure of success can be obtained. It is r intention mainly to consider the subject from the int of view of the origin and the significance of the ts—botanist, chemist, and physiologist alike have interest in this question. We shall strive to licate what has been already established as well the lacunæ in our knowledge. We shall propound estions and seek answers, thereby hoping to imulate the interest of our colleagues.

I.—The Fatty Acids.

As is well known, the natural fats, both animal nd vegetable, are usually triglycerides of straightain fatty acids in which all three hydroxyl groups glycerol are acted upon either by the same or by fferent fatty acids, the product being termed either simple or a mixed glyceride. Fatty diglycerides not normally occur as such, but they may be rmed by fermentative action. The place of one or ore of the fatty acid radicals may be taken, however, an acid of a different kind, as, for example, phosric acid in the case of lecithin. Other alcohols sides glycerol are found associated with fatty acids. ey constitute the waxes, which are mixtures of ers of monohydric alcohols with the fatty acids of h molecular weight and occur as a rule in other rts of the plant than the fats, which are practically nfined to the fruits and seeds. Their function seems be that of protection against water, and not that a reserve energy-producing material. In lecithin e third hydroxyl group of the glycerol is coupled an ester union with phosphoric acid. It will be ar that the opportunity for isomerism and stereomerism in this group is large, and that the number possible arrangements even of such apparently nple materials as glycerol and a few fatty acids is nsiderable.

We are once more brought face to face with the riety which nature is able to evolve from apparently nple materials. We shall use the term fats as covering both the solid fats and the liquid oils; it avoids confusion often present in the lay mind, resulting from the use of the term "oil" for mineral and essential oils.

The fatty acids which occur in nature in the fats as glycerides range from C_4 to C_{24}, inclusive. It is a remarkable fact that only acids with an even number of carbon atoms are present; this fact will be discussed further later.

The waxes contain still higher saturated acids and range from C_{14} to C_{30}.

Both saturated and unsaturated acids occur, some fats—liquid oils—being particularly unsaturated and liable to undergo change. A special class contains an hydroxyl group; in it occur both saturated and unsaturated forms.

Lastly there are the cyclic acids of the chaulmoogric series.

A brief summary of the chemical structure of some of the members of each group seems desirable to facilitate the understanding of the second portion of the paper; it will show the many gaps in our knowledge.

The saturated acids, $C_nH_{2n}O_2$.

The saturated acids call for little comment—they all contain a straight chain of carbon atoms, and no isomerism is possible; they crystallise in one form only, the crystal unit being composed of two molecules arranged end to end with the carboxyl groups adjacent to each other. It is of interest that the synthetic acids containing an odd number of carbon atoms in this series are many of them enantiotropic—they have two melting points and crystallise in two forms. This difference is ascribed by Garner and Randall to alternative methods of arrangement of the two molecules of the acid which go to make up the crystal unit.

The unsaturated acids, $C_nH_{2n-2}O_2$.

Myristoleic acid, $C_{14}H_{26}O_2$, has been isolated by Tsujimoto as a constituent of sperm and dolphin oils, being chiefly responsible for the iodine absorption of the lower fractions of the methyl esters. It is shown to have the structure:

$$CH_3{\cdot}[CH_2]_7{\cdot}CH{:}CH{\cdot}[CH_2]_3{\cdot}CO_2H.$$

It is of interest that the ethenoid bond is in the same position with regard to the CH_3 group as it occupies in oleic acid as well as in erucic acid.

Palmitoleic acid, $C_{16}H_{30}O_2$, is not a common constituent of oils, at any rate in other than very small amounts, but it occurs in greater quantity (17%) in whale oil, from which it can be separated in almost pure state, and to the extent of 12% in skin grease.

* Presidential Address read at the Annual Meeting, Liver ol, July 9, 1914.

It gives a solid iso-acid melting at 21°–22° under the same experimental conditions as oleic acid forms elaidic acid. The position of the ethenoid bond in it is unknown.

Oleic acid.—This acid is characteristic of every fat, and its presence gives to the fats some of their best-known attributes. A number of isomerides are theoretically possible according to the position occupied by the ethenoid bond; there is also the possibility in each instance of *cis-trans* geometrical isomerism.

Several isomeric oleic acids, $C_{18}H_{34}O_2$, have been described, viz :—

(1) Ordinary oleic acid, which has the ethenoid bond in the middle of the chain between carbons 9 and 10, counting the CO_2H group as 1. It has the formula :

$$CH_3{\cdot}[CH_2]_7{\cdot}CH{:}CH{\cdot}[CH_2]_7{\cdot}CO_2H.$$

(2) Hepatic oleic acid, 12:13, was identified by Hartley as having the structure :—

$$CH_3{\cdot}[CH_2]_4{\cdot}CH{:}CH{\cdot}[CH_2]_{10}{\cdot}CO_2H.$$

(3) Iso-oleic acids of unknown constitution are formed during the distillation of commercial stearin or during hydrogenation of oleic acid. Moore has provisionally ascribed an 11:12 ethenoid structure to one of these.

(4) Oleic acid, 2:3, was prepared by Le Sueur from stearic acid.

(5) Elaidic acid, m.p. 44·5°, which is the geometrical solid isomeride of liquid 9:10-oleic acid.

It is customary to describe oleic acid as the *trans* acid for reasons of which we must plead ignorance, though it is usual in other cases of geometrical isomerism, in the absence of any definite evidence, to regard the more stable higher-melting form as the *trans* isomeride, which would therefore lead us to assign this structure to elaidic acid. The latter is obtained by the action of nitrous acid on oleic acid and can be reconverted into it.

In agreement with us, Muller and Shearer as the result of X-ray measurements regard elaidic acid as a *trans* compound. Accordingly the relationship of the two acids is to be expressed by the formulæ :—

$$\begin{array}{ll} CH_3{\cdot}[CH_2]_7{\cdot}CH & CH_3{\cdot}[CH_2]_7{\cdot}CH \\ \qquad\quad \| & \qquad\quad \| \\ \qquad HC{\cdot}[CH_2]_7{\cdot}CO_2H & CO_2H{\cdot}[CH_2]_7{\cdot}CH \end{array}$$

Elaidic—*trans* acid. Oleic—*cis* acid.

The abundant occurrence of oleic acid is no evidence in itself that it is the most stable form in the chemical sense; rather the contrary, in view of its production as the result of chemical changes induced by enzyme action in the living cell. There is no evidence that elaidic acid is a natural product.

(6) Petroselinic acid, said to be oleic acid-6:7, is obtained from parsley. It melts at 33°—34° and is represented as—

$$CH_3{\cdot}[CH_2]_{10}{\cdot}CH{:}CH{\cdot}[CH_2]_4{\cdot}CO_2H$$

It also has a stereoisomeric elaidic form.

(7) Cheiranthic acid, m.p. 30°, is very similar to petroselinic acid: its constitution has not been determined.

Erucic acid, $C_{22}H_{42}O_2$.—This occurs as a glyceride in cruciferous oils, etc.: it has been usually regarded as a *trans* acid but we prefer to assign this structure to the isomeric brassidic acid, and in this view we have again the support of Muller and Shearer. The acids accordingly have the subjoined formulæ, the ethenoid bond being between carbons 13 and 14, that is the same distance from the CH_3 group as in oleic acid.

$$\begin{array}{ccc} CH_3{\cdot}[CH_2]_7 & & [CH_2]_{11}{\cdot}CO_2H \\ & C = C & \\ H & & H \end{array}$$

Erucic acid.

$$\begin{array}{ccc} CH_3{\cdot}[CH_2]_7 & & H \\ & C = C & \\ H & & [CH_2]_{11}{\cdot}CO_2H \end{array}$$

Brassidic acid.

Unsaturated acids, $C_nH_{2n-4}O_2$.

Linoleic (linolic) acid, $C_{18}H_{32}O_2$.—Great confusi[on] is introduced into attempts to determine the stru[c]tural formulæ of this group of acids owing to the[re] being four geometrical isomerides possible of ea[ch] substance. Probably more than one linoleic ac[id] occurs in the animal and vegetable fats, but wheth[er] the isomerism is structural or geometrical cann[ot] be stated.

The accepted formula for linoleic acid is :—

$$\underset{}{CH_3{\cdot}[CH_2]_4{\cdot}\underset{13}{C}H{:}\underset{12}{C}H{\cdot}CH_2{\cdot}\underset{10}{C}H{:}\underset{9}{C}H{\cdot}[CH_2]_7{\cdot}CO_2H}$$

The acids of Chinese and Japanese wood oil, vario[usly] named elæostearic and elæomargaric acid, characterised in particular by the readiness [with] which they undergo oxidation. This suggests [an]other arrangement of the ethenoid bonds in t[he] and the latest constitutional formula suggested

$$CH_3{\cdot}[CH_2]_3{\cdot}\underset{14}{C}H{:}\underset{13}{C}H{\cdot}CH_2{\cdot}CH_2{\cdot}\underset{10}{C}H{:}\underset{9}{C}H{\cdot}[CH_2]_7{\cdot}CO_2$$

Unsaturated acids $C_nH_{2n-6}O_2$.

Linolenic acid with three unsaturated eth[enoid] linkages offers opportunity for still greater isom[erism] and confusion. The formula suggested by Erd[mann] and Goldsobel has the double bonds between ca[rbons] 9 and 10, 12 and 13, 15 and 16. Salway ass[umes] the presence of a grouping :—

$$-\underset{14}{C}H : \underset{13}{C}H{\cdot}\underset{12}{C}H : \underset{11}{C}H{\cdot}\underset{10}{C}H : \underset{9}{C}H-$$

but this conflicts with the formula agreed for l[inoleic] acid. This field invites further investigatio[n] much has to be done first to characterise t[he] saturated acids and their decomposition pr[oducts].

The more unsaturated acids have not [been] isolated: they occur in the oils derived from animals as evidenced in the analyses in Tab[le]

Acids $C_2H_{2n-2}O_3$.

Ricinoleic acid, $C_{18}H_{34}O_3$, is the acidic co[nstituent] of the principal glyceride of castor oil. It [has an] ethenoid bond as in oleic acid between [carbons] 9 and 10 and the hydroxyl group on carb[on]

ɛpressed by the formula :—

$$\begin{array}{l} CH_3{\cdot}[CH_2]_5{\cdot}CH(OH){\cdot}CH_2{\cdot}CH \\ \qquad\qquad\qquad\qquad\qquad\quad \| \\ \qquad\qquad\qquad\qquad\quad HC{\cdot}[CH_2]_7{\cdot}CO_2H. \end{array}$$

It thus occupies an intermediate position between eic and linoleic acids, if it be supposed that the ydroxy compound precedes ethenoid bond for- ation.

It is optically active; nitrous fumes convert it ıto the stereoisomeric ricinelaidic acid.

It remains only to mention the closed-chain acids the chaulmoogric series, which are isomeric with ıoleic acid, but contain only one ethenoid bond.

Mixed glycerides.

Our knowledge of the processes of nature enables to be stated that in all cases selective action is work choosing one form of a substance out of any for further elaboration. Materials, whether ey be proteins or carbohydrate derivatives, c., are made to a definite geometrical pattern most as if they were laid down against an existing mplate. The fats in nature form no exception this rule, the fatty acids being stored in the form mixed glycerides which are asymmetric and fer from one another in the location of a particular tty acid radical in the glycerol molecule.

A diglyceride may thus be either :—

$$C_3H_5\begin{cases} OR_1 \\ OR_2 \\ OR_2 \end{cases} \quad \text{or} \quad C_3H_5\begin{cases} OR_2 \\ OR_1 \\ OR_2 \end{cases}$$

hilst for a triglyceride there are three alternatives :—

$$C_3H_5\begin{cases} OR_1 \\ OR_2 \\ OR_3 \end{cases} \qquad C_3H_5\begin{cases} OR_2 \\ OR_1 \\ OR_3 \end{cases} \qquad C_3H_5\begin{cases} OR_1 \\ OR_3 \\ OR_2 \end{cases}$$

Glycerides, as is well known, are hydrolysed by an ızyme named lipase, but we have no knowledge as to ɔw a given preparation of lipase would behave ards the three isomeric triglycerides represented ɔve. They might be hydrolysed at the same rate, different rates or in stages. In order that such stions can be answered, it appears eminently irable that all these compounds should be prepared l their properties studied.

We are able to report some experiments by C. W. ore on the saponification of fatty acid esters and cerides with alcoholic potassium hydroxide. He ls that the primary esters of the higher fatty acids hydrolysed at the same rate in equimolecular ıcentration, and concludes that the α-mono- cerides of the acids would also be hydrolysed at the ne rate. He was unable to prepare β-mono- rin to compare its behaviour with the α-isomeride ing to internal rearrangement in the molecule ing place, but he was able to show that trilaurin l monolaurin are changed at the same rate and t the hydrolysis does not take place in stages.

It is probable, indeed, that the action of lipase is affected by the nature of the fatty acid radical ept in so far as this may have a secondary influ- : in affecting the nature of the emulsion between yme and glyceride.

The synthesis of glycerides of definitely known structure is complicated by the possibility of internal rearrangement and the wandering of acyl groups in the molecule. Fischer has used acetoneglycerol :—

$$\begin{array}{l} CH_2\text{——}CH{\cdot}CH_2{\cdot}OH \\ | \qquad\qquad | \\ O{\cdot}CMe_2{\cdot}O \end{array}$$

as the starting-point for the preparation of α-mono- glycerides such as α-monolaurin, α-monopalmitin, α-monostearin. These are readily converted into such triglycerides as α-lauro-$\alpha'\beta$-distearin on treat- ment with the corresponding acid chloride and quinoline or pyridine :—

$$\begin{array}{ccc} CH_2{\cdot} & CH{\cdot} & CH_2 \\ | & | & | \\ OA & OH & OH \end{array} \qquad\qquad \begin{array}{ccc} CH_2{\cdot} & CH{\cdot} & CH_2 \\ | & | & | \\ OA & OB & OB \end{array}$$

Under similar conditions the α-iodohydrin gives a diacyl derivative, presumably $\alpha\beta$, which, however, owing to the wandering of an acyl group, changes to the symmetrical $\alpha\alpha'$ derivative :

$$\begin{array}{ccc} CH_2{\cdot} & CH{\cdot} & CH_2 \\ | & | & | \\ OH & OB & OB \end{array} \qquad\qquad \begin{array}{ccc} CH_2{\cdot} & CH{\cdot} & CH_2 \\ | & | & | \\ OB & OH & OB \end{array}$$

On introducing the third acyl group A the final product :—

$$\begin{array}{ccc} CH_2{\cdot} & CH{\cdot} & CH_2 \\ | & | & | \\ OB & OA & OB \end{array}$$

is isomeric with that above, having a higher melting point and lower solubility in accord with its sym- metrical structure.

A method for the preparation of mixed glycerides, in order to be of many-sided applicability, must be of such a nature that the three OH groups of the glycerol can be so differentiated that it is possible to treat them differently at the individual stages of the process; the starting material must, therefore, be such that two of three substitutable groups in the glycerol are at first masked and are uncovered only in the further course of the synthesis and then only successively. A substance fulfilling these require- ments is the compound 2-phenyl-5-hydroxymethylox- azolidine :—

$$\begin{array}{l} HO{\cdot}CH_2{\cdot}CH{\cdot}CH_2{\cdot}NH \\ \qquad\qquad\;\; | \qquad\quad\; | \\ \qquad\qquad\;\; O\text{——}CHPh \end{array}$$

suggested by Bergmann, which has but one alcohol group available for esterification. A second, how- ever, can be produced by the action of acids, whereby it is hydrolysed to benzaldehyde and aminopropylene- glycol, $HO{\cdot}CH_2{\cdot}CH(OH){\cdot}CH_2{\cdot}NH_2$, and finally the third is produced by treating the last compound with nitrous acid.

The actual physical properties of a fat are due to the nature of the glycerides of which it is composed. Two fats may contain the same acid radicals in much the same proportions and yet appear very different in texture, melting point, etc.—factors which are of the greatest importance in their technical applica- tion. Thus analyses of cacao butter and of South American mutton tallow made in our laboratories show that the percentage of fatty acids obtained from

them is very nearly the same and yet the two fats are entirely different :—

	Cacao butter.	Mutton tallow.
Myristic acid	0	1 5
Palmitic acid	23 2	21 0
Stearic acid	33 6	30 0
Oleic acid	41 8	43 0
Linoleic acid	1 4	5 0

Crystallisation from solvents has been the usual means of effecting the separation, but a far more satisfactory method is required. We would go so far as to say that this is the most pressing practical problem awaiting solution in this field of inquiry.

The glycerides in butter fat are mainly mixed glycerides. Oleopalmitobutyrin has been isolated, and it is probable that the whole of the butyric acid found in the fatty acids exists in this form.

The mixed glycerides in lard have been carefully studied by Amberger and Wieschahn, who have compared those isolated with those synthesised and those obtained by their hydrogenation. They have identified the presence of :—

β-Palmito-$\alpha\gamma$-distearin.
β-Stearo-$\alpha\gamma$-dipalmitin.
α-Oleo-$\beta\gamma$-distearin.
α-Palmito-$\beta\gamma$-diolein.
β-Oleo-α-palmito-γ-stearin.

Beef fat contains tristearin, distearopalmitin, and dipalmitostearin (Dekker).

In palm kernel oil, Bömer has identified the presence of the following glycerides :—

Caprylmyristo-olein,	m.p. 14°
Dilauromyristin,	m.p. 33°
Laurodimyristin,	m.p. 40°
Dimyristopalmitin,	m.p. 45°
Myristodipalmitin,	m.p. 51°

Oleodistearin and oleodipalmitin are said to be constituents of cacao butter; in addition it must contain either triolein or glycerides containing two molecules of oleic acid.

II. THE DISTRIBUTION OF THE FATTY ACIDS IN NATURE.

We shall consider the fascinating question of the distribution of the fatty acids in nature under the headings of animal, vegetable, and marine animal fats, etc., adopting this order mainly because it corresponds to increasing complexity. The published information with regard to the fatty acids present in natural fats is scanty, but we are able to include data with regard to a number of fats based on analyses carried out in our laboratories mainly by the ester method by Drs. C. W. Moore, C. H. Clarke, and others during the last twelve years. Until quite recently but little work in this direction has been performed; in future no fat can be considered to have been properly characterised until a full analysis of this type has been made. The method, of course, gives only an approximation, but with much experience comparable, trustworthy results are obtained. Failing the complete analysis, some information as to the composition of a fat is given by the iodine value and saponification equivalent.

Animal fats.

The animal body contains a variety of fats accord ing to the part of the body in which the occur; in addition, the nature of the body fat influenced by the composition of the food which th animal eats. The particular fatty acids taken the food are liable to pass into the body fat and in the milk fat, though the fats themselves are broke down in the processes of digestion to be subsequent reconstituted after absorption. Consequently, cannot be said that each animal is characterised by specific kind of fat, though, inasmuch as most anima live on a diet which is characteristic of the speci it is broadly possible to associate specific qualit with the fat of each animal. Further, abnorn feeding usually means an abnormal body or milk fa hence the variations encountered by the analyst

For example, hogs fed on dried fish yield lard c disagreeable fishy taste, and the modern practice America of feeding hogs on maize is stated to ha produced much softer lards than used to be obtair Similar differences are to be observed with tallo cattle fed on grass on the plains of South America Australia give a harder tallow containing more sa ated fatty acids than those fed on oil cakes wl are richer in olein.

Horses fed continuously on grass or green foo deposit a fat very similar to that of the sheep and whereas the fat of a horse when corn-fed is more oi corn-fed animals give rise to softer fats than t fed on grass.

Fish, which feed on smaller marine animals taining fats of high iodine value, normally conta fat with an iodine value of 110; when fed on mu tallow the iodine value of their fat fell to 79.

Lewkowitsch quotes the following figures :—

Fat from		Iodine val
Rabbit—	wild	101·1
	tame	64 4
Goose –	wild	99 6
	wild, held in captivity 2 years	67 0
	domestic	67 0
Hog –	wild	76 6
	domestic	66 0

as illustrating the very marked influence of d and life habit on the character of the fat. I case of the goose the feeding on fish may expla high iodine value.

In connexion with their researches on vit Channon, Drummond, and Golding have beg study of the alteration in the composition of fat produced by the inclusion of various oils daily diet of cows. The cows were given first a roots and hay diet, then this, plus coconut or a oil, then the basal diet again, then this supple by cod liver oil, and were finally put out to p In all cases the cod liver oil period was marke fall in the fat content of the milk. The ara supplement produced surprisingly little che the analytical characteristics of the fat, but the cod liver oil period the values varied ma showing the passage of the cod liver oil or s its constituents into the milk—the iodine nearly doubled, the saponification value fe 237 to 221.

The fat in the eggs of hens fed on barley had an odine value of about 70; this rose to 97 when nseed was substituted and to 120 with hemp seed. he body fat of the hen in the last instance also had an odine value of 119. However, the fatty acid from ne purified egg lecithin had a normal iodine value, howing that not every fatty acid can enter into the ecithin molecule.

The stored reserve fat of the connective tissues ontains more olein than that of the internal tissues, s for example the fat around the kidneys.

In very fat animals including marine animals the odine value is progressively less in the layers of fat nore remote from the skin, the surface fat consequently containing most olein and having the lowest nelting point. In the hog, Henriques and Hansen bserved the following melting points of the fat :—

At a depth of 1 cm.	33·7°
" " " 2 "	34·8°
" " " 3 "	37·0°
" " " 4 "	39·0°

ch organs as the kidney and liver etc. in which tabolism is active contain fats with a much higher ine value than the connective tissue fat, and rtley has shown that the unsaturated acids contain nbers even of the 2n–6 and 2n–8 series analogous those of the fish liver oils. We shall discuss the ificance of this difference in connexion with the tabolism of the fats, remembering for the moment t the liver is the site of the formation and degradion of fats.

Butter or milk fat is remarkable in that it contains nsiderable amounts of the lower fatty acids volatile a current of steam, in particular butyric acid, ich is absent from the vegetable nut oils. It ntains no acid less saturated than oleic, and only all quantities of stearic acid.

About 30% of the non-volatile acids are composed oleic, but the proportion of this increases as the tation period advances. Human milk fat contains rly 50% of oleic acid and has an iodine value of compared with about 33 for butter. The percene of fat in the milk varies very much with different mals :—

Human	about	3·5
Cow	"	3·5
Dog	"	10·5
Goat	"	4·0
Ass	"	1·3
Pig	"	6·4
Elephant		20
Dolphin		44

The stored fats of the connective tissue, consisting he main of stearin and palmitin, with a proportion olein, all substances relatively stable towards lising agents, are converted in the liver into nly unsaturated, easily oxidised acids with the e number of carbon atoms; this represents an rmediate stage before the break down into simpler ducts, the combustion of which presents no ficulty in the cells of the body. The outstanding rk of Hartley has proved the liver of pigs to ntain the following acids in addition to palmitic l stearic, approximately one half of the acids sent being unsaturated:

1) An oleic acid with the unsaturated link between carbons 12 and 13, which is therefore isomeric with ordinary 9 : 10-oleic acid.

(2) Two linoleic acids, one of which has the unsaturated linkages between carbons 9 : 10 and 12 : 13. Curiously enough no linolenic acid is present. Linoleic acid is present in greater amount than oleic acid.

(3) At least 10% of an acid $C_{20}H_{32}O_2$ with 20 carbon atoms and belonging to the C_nH_{2n-8} series.

Some special explanation seems necessary to account for the presence of this acid, as the saturated arachidic acid is only present in lard in traces at the most and it affords an instance of the synthetic activity of the liver in building up fatty acid chains.

Whilst in herbivorous animals fats are largely formed from carbohydrates, in flesh-eating animals the fat of the food is the usual source of the fat of the body, but it may arise from other materials. Fats are emulsified and hydrolysed in the intestine, the soluble glycerol and fatty acids diffuse into the epithelium cells, where the fats are re-formed and pass *via* the chyle and the blood to the cells of adipose tissue where they are stored. The fat has the same composition here, so far as concerns the identity of its fatty acids, as it had in the food, as is evidenced by the appearance of unusual fatty acids when they are administered in the food.

Obviously mixed glycerides, derived for illustration from cacao butter, will be hydrolysed by lipase in the intestine and the fatty acids recombined in the connective tissues to form quite other simple or mixed glycerides such as are characteristic of the animal.

When the stored fat is required to be utilised it is again rendered soluble in the blood for transportation, the active agent being the enzyme lipase. This enzyme is widely distributed in the body and occurs also in many oil seeds; it has been established that it can act both as an analytic and a synthetic agent. Much remains to be done in studying the distribution and the nature of the activity of the lipase. The liver is the organ which plays the chief rôle in the preparation of the fats for subsequent changes.

The fact that fat may arise from carbohydrate food was first firmly established by Lawes and Gilbert, in their classical experiments on the fattening of cattle and sheep nearly 70 years ago. Whether fats can also arise from proteins is a controversial question. Under abnormal conditions, as for example glucosuria, there is definite evidence that fat is converted into sugar, the seat of conversion being the liver, which is likewise the organ in which the synthesis is effected.

Vegetable fats.

Compounds of fatty acids in the form of fats or waxes are of as frequent occurrence throughout the vegetable kingdom as they are in the animal kingdom. It is to be noted, however, that whilst the fatty glycerides are found in all animal tissues and organs, the same statement cannot be made regarding plants since it is almost without exception in the fruits and seeds that the mixtures of glycerides which constitute the vegetable fats are found. An

example of departure from this is the presence of fat in certain rhizomes, as for instance those of *Cyperus esculentus*.

An outstanding fact in connexion with the vegetable fats is the fixity of their composition The iodine value and saponification equivalent of the commercial oils, of which enormous quantities are used originating from all parts of the world, show a minimum of variation. This is particularly the case with cotton seed oil—the fine breeding to which the cotton plant has been subjected for the purpose of the staple seems reflected also in the constancy of the composition of the oil.

It would appear that the oil contained in seeds is a food reserve for the germinating seed, but it is doubtful if this explanation can be made applicable to such fruits as the olive, that of the West African oil palm, and others, where large proportions of oil are found in the pulpy pericarp, which is separated from the embryo by a hard woody shell and is in all probability dispersed before germination takes place. As a sidelight on its utility or otherwise it may be mentioned that the germination of palm nuts is much more rapid and certain, if the oily pericarp be removed before the nuts are planted.

In other parts of plants, as for instance on the stems and leaves of the *Gramineæ*, in the bark and roots of most trees, and even in the petals of flowers, fatty acids are found combined with a diversity of monohydric and a very few dihydric alcohols in the form of waxes.

This marked difference in composition indicates a provision of the two classes of material for entirely different purposes, and whilst the fats are obviously food reserves, the waxes act as resistants to protect the vegetable tissues from water penetration and the resultant destruction which would follow.

The saturated fatty acids in the vegetable fats are as numerous as those occurring in animal fats (prominently C_6 to C_{22}), but the unsaturated acids are almost wholly C_{18} acids, and their unsaturation is not known to exceed three ethenoid linkages. Probably very small amounts of palmitoleic acid do occur in a number of vegetable fats, but this has not been proved with any degree of certainty.

It cannot be said that plants of the same botanical order yield fats having the same composition, though this is sometimes the case. The *Palmæ* for instance produce nuts very similar in character which yield fats all of which are remarkable for the large percentage of glycerides of low molecular weight which they contain. A considerable number of these fats are found in commerce, and so generally is this fact in their composition recognised that they are frequently classified as "nut oils."

Even from the *Palmæ*, however, fats can be obtained which do not exhibit this special feature, since that obtained from the pericarp of *Elæis guineensis* is the well-known palm oil, a fat having many of the characteristics of and approximating in composition to a soft tallow, whereas the kernel fat is one of the most prominent "nut oils."

This difference in the properties of fats from different parts of the same fruit is not confined to the *Palmæ*, but is also exhibited by members of other orders. Thus the mesocarp of *Stillingia sebifera* (order *Euphorbiaceæ*) yields the well-known solid fat, Chinese vegetable tallow, whilst the seeds furnish a liquid yellow oil having marked drying properties.

In the case of the olive, however, the pulp and kernel fats are very similar to each other when both are extracted from fresh material, but the kernel oil, as usually marketed, is highly rancid, being prepared from residues left after the pulp oil has been extracted.

In a few cases the family to which a plant belongs is indicative of certain characteristics which can be observed, particularly in the composition of the fat in various parts of the seed. A specific example of this is to be found in the genus *Palmæ*, in which the fat of the endosperm is marked by the peculiarity that it always contains an unusually s[illegible] percentage of unsaturated glycerides and a h[illegible] content of glycerides of saturated acids contain[illegible] 10, 12, and 14 carbon atoms. The endosperm [illegible] these fruits is developed in the interior of a h[illegible] woody shell which, in the early stages of the for[illegible]tion of the endosperm, contains a highly sacchari[illegible] liquid, the endosperm itself developing from [illegible] glutinous slime to the hard almost horny con[illegible] in which it is found in the ripe seed. It migh[illegible] expected that the fat in such a seed would be [illegible] similar composition throughout its mass but, [illegible] Richardson has shown in the case of the coco[illegible] this is not so since the fat contained in that port[illegible] of the seed next to the shell, which includes the te[illegible] or thin brown skin which surrounds it, contain[illegible] much higher percentage of unsaturated acids tha[illegible] found in other parts of the kernel. It is proba[illegible] that this difference is due to the presence of a grea[illegible] proportion of olein in that part of the seed, since al[illegible] with an increased iodine value, which is a measu[illegible] of the unsaturation, there is also a marked increa[illegible] in the saponification equivalent, a measure of t[illegible] average molecular weight of the glycerides.

From the examination in our laboratory of a la[illegible] number of coconuts from all parts of the world, [illegible] W. Moore has been able to establish this as a gen[illegible] feature of many varieties of *Cocos nucifera*, [illegible] investigation of the seeds of other members of [illegible] order *Palmæ* would seem to indicate that the pe[illegible]liarity is general. Such highly different palms [illegible] *Elæis guineensis*, which furnishes the West Afri[illegible] palm kernel, and the Brazilian *Attalea*, which is [illegible] source of babassu kernels, exhibit the same charac[illegible]istic feature. The same applies to the kernel of [illegible] Brazil nut, though in a less pronounced degree.

TABLE 1.

Comparison of Oil from the whole Kernel and Kern[illegible] Parings of the Coconut.

	Kernel oil. Sapon. equiv.	Kernel oil. Iodine value.	Parings oil. Sapon. equiv.	Parings oil. Iod. va[illegible]
Malay States	214	7·2	244·2	2[illegible]
Malabar (Cochin)	219	8·7	252·5	4[illegible]
Java	214·5	8·5	253·1	5[illegible]
Celebes Islands	216·5	9·6	249·7	2[illegible]
Philippine Islands	216	7·3	241·8	3[illegible]
Trinidad	216	8·0	246·0	3[illegible]
Fiji Islands	217·5	8·5	237·0	[illegible]

On the other hand an analysis after the s[illegible] manner of the testa obtained from arachis nuts

almonds gave figures indicating an exact similarity between the oil contained in this part of the seed and that in the whole endosperm.

TABLE II.

Comparison of Oil from the whole Kernel and Kernel Parings of various Nuts.

	Kernel oil. Sapont. equiv.	Kernel oil. Iodine value.	Parings oil. Saponif. equiv.	Parings oil. Iodine value.
Palm kernels	231 0	13 5	240 0	29 6
Babassu kernels	221 2	12·2	241·1	22 8
Brazil nuts	289·2	104 8	290 6	114·3
Almonds (sweet)	290 1	101·0	289·4	100·5
Arachis	296 0	97·0	296 0	95 0

The enzyme lipase appears to be absent or at least in a quiescent form in resting seeds, but it develops during germination when the stored-up fat is hydrolysed to fatty acid and glycerol. There is a continuous production of sugar, both sucrose and dextrose, which must come from the fat, the sugar in its turn acting as the antecedent of starch. The work of ... Fürth with sunflower and castor oils has established that, during germination, there is a fall in the molecular weight of the acids as indicated by an increase in the saponification value and a lowering of the iodine and acetyl values. In other words, lower fatty acids are being formed from the higher acids at the expense of the unsaturated linkages and the hydroxylated carbon atoms which constitute the weak points in the chain.

As Gerber has shown, during ripening so long as the seed is soft and green, more oxygen is used than carbon dioxide eliminated. When the seeds become hard and the testa coloured the reverse is the case, more carbon dioxide being eliminated than oxygen used. Finally in the ripe seeds the oxygen intake becomes the greater again. In the olive, which contains mannitol in the unripe condition, this alcohol and protein disappear as fat is formed.

	June 30.	July 30.	Aug. 30.	Sept. 30.
Fat	1 4	5 5	29 2	62 3
Protein	—	—	14 6	4 2

The change from carbohydrate into fat in the case of almonds is exemplified in the following :—

	June 6.	July 4.	Aug. 1.	Sept. 1.
Dextrose	6 0	4 2	0	0
Sucrose	6 7	4 9	2 8	2 6
Starch	21 6	14·1	6 2	5·4
Fat	2	10	37·0	44

It is stated by Russow that in most woody plants starch is in part converted into fat during the winter, the reverse process taking place in the spring. Low temperatures favour the former change; higher temperatures induce the latter.

The investigation carried out by H. L. White on the condition of the oil in soya beans during germination has shown that while the oil is being used for the nourishment of the growing plant the processes of metabolism continue to supply fatty acids of practically the same degree of unsaturation, at least up to the formation of the first set of leaves.

So far as we are aware, the changes in the nature of an oil during the ripening of the seed have been studied in detail in one case only, *viz.*, that of flax or linseed oil, and we are particularly fortunate in being allowed to make reference to certain unpublished results of Dr. J. V. Eyre, which he has communicated to us privately, which are of the highest importance and interest.

Oil formation occurs moderately early in the life of the seed, and proceeds at a rapid rate, amounting approximately to 3% per day on the dry seeds over a period of ten days. The unsaturated nature of the oil of the seed (which is the well-known characteristic of this drying oil) becomes more and more pronounced as the seed advances in age, as evidenced by the following figures :—

Days after flowering.	Oil on dry seeds, %	Iodine value of oil.
10	2·5	114
14	15 1	119
17	31 1	127
23	37	143
28	37	170
35	39	180
51	36 3	190

The greatest rate of increase in the iodine value of the oil takes place after the oil content has attained its maximum value.

The flax seed shortly after fertilisation consists of a white envelope containing an aqueous fluid; during the early days solid material accumulates and the seed swells, becoming green about the 14th day. From this point carbohydrates, oil, and protein are rapidly accumulated and the curves showing the increase in oil and that in carbohydrate and protein combined are roughly parallel. The iodine value of the oil when it first appears is probably as low as 100. Extracts from young seeds have a high fatty acidity which rapidly decreases as the seed ages, showing either that glycerol appears later than fatty acid or that synthesis of the glyceride does not occur immediately.

Marine-animal fats.

The variations in the nature of the body fat of animals according to species, food, and location of fatty tissue has already been indicated. The differences thus created are most strikingly exhibited amongst the fats obtained from marine animals. Even the briefest consideration of their properties necessitates their division into three groups, viz. :—

(1) Fish oils obtained from the bodies of various fish.

(2) Liver oils, obtained from the internal organs, chiefly the liver, of various fish.

(3) Blubber oils, obtained from the fatty tissue of marine mammals.

Our knowledge of these fats is still very incomplete and very much that is published as to their composition must be accepted with considerable reserve. As a class, however, they contain glycerides of certain highly unsaturated fatty acids ($C_nH_{2n-8}O_2$ and $C_nH_{2n-10}O_2$), a fact which clearly distinguishes them from the terrestrial animal and vegetable fats. It is probable that acids containing 18, 20, 22, and 24 carbon atoms exhibit this extreme state of unsaturation, and it would appear also that the characteristic "fishy" odour which is possessed by all of them as generally prepared, is due to the presence of oxidation products of these highly unsaturated glycerides.

The bodies of fish of which the livers are rich in fat rarely contain more than a small percentage of fatty glycerides and the reverse also holds good. The liver fats can generally be distinguished from

TABLE III.

Percentage composition of fatty acids from fats

	C_4	C_6	C_8	C_{10}	C_{12}	C_{14}	−2H	C_{16}	−2H	C_{18}	−2H	−4H	−6H	C_{20}	Average unsaturation in terms of −H	C_{22}	Average unsaturation in terms of −H	C_{24}
[1]Butter fat	3·4	3 3	1·9	3·0	3·7	12·9		20·8		6·2	27 0		*Unidentified* 9 8					
Coconut oil		0 25	0·25	19·5	40	24		10·6			5·4							
Palm kernel oil			3·0	6·0	50	16		6·5		1·0	16·5	1·0						
Skin grease						7 5		25·0	12 0	10·0	42 0	3 0						
S. American beef tallow..						2 5		25 0		20·0	47·5	5·0						
Australian beef tallow ..						2·0		26·5		22·5	49·0							
N. American beef tallow.						2·0		32 5		14·5	48·3	2·7						
S. American mutton tallow						1·5		21·0		30·0	43 0	5·0	Traces					
Australian mutton tallow						2 0		25·0		23·0	47·3	2·7						
[2]Horse fat								29·5		6·8	55·3	6·7	1·7					
[3]Camel hump fat								37·0		16·0	47·0							
Palm oil						1 0		35·5		8·5	48·0	7·0						
Chinese vegetable tallow..								66·5			33·5							
Cacao butter								23·2		33·6	41·8	1·4						
[4]Arachis (Spanish type) ..								8·2		6·2	52·9	24·7		4·0				3·1
[5]Arachis (Virginia type) ..								6·3		4·9	60·6	21·6		3 3				2·6
Arachis (Senegal)								7·3		2·6	65·7	19·2		2 6				2·6
[6]Hubbard squash oil ..								13·0		6 0	37·0	44·0		Trace				
[7]Melon seed oil						0 3		10·3		4·5	27·6	57 3		0 4				0·2
[8]Maize oil								7·9		3·6	26·3	41·6	2·2	0·7				0·1
[9]Soya bean oil								6·5		4·4	33·4	57·5		0·6				0·4
[10]Sunflower seed oil ..								3·5		2·9	34·0	58·4	7·6					
[11]*Pinus abies* seed oil ..								0·7			42·4	49·3	7·5					
[12]*P. sylvestris* seed oil ..								2·8		0·1	35·1	54·5						
Cottonseed oil								23·4			23 0	53·6						
[13]Grape seed oil								5·5		2 4	36·8	55·3						
Tung oil											7·4	92·6						
[14]Linseed oil. *Saturated acids*										8·7	4·8	62·0	24·0	*Hydroxy acids* 0·5				
Japanese fish oil						5 5		9 7	13 0	2·3	14·2	10·0	Traces		26·0 (−5H)		19·0 (−5H)	
Menhaden oil						5 9		16·3	15·5 (−3H)	0·6	29 6 (−4H)			0·6	19·0 (−10H)	0·8	11·7 (−10H)	
Southsea whale oil ..						8·0	1·5	12·1	15·0	2·3	33·4	9·0			8·2 (−7·5H)		10·5 (−9H)	
Newfoundland whale oil ..						7·6	1·4	9·7	18 3	2·8	35 1	8·8					16·0 (−8H)	
Whale oil .. .. .. (iodine value 151)						4·1		10·6	18 4 (−2 5H)	3·5	32·8 (−3H)				19·3 (−7H)		11·3 (−8H)	

[1] Frog and Schmidt-Nielsen. [2] Heiduschka and Steindruck. [3] McClelland [4 5 6 7 8 9 10] Baughman and Jamieson. [11 12] E. Friedrichs. [13] F. Rabak. [14] Eibner and Schmidinger.

acids may be present. It would appear that whatever may be the mechanism of synthesis, there is a tendency to form compounds with 18 carbons, produced it may be from three molecules of glucose, either as such or in the form of the nucleus of starch. The other fatty acids may be formed by secondary reactions from the C_{18} molecule; there would be reason to expect much the same mixture of acids in all fats, at least qualitatively, if the same mechanism were concerned in every case. There is a good deal known about such secondary changes, particularly in relation to the theory of β-oxidation first enunciated by Knoop and subsequently elaborated by Dakin.

If it be admitted that C_{18} acids are derived from starch or from glucose by one of the processes suggested, the method of formation of palmitic acid C_{16} and the higher acids C_{20}, C_{22}, C_{24} requires some consideration.

The summary on page 3 indicates that increasing unsaturation is roughly a function of the length of the chain and that C_{18} acids are not really much more in evidence when other acids are present with them than are the lower and higher members.

Palmitic acid may well be formed as the result of a β-oxidation process, and when palmitoleic and myristic acids accompany it we are inclined to this view. In other cases some mechanism to account for its direct synthesis seems desirable; this we are not yet in a position to suggest.

The formation of higher acids C_{20} to C_{24} is still more difficult to explain—since Hartley found them in the pig's liver derived in all probability from C_{18} acid in the tissues—they may perhaps arise by the condensation of small fractions produced during the oxidation of stearic acid *in vivo*. The location of the ethenoid linkings has to be determined before such questions can be answered.

In vivo, in the animal, the hydrogen attached to the β or the third carbon atom of a fatty acid is selected for oxidation so that a long chain compound loses two carbon atoms every time. For example, phenylvaleric acid becomes phenylpropionic acid and this in turn benzoic acid. Butyric acid is converted first into β-hydroxybutyric acid and then into acetoacetic acid:

$$CH_3{\cdot}CH_2{\cdot}CH_2{\cdot}CO_2H \rightarrow CH_3{\cdot}CH(OH){\cdot}CH_2{\cdot}CO_2H \rightarrow CH_3{\cdot}CO{\cdot}CH_2{\cdot}CO_2H.$$

An exactly similar change is brought about by hydrogen peroxide, as shown by Dakin, when β-keto-acids and the corresponding ketones are formed. This is, however, not the only action of hydrogen peroxide, as there is undoubtedly some oxidation in both the α- and the γ-position. Working with stearic acid Clutterbuck and Raper show that the relative amounts of the acid undergoing β- and γ-oxidation are of the order 7 to 1 respectively. It is suggested that γ-oxidation may also take place in the body, but Dakin considers that all the physiological evidence is against this.

Embden has shown that in the liver acetoacetic acid is only formed from the higher fatty acids with an *even* number of carbon atoms; this is not only a striking confirmation of Knoop's theory, but also indicates that the degradation of the higher acids is progressive, two carbons being split off each time, and that there is no break in the middle of the chain in oleic acid, for example, which might lead to the formation of C_9 units.

A clue to the mechanism of the oxidation of the fatty acids which contain an *uneven* number of carbon atoms is afforded by Ringer's proof that in diabetic organisms they are converted into glucose about in proportion to the amount of propionic acid they might furnish through β-oxidation. According to the evidence, propionic acid is presumably converted into lactic acid or pyruvic acid, and it is well known that the former is quantitatively and the latter partially converted into glucose in the diabetic organism.

The mechanism of β-oxidation has been fully studied by Dakin, who has proved that $\alpha\beta$ unsaturated acids are formed in the animal body either indirectly through the intermediate formation of hydroxy-acids or directly.

In the liver, as Hartley's work has shown, unsaturated acids are formed both from stearic and oleic acids by the introduction of an ethenoid bond between carbons 12 and 13. If oleic acid is formed in nature from stearic, it follows that the ethenoid bond is introduced between carbons 9 and 10 and in linseed, as Eyre has proved, unsaturated acids are formed during ripening. The question arises as to whether these ethenoid bonds are introduced in their final positions at specific points of weakness in the chain of carbon atoms or whether there has been a migration of the bond from some other point where it was first formed to its present position.

It would lead us too far to discuss the migration of ethenoid bonds—a phenomenon well known to the organic chemist—but the conversion of oleic acid into palmitic and acetic acids, together with smaller quantities of lower homologues of palmitic acid on fusion with potash, a reaction involving both oxidation and shifting of the ethenoid link, may be recalled in this connexion.

There is a good deal of evidence known to the organic chemist that acids of a homologous series show an alternation in properties between the odd and even members. This applies to the dibasic acids of the oxalic series as well as to the monobasic fatty acids as Challenor and Thorpe have shown. In the former instance, in addition to differences in physical properties, another property is the ease with which the even members of the series are produced by the direct oxidation of suitable substances, whereas the yield of the odd members is very small, except under carefully regulated conditions, the substance being oxidised to the next lower even number. Thus ricinoleic acid on oxidation with nitric acid yields azelaic acid, $C_9H_{16}O_4$, and suberic acid, $C_8H_{14}O_4$, in about equal proportions, although theoretically only azelaic acid should be obtained. The authors quoted consider that in

district and the centre of what might be called the produce importation of Britain.

With all this going on the citizens of Liverpool had yet time for the other side of life, the higher side—its humanities. The presence of the University, the outcome of magnificent endowments that citizens of Liverpool had bestowed, pointed to the fact that science was not forgotten here. If, as a result of their meeting, the Society could leave a message behind, it should be one of encouragement to the citizens of Liverpool to go on taking an interest in science and all that science means, and to go on taking an even greater interest in the University, if that be possible. Much as Liverpool had done, it was only a tithe of what she would be able to do in the next twenty years if she took advantage of all the facts science could lay at her feet. On behalf of the members of the Society he thanked the Lord Mayor and the Vice-Chancellor for their welcome.

THE KING AS PATRON.

The PRESIDENT recalled the fact that his Majesty the King had very graciously become Patron of the Society on the occasion of the present meeting, and he proposed that the following loyal telegram be sent :—

"Members of the Society of Chemical Industry assembled at the University of Liverpool at their Annual General Meeting beg your Majesty to accept this expression of their gratitude for your Majesty's gracious patronage and this assurance of their loyal devotion. (Signed) PRESIDENT."

This was agreed to with acclamation.

APPOINTMENT OF SCRUTINEERS.

The President announced that Dr. Auden, Prof. Bannister and Dr. C. H. Clarke were willing to act as scrutineers for the ballot for the election of the Council, and it was agreed that they should be appointed as such.

The PRESIDENT formally declared the ballot closed.

HONORARY MEMBERS.

The Minutes of the last Annual Meeting having been taken as read :

The PRESIDENT reported the fact, which had already appeared in our *Journal*, that the Council had added two more distinguished names to their short but very notable list of Honorary Members, namely, those of Dr. Ernest Fourneau and M. Armande Solvay.

M. Fourneau was working at the Pasteur Institute in Paris, and was probably one of the finest manipulators, as a pure organic worker, amongst chemists to-day. His early brilliant work, the production of a lumbar anæsthetic, which with the delicacy of wit so characteristic of France he named Stovaine as a compliment to this country, would be well remembered. His later work, even more remarkable, had been the identification of the "Bayer 205" cure for sleeping sickness and its synthesis. It would be [illegible] the Germans had proposed to keep this remedy secret, contrary to the customary usage of all civilised nations, and to use it as an offensive weapon. The French, thanks to M. Fourneau, had been able to frustrate this action, and the specific would now be available for the use of the whole world. M. Fourneau's work was so remarkable that the Council felt that in honouring him they were certainly honouring themselves.

The name of Solvay hardly required any commendation in Liverpool, and in taking M. Armande Solvay into their ranks they took the head of the great Solvay organisation, the son of a very illustrious father, a man who himself occupied the very highest positio[n] in the great firm, both technical and otherwise M. Solvay's interests in the prosecution of pur[e] science and the encouragement of pure science wer[e] probably well known to many.

Both these gentlemen would have liked to b[e] present at the meeting, but unfortunately they ha[d] been prevented owing to other engagements. F[He] felt sure the meeting would most cordially appro[ve] the selection of these two Honorary Members.

The following Report of Council was taken as rea[d]

REPORT OF COUNCIL.

The Council has the honour to submit to [the] Members the following Report on the activities [of] the Society of Chemical Industry during the y[ear] 1923–24 :—

Membership.

The number of members on the register at Jul[y] 1924, is 4834, as compared with 5060 on June 1923. Since the last Annual Meeting 225 mem[bers] have been elected, 47 former members have [been] restored to membership, and the losses through de[ath,] resignation, etc., have been 498.

The Council regrets to have to record the de[aths] during the past year of the following 40 mem[bers,] of whom 10 were Original Members :—

Dr. G. H. Bailey, Harold J. Bailey, Hu[gh] Barker, Ernest Bentz, Frederick W. Berk, Fr[...] Bloomer, Dr. Charles E. Calm, Edgar V. Cha[...] Dr. Frank Clowes, Louis C. Daniell, F. M. Dick[...] Sir James J. Dobbie, F.R.S., Lincoln W. Eva[...] Farrington, Thomas Fox, Jr., W. H. Francis, J[...] Gall, Robert G. Grimwood, James Hope, A. E. [...]han, Fred Kuttroff, Dr. Albert R. Ledoux, Wil[...] Leonard, Charles Lorleberg, James McAlley, J[...] Mansfield, William E. Moulsdale, Dr. E. K. Mu[...] S. K. Muspratt, William F. Oburg, Edgar Ri[...] F. G. Adair Roberts, Dr. S. P. Sadtler, Fre[...] Seard, Dr. J. E. Stead, F.R.S., George B. [...] William Thomson, Alexander E. Tucker, J[...] Wilkie, and Herbert T. Wilkinson.

Dr. F. Clowes (Original Member) was Pres[ident of] the Society in 1897–98.

During the past three years a considerable [number] of members have had to relinquish their mem[bership] owing to lack of employment, and the Co[uncil have] made arrangements whereby they may resu[me] membership on payment of the current ye[ar's sub]scription only. It is satisfactory to note th[...]

former members have already taken advantage of this concession.

The following table shows the gains and losses in membership during the past five years :—

	1919–20	1920–21	1921–22	1922–23	1923–24
Membership at beginning of year ..	5236	5612	5654	5270	5060
Gains ..	633	472	282	288	272
Losses ..	257	430	666	498	498
Net Gain or Loss	+376	+42	−384	−210	−226
Membership at end of year ..	5612	5654	5270	5060	4834

Honorary Members.

The Council, a year ago, conferred the honorary ·mbership of the Society on the following distin- ished chemists :—

Prince Ginori Conti, Professor C. F. Chandler, ›nsicur Paul Kestner, Prof. J. Sakurai, and Sir J. Tata, and to this list it has now added the mes of Prof. E. Fourneau and Monsieur Armand lvay.

Council.

Dr. E. Frankland Armstrong, F.R.S., retires from office of President at the close of the Annual neral Meeting, and the Council has nominated as successor Mr. W. J. Uglow Woolcock, C.B.E., General Manager of the Association of British emical Manufacturers.

Mr. E. V. Evans and Sir William J. Pope, K.B.E., ve been re-elected Honorary Treasurer and Honor- Foreign Secretary, respectively.

The four Vice-Presidents who retire this year Mr. Julian L. Baker, Mr. C. S. Garland (who will, wever, remain on the Council as Chairman of the emical Engineering Group of the Society), Sir ıx Muspratt, Bart., and Sir Wm. J. Pope, K.B.E., 10 remains on the Council as Honorary Foreign cretary.

To these vacancies the Council has nominated Dr. Frankland Armstrong, F.R.S., Prof. J. W. Hinch- , Prof. J. C. Philip, F.R.S., and Sir Richard relfall, K.B.E., F.R.S.

Four Ordinary Members retire from the Council, d to fill the vacancies thus created six nominations ve been received, and a ballot is being taken, the ult of which will be made known at the Annual eting.

Local Sections.

The following changes take place in the represen- ion of the Local Sections :—

merica : Chairman, Mr. H. S. Miner (*vice*— . R. H. McKee).

irmingham : Chairman, Prof. G. T. Morgan —Dr. E. B. Maxted).

anadian Pacific : Secretary, Dr. R. H. Clark - Mr. J. A. Dawson).

hemical Engineering Group : Chairman, Mr. . Garland (*vice*—Mr. J. A. Reavell).

lasgow : Chairman, Mr. D. A. McCallum (*vice*— W. E. Moodie).

Montreal : Chairman, Mr. J. B. Bell (*vice*—Mr. F. W. Horner). Secretary, Mr. M. C. C. McFee, in place of Mr. C. F. Bardorf.

Newcastle : Chairman, Prof. W. M. Haworth (*vice*—Mr. A. Trobridge).

Nottingham : Chairman, Mr. G. J. Ward (*vice*— Mr. S. F. Burford).

South Wales : Chairman, Mr. W. R. Bird (*vice*— Capt. H. Vivian).

Dr. H. E. Cox, Honorary Secretary of the South Wales Section, resigned in consequence of his removal to London, and Mr. H. W. Webb was elected his successor.

Mr. F. E. Dickie has resigned the Secretaryship of the Shawinigan Falls Section, but his successor has not yet been appointed.

The Council records with great regret the death of Mr. J. M. Wilkie, for many years Honorary Secretary of the Nottingham Section, and who, a year ago, was elected Chairman of the Section. Mr. Wilkie was a keen and energetic member of the Society, and did much excellent work as an honorary official of the Nottingham Section. Mr. S. F. Burford, the previous Chairman, very kindly undertook the duties of the office for the remainder of the session.

The Council desires to convey its cordial thanks to the retiring officers for their services to the Society.

The formation of one or more Local Sections in India has been proposed, with the objects of obtaining new members for the Society, and also as a means of bringing together the chemists of the country and assisting generally in the promotion of the interests of Chemical Industry there.

An Overhead Committee, representative of the Society's membership in India, has been formed to consider the practicability of carrying on Sections at Bombay and Calcutta.

Associates of the Sections.—The scheme under which Local Sections have been permitted to elect students as Associates has been adopted during the year by the Birmingham and Newcastle Sections, and has been found to serve a useful purpose by the Sections who previously took advantage of it. Associates who must be under twenty-five years of age when elected, may continue as Associates until attaining the age mentioned, or for three years, whichever is the longer period. They pay a nominal subscription, and have the right to attend the local meetings, but they have no vote in the affairs of the Section, and do not receive the *Journal*. Many persons elected Associates have subsequently become members of the Society.

Annual Meetings.

At the Annual Meeting of the Society in 1923, held in Cambridge the invitation of the Liverpool Section to hold the Annual Meeting there in 1924 was unanimously accepted.

The Council has received an invitation from its Yorkshire Section to hold the Annual Meeting in 1925 at Leeds and recommends its acceptance.

Messel Medal.

The Council has awarded the Messel Medal for 1924 to the Right Hon. Viscount Leverhulme, and it will be presented to him at the Annual Meeting on the occasion of his delivering the Messel Memorial Lecture. The subject of the Lecture is "Science and Religion."

Finance.

The audited Balance Sheet and Statement of Income and Expenditure account of the Society, and of the Messel Fund for the year ending December 31, 1923, will be laid before the Annual General Meeting.

In view of the continued necessity for exercising the strictest economy, a House Committee, consisting of the President, Hon. Treasurer, Hon. Foreign Secretary, with Mr. Julian L. Baker, Prof. J. W. Hinchley, and Mr. W. J. U. Woolcock (Chairman), has been appointed to control the business affairs of the Society, and to report regularly to the Council.

Journal.

The Council has devoted constant and most careful attention to the development of the *Journal* as a weekly publication. Several economies have been introduced with the result that the expenses of publication have been considerably reduced. The appearance of the *Journal* has been materially improved by the adoption of a uniform paper for all Sections, by a slight increase in the width of the page, and by the substitution of a larger and clearer type in place of that formerly employed.

The *Journal* for 1923 (52 issues) contained 3026 pages of text (Review 1264; Transactions 510; Abstracts 1252) compared with 1958 in 1922 (24 issues), and 1348 pages of Advertisements in 1923, as compared with 918 in 1922.

Some new features have been introduced into *Chemistry and Industry*, with the object of rendering it increasingly attractive and useful to its readers, and it is believed that the development of the correspondence column has proved both interesting and stimulating to chemists generally.

At the inception of the weekly *Journal* the Council was aware that the cost of establishing it on a firm footing would exceed any additional revenue which a weekly journal would produce during its first year, and they therefore temporarily invested £5000 out of income as a development fund to meet the increased outlay. This investment has been sold, and the sum realised has been used for the purpose mentioned.

Bureau of Chemical Abstracts.

An important step was taken in conjunction with the Chemical Society in forming the Bureau of Chemical Abstracts. The Bureau, which has for its aim the unification of British Abstracts now supervises the preparation of the Abstracts in Applied Chemistry, hitherto published by the Society, and those in Pure Chemistry, hitherto published by the Chemical Society, and is under the management of a Committee consisting of representatives of the two Societies. The Society of Chemical Industry is represented by Dr. E. F. Armstrong, Mr. Julian L. Baker, Mr. E. V. Evans, and Sir Wm. J. Pope; the Chemical Society by Dr. Irvine Masson, Prof. G. T. Morgan, Prof. J. F. Thorpe, and Prof. W. P. Wynne, and the Chairman is Prof. J. C. Philip. The Society will bear the expenses of producing and printing the Abstracts in Applied Chemistry during the current year as hitherto, and any expenses common to the two sets of Abstracts will be borne in equal proportion by the two Societies.

Mr. T. F. Burton has been appointed Editor in full control under the Bureau of the preparation and publication of the Abstracts in Pure and Applied Chemistry from the beginning of 1924, and he is assisted in the work by a group of Assistant Editors with special knowledge of the subjects dealt with.

Transactions and Annual Reports.

On the establishment of the Bureau it became unnecessary to continue the services of the Publications Committee, whose work had been chiefly concerned with the Abstracts section of the *Journal* and the Council took the opportunity of conveying to the members of the Committee "the best thanks of the Society for the most satisfactory manner in which they have voluntarily discharged the duties of the supervision and preparation of the *Journal* since its inception, thereby enabling the Society to fulfil one of its prime functions in a manner which has redounded to the credit of all concerned." In particular, mention was made of Messrs. J. L. Baker, W. J. A. Butterfield, C. F. Cross, H. Hemingway, W. R. Hodgkinson, E. Grant Hooper, J. Huebner, C. A. Keane, A. R. Ling, W. Macnab, R. R. Proctor, W. F. Reid, and L. T. Thorne, who have served the Committee for upwards of ten years.

In order to assist in carrying on the publication of the Transactions and the Annual Reports of the Progress of Applied Chemistry, in the meantime a Committee consisting of Messrs. J. L. Baker, W. Coleman, J. W. Hinchley, W. R. Hodgkinson, E. Grant Hooper, W. F. Reid, and W. G. Wagner, was appointed, with Mr. T. F. Burton as Editor.

Leonard Bequest.

Early in the present year, intimation was received that Mr. W. J. Leonard, a member of the Society, who died in September, 1923, had, by a Codicil dated August 19, 1921, to his will directed his trustees to pay to the Society the sum of £5000 as soon as a definite scheme for the provision either by the Society or in conjunction with other Chemical Societies of a building and accommodation to form a central Institute or Club for chemists has been decided upon and is being carried into effect, the decision of the trustees as to whether such scheme has been decided on and is being carried into effect or not to be final and binding upon the Society. In the meantime the income from the Fund will be paid yearly to the Treasurer of the Society for the general purposes of the Society for a period of seven years from the time of the testator's death, or until before the expiration of such period a definite scheme has been decided upon. But if at the expiration of such period of seven years no definite scheme as aforesaid is being carried into effect, then the Trust Fund shall

:o and form part of the testator's residuary estate. The Council decided to open a fund to be called ľhe Leonard Bequest Fund," into which all monies all be paid, including the income from the Trust md.

Chemistry House.

The President (Dr. E. F. Armstrong) shortly there- ter put forward a detailed scheme for the purpose of :uring a home for such of the Chemical organisa- ns as are willing to join together to secure offices the same building, and the Council of the Society nimously authorised him to consult other inter- ed Societies and the Federal Council with a view carrying it at once into effect if it be found prac- able. The scheme has been referred to the Federal uncil, who have appointed a Committee to con- ler it fully.

British Empire Exhibition.

The Society has co-operated with the Association of itish Chemical Manufacturers and other Societies in ganising the Section covering Pure and Applied iemistry, and is represented on the Joint Committee Dr. H. Levinstein, who acted as Chairman of the mmittee, and Mr. E. V. Evans. This Committee has anised the Scientific Exhibit. Under the Chairman- ip of Dr. E. Frankland Armstrong the Publicity ommittee has published a series of pamphlets, ited by Dr. Miall, written in popular language aling with the Scientific Exhibit, and has arranged e publication of "Chemistry in the Twentieth ntury," a scientific record of the state of chemistry the time of the Exhibition as illustrated by the entific Exhibit.

The Council joined in the Scheme promoted by the itute of Journalists for the erection of a stall at Exhibition where Trade and Technical journals ıld be on view, and at this stall (No. 277 in Palace of Engineering) the Society's Journal is played from week to week, along with the Annual orts.

Co-operation.

t is with great pleasure that the Council places record the growth of co-operation between the ety of Chemical Industry, the Allied Societies, other scientific bodies. In particular, it welcomes special arrangement made last year, whereby llows of the Chemical Society could purchase *emistry and Industry* at a considerable reduc- n in price, and a similar arrangement, with newhat altered terms, is in operation during current year. In order to give further facilities each Society to acquire the publications of the other iety a reciprocal arrangement has been entered between the Society of Chemical Industry and Chemical Society, by which members of the mer can obtain the *Abstracts in Pure Chemistry* the price of £1 10s. per annum, and Fellows of the emical Society can obtain the *Abstracts in Applied emistry* for a similar amount.

The scheme arranged between the two Societies der which papers intended for the Chemical ciety may be read at provincial local sections of the Society of Chemical Industry has been success- fully continued during the present year. A similar arrangement has been entered into with the Faraday Society.

Consideration is being given to a proposed scheme under which persons may become members both of the Society of Chemical Industry and the Chemical Society on payment of a reduced total entrance fee.

An arrangement has been made with the Institu- tion of Chemical Engineers for supplying those of its members who are not members of the Society with *Chemistry and Industry* on the same terms as it is supplied to Fellows of the Chemical Society; in return for this the *Journal* of the Society will be adopted as the official organ of the Institution.

A proposal from the Institute of Brewing to share with the Society the expenses of writing and setting-up the Fermentation Section of the Annual Reports of the Progress of Applied Chemistry was approved, and the selection of the author of the Report will in future be a matter of arrangement between the Society and the Institute.

At the request of the British Electrical and Allied Manufacturers' Association, the Council undertook the organisation of the Chemistry and Physics Section of the World Power Conference which is being held at Wembley from June 30 to July 12, and it has deputed the carrying through of the arrangements to the Committee of the Chemical Engineering Group. In addition to the Section mentioned, a Gas and Fuel Section has been added as an outcome of the activities of the Group.

Many joint meetings have been held during the year, both at home and overseas Sections, with other Societies and Institutions.

It has been the custom of the Society for the past two or three years to hold a Dinner for its members in London in the autumn, and last year the scope of the function was widened, the Dinner taking place under the joint auspices of the Society of Chemical Industry, the Chemical Society and the Institute of Chemistry.

Representation on Outside Bodies.

The Society is associated with the activities of many outside bodies through representatives nominated to their Councils. A list of these representatives will be found in the *Journal*. The following recent alterations in the list have to be recorded: Prof. J. W. Hinchley has been appointed on the General Board of the National Physical Laboratory in place of Prof. F. G. Donnan retired, and Dr. R. T. Colgate has been appointed to the Committee on Tests of Graduated Glassware in place of Mr. J. L. Baker, resigned.

Delegates from the Society have attended the meetings of the British Association for the Advance- ment of Science, in Liverpool, 1923; the Annual Meeting of the American Chemical Society, 1924; the International Cement Congress, 1924; the Jubilee Celebrations of the Physical Society of London; the Inauguration of President Stratton at the Massachusetts Institute of Technology, and the National Gas Exhibition at Birmingham.

Dr. E. F. Armstrong has been invited by the Council to represent the Society on the occasion of

the celebration, on June 16, 1925, of the Centenary of the Discovery of Benzene by Faraday in the Royal Institution. He will also attend the Centenary Celebrations of the Franklin Institute to be held in Philadelphia, Pa., in September.

Mr. W. F. Reid will represent the Society at the Kelvin Centenary Celebrations in London in July.

The Empire Sugar Supply (Technical) Committee, formed by the Society of Chemical Industry some years ago, has been re-elected, and Mr. J. L Baker has agreed to act as Chairman in place of Prof. A. R. Ling, resigned.

Latham Research Fellowship.

Through the good offices of Mr. C. F. Cross, F.R.S., the Society received the gift of £300 from Sir Thomas P. Latham, Bart., for the purposes of a Research Fellowship. Two chemists have held the Fellowship in succession for one year each. Mr. James Craik, M.A., B.Sc., the first Fellow, carried out research work at St. Andrews University under the direction of Prof. J. C. Irvine, F.R.S., and the results are embodied in a paper entitled "The Mechanism of the Oxidation of Typical Carbohydrates with Hydrogen Peroxide and Hypochlorous Acid," which, with a prefatory note contributed by Mr. Cross, is published in the Transactions of the Society (1924, pp. 171-177).

Mr. Leslie Hall has worked under the direction of Dr. Charles Dorée at the Borough Polytechnic on the Constitution of Lignone and the Ligno-Celluloses. A paper containing the results of this research is in course of preparation, and will also be published in the Society's Transactions.

The subjects of these researches were selected by Mr. Cross, who has exercised a constant general supervision over the whole of the work.

Grants.

In response to an appeal for a gift of books to the Tokyo Imperial University Library, received from Sir I. Gollancz, it was resolved to make good as far as possible any loss in respect of the Society's publications that the Library may have sustained.

Since the last Annual Meeting of the Society grants have been made to the Chemical Society's Library (£100), and to the British Empire Exhibition, Scientific Exhibit (£500).

Dr. J. T. CONROY, in moving the adoption of the Annual Report of Council, said he thought most members would feel great regret to see that the drop in membership, started two years ago, was still continued. The reason no doubt was that mentioned in the first paragraph, lack of employment, but the efforts made by the Council in improving the *Journal*, including the Abstracts, and in other ways, must appeal to chemists and tend in the long run to increase the membership. He hoped that increase of membership would begin to take place at a very early date. The Council had done very good work for the Society, and the members were all very thankful for their efforts.

Dr. R. S. MORRELL said that the Report showe restless energy on the part of the President and Counc and of all the Officials of the Society. There we several points in the Report that appealed special to him. There was the proposal to grant the form tion of one or more Local Sections in India. T Indian chemists were becoming more and mc active, and we should have the value of their co munications on the raw products of India, to supp ment the excellent reports from the Imperial Institu and the Government. In reference to the *Journ* he felt that the literary character of the articles *Chemistry and Industry* was most stimulati refreshing the reader before he ventured into t narrow strip, sometimes rather stony, of the Trans tions or plunged into the vast forests of the Abstrac He considered that the Abstracts were the best any language whatsoever. There was no ot Society in the section of industry in which he particularly interested which gave such admira Abstracts. He was sure that all members wo welcome the efforts of the President in connex with the proposed Chemistry House. It was institution of an ideal social side, and was alr verging on the millennium. With the Council of Society working in co-operation with other organ tions, it was to be hoped that that ideal would s be realised. The Report contained many insta of valuable co-operation on the part of the Soc with other Societies, as was shown in the ext at Wembley and in many other directions. It to be hoped that the Society would be equ successful in time in settling the designation of ch ists and in clearing up the confusion that now exi between chemists and pharmacists. He had n pleasure in seconding this Report, which he was would be received with hearty appreciation b members of the Society.

Mr. W. CULLEN said that he thought the Co might have issued the Report at least a wee advance of the meeting, in order to give mem the opportunity of reading it beforehand.

As he had pointed out last year, the meeting the one opportunity in the whole year when men met together to discuss the affairs of the Socie a whole. He thought it would be desirable in f years to consider the advisability of devoti little more time to the general meetings of the So These were, after all, the Parliament of the Society.

The PRESIDENT then put the motion to the me and it was carried.

FINANCIAL STATEMENT.

Mr. E. V. EVANS (Hon. Treasurer), in prese the balance-sheet and accounts for 1923 (see *J* of June 27), said that the year had been an ex ingly important one from the point of view of fin The statement of expenditure might be divide two parts, one relating to the management Society and the other to the publication c *Journal.*

With regard to the first he was glad to say th working expenses of the Society for the yea

l been less than in the previous year. It was :essary, however, to deal in some considerable ail with the expenditure upon the *Journal*. He l reported last year that the Council had been icerned at the decreasing revenue from advertise- nts and had decided to put into operation a scheme producing a weekly *Journal*. For this purpose a n of rather over £5000, which had been led to the accumulated fund over the past few ws, had been put aside as a Development Fund the purpose of defraying the initial expenditure connexion with the exploitation and popularisation a weekly Journal. The analysis of the accounts uld show that the total cost of producing the *urnal* last year had been £26,823 as against £21,066 1922. That increased expenditure of £5757 was c to the inclusion of *Chemistry and Industry*.

The extra expenditure of nearly £6000 had been :t from the amount allotted by this Development ınd, together with the revenue from separate sales *Chemistry and Industry*. It would be noticed that : Council has refrained from apportioning a part of : revenue from advertisements to the *Chemistry d Industry* account, although, of course, they uld very justly have done so.

Having dealt with the cost of the *Journal* as a parate item, the analysis of the accounts then came very simple. The revenue to the Society s £500 less in 1923 than in 1922, but the expenses curred by the Society other than those of the *urnal* were £300 less. It would therefore be pected that the excess of income over expenditure uld be about £200 less than last year. That was ually the case. Last year there had been a surplus £580, this year the surplus was £380—the precise ure was £387 17s. 1d.

He did not wish to leave the impression that the ekly *Journal* had been launched with the sole aim ncreasing the revenue from advertisements. The *urnal* of 1922 had been essentially a publication for chemist in industry, and had failed entirely to be ful to that large army of workers who, though rested in chemical matters, were not usually gnated chemists. It was not his place to discuss ther the weekly *Journal* had achieved that, but h a *Journal*, by virtue of its greater popularity, s assuredly a more valuable advertising medium n formerly. The revenue from advertisements s about £800 greater than in the previous year. A ge increase was hardly to be expected in so short a e, but he feared to contemplate to what extent might have decreased had they failed to modify e nature of their publication. The question t would naturally be asked was, "Having nched your weekly *Journal*, what to-day the extent of expenditure in relation to ome ?" In this respect he was pleased to be able report that as a result of having made these itial expenses, as a result of economies in printing d paper, there was every reason to believe that in e present financial year their expenditure would be ... tuned to that justified by their income. ... were realised, the few who persisted in believing that the Society had acted unwisely in shouldering a new burden would have their objection adequately met, and in presenting for adoption the Annual accounts, he suggested that the Society would have failed in its duty had it not increased the scope of the *Journal* to meet the require- ments of an industry which had undergone such rapid development in recent years.

By its action the Society had, with intention, reduced its accumulated fund by £4650, the sum which had been set aside for increasing the value of the Society to members. Had it not done this the Society, he suggested, would have failed to pursue a creative and progressive policy. He referred to the valuable work of Dr. Miall in his contribution to the reduction of printing and paper costs, and also to the excellent work done by the House Committee under the Chairmanship of Mr. Woolcock in controlling the business affairs of the Society. Finally he took this opportunity of thanking the Council for its help and guidance.

Mr. C. S. GARLAND said it was with considerable confidence and with very great pleasure that he had to recommend the adoption of the Report and Accounts to the Annual Meeting. It was, in his opinion, seldom that they had had a more satis- factory financial statement. They had a small balance on the right side. It was perfectly true, as the Treasurer had said, that the Council had used a part of its accumulated fund for the purpose of founding a new weekly *Journal*, which was of the greatest value to the members, and he thought that was an extremely proper course for the Council to have taken.

It must be remembered that the subscriptions of past members and present members were provided for the purpose of advancing the cause of chemical industry in this country. They were not subscribed in order to be put into a banking account so that the members in the future might draw five or four and a half per cent. dividend from Government stocks. They were intended to be used, and the Council was to be congratulated on the step they had taken in using part of the accumulated fund and making the Society of much greater value to its members. There was in the balance-sheet nothing unforeseen. At the last Annual Meeting it had been known that this sum was to be expended for the purpose indicated, and in bringing out a balance-sheet at the end of the year with a small balance to the good, he thought the Society was following in every way the proper course. They ought not to have a large balance to the good, although they did not want a deficit.

There was only one point for regret with regard to the accounts, and that was that members' sub- scriptions had been rather less. But in that con- nexion it must be remembered that industry in this country was still going through a very troublesome time. The chemical industry in particular was still far from being on the upper side of the wave which all were hoping was coming some time in the future, and that being the case there was less employment for chemists in the chemical industry, with the result

that some of the members found it impossible to continue their subscriptions. At the same time there was a satisfactory number of new members coming forward, and from the steps he knew the Council was taking, when the chemical industry improved in this country the income from members' subscriptions would be increased. That was, he thought, the only point, not of criticism but of regret, with regard to the Accounts.

In recommending to the meeting, as he did, with very great confidence, that the Treasurer's Report and Accounts be adopted, he coupled with that a very sincere vote of thanks to their Treasurer, who had had an extremely hard task during the past year. He gave an immense amount of time and work to the affairs of the Society, and he gave at every Council Meeting month by month the fullest record of the progress of the Society's finances. He could say from a knowledge of the inside of the Council that the Council was extremely anxious about the Society's finances. They watched them extremely closely, and an immense amount of work devolved upon our Treasurer in seeing that things were going as he wished. The outcome was the extremely satisfactory balance-sheet before them. In recommending that the Report and Accounts be adopted, he wished to couple with that a very hearty vote of thanks to the Hon. Treasurer for his work during the past year.

Mr. EDWIN THOMPSON wholeheartedly supported everything Mr. Garland has said, and seconded the adoption of the Treasurer's Report and Accounts.

Mr. W. CULLEN said that he had come to the meeting exceedingly depressed by the balance-sheet, but to a certain extent his anxiety had been relieved by listening to the statements of the Honorary Treasurer and Mr. Garland. Last year the expenditure on the *Journal* had been £26,824, and apparently the income from advertisements, subscriptions, and sales had come to £15,128, a net deficit of something like £11,700. Thus the whole of the subscriptions from members last year, amounting to £10,786, plus the entrance fees, plus the life composition fees, all amounting together to about £11,000, had been wiped out. In other words, the whole of the subscriptions had gone towards meeting the deficiency on the publication of the *Journal*. In addition approximately £5000 had been taken from this capital fund, so that the position was really worse than he had shown. On the other hand it was only fair that the membership subscriptions should go a considerable way towards the cost of publishing the *Journal*.

He asked the Hon. Treasurer if he considered we were going to get through the present year without further sacrifice of our capital stocks.

He also asked the Honorary Treasurer if there was no credit to the Chemical Engineering Group account from advertisements? He had understood that there was some off-set against their expenditure in the way of advertising. Further, Annual Reports of Applied Chemistry showed an apparent profit of £48 15s.; he had always understood that the pu tion of these Reports involved loss.

The PRESIDENT pointed out that it had a been the custom of the Society to issue the A Report for the first time at the Annual Me He thought Mr. Cullen's suggestion that it to be in the hands of members earlier was a one. The balance-sheet had been issued i *Journal* of June 27.

The Hon. TREASURER said that the £5000 capital had been put on one side with the s object of developing the weekly *Journal*, as l told the meeting last year at Cambridge. As r the present year, he would not be so unwise as ticipate what was going to happen between nc December, but there was every reason to from the figures which were before them mo month that the income would be nearer the ex ture—they would get very much nearer to a b and would not have to use any monies from account.

Regarding the Chemical Engineering Gro Council had made an arrangement with the whereby a certain sum was allotted each the production of their Proceedings. As the Annual Reports, the figure at which th had been taken was approximately half the price.

Mr. E. GRANT HOOPER said he was sure the n would have welcomed the answer which the T had just given to Mr. Cullen, to the effect thought that next year we should find we dr our reserves to a less extent.

It must not be forgotten in regard to the of the Council, that the members had very fe tunities of conferring together and deciding policy or the men to be placed on the Cour particularly objected to a Council which wa under such circumstances making such an i departure as the publication of a weekly without consulting the Society at large.

The PRESIDENT said that only those who in progress would realise how difficult it wa progress. He put to the meeting the T Annual Report and balance-sheet, which moved and seconded.

The motion was carried.

PLACE OF MEETING FOR 1925.

Dr. L. L. LLOYD extended to the Society invitation to hold its Annual Meeting in I year. This was seconded by Mr. B. A. B the motion carried.

ELECTION OF AUDITORS.

Mr. F. H. CARR proposed the re-election Price, Waterhouse and Co. as Auditors for t year.

Dr. A. C. CUMMING seconded th which was carried

THE PRESIDENTIAL ADDRESS.

The PRESIDENT then proceeded, in the short time maining, to give a very condensed abstract of his residential Address (printed in the *Journal* of uly 11). At the conclusion of the address the ident apologised for having inflicted upon the ting such a technical talk. He was only too conus of having undertaken a task far too difficult to complish in so short a time, but he wanted to cite enthusiasm in these problems, to show how ll of interest they were, how extraordinarily broad ey were, and how many were the aspects and angles n which they could be approached; and, further, wished rather to stress that it was the duty of Society to draw attention to this sort of fundantal problem and to incite progress. Their funcns were to make chemistry go forward, and not stop d say: "We are very proud of what we did fortyee years ago." They must encourage work and gress, and bring home to all the breadth of chemry and promote social progress.

There was never a time when Britain was in more xtreme peril than to-day. The best men, as the sult of the political system, were leaving the untry day after day; every ship that left the port Liverpool carried some of the best artisans, who ere the best because they wished to be unfettered the trammels of custom, would not tolerate ades Unionism, and wanted to go out into the orld where their hands and brains could have full velopment. So long as he was connected with the ciety he should fight to the last for progress.

Dr. LEVINSTEIN said that the President had added e more to the very great obligations which the ciety had already incurred from him by the extrarily interesting and valuable address which just delivered. The Society had had two tal years, in which no doubt they had incurred ms, but it must be admitted that they had made a strenuous effort to widen the scope of the Society.

The President's address was very different from ordinary Presidential addresses, and one which he thought was more appropriate than any to which he had listened or read. He had given them an epitome of the modern chemical industry which, he thought, was extraordinarily useful for those who attended these meetings and were engaged in chemistry.

It was to him most refreshing to listen to Dr. Armstrong at all times, because he was a modern business man and also a scientist, and had therefore acquired proficiency in the scientific principles underlying his business.

It gave him the greatest possible pleasure to propose a very hearty vote of thanks to the President for his most admirable address, and their most grateful thanks to him for the great services which he had rendered to the Society during the two years he had adorned the Presidential chair.

Without the formality of a seconder the vote was carried with acclamation.

The PRESIDENT thanked the members very much indeed for their most kind expression of thanks.

ELECTION OF OFFICERS.

The PRESIDENT reported the result of the ballot with regard to the officers for next year as returned by the Scrutineers.

President: Mr. W. J. Uglow Woolcock.

Vice-Presidents: Dr. E. Frankland Armstrong, Prof. J. W. Hinchley, Prof. J. C. Philip, and Sir Richard Threlfall.

Members of Council: Mr. W. A. S. Calder, Mr. W. H. Coleman, Dr. W. Cullen, and Mr. J. A. Reavell.

INSULIN AND ITS MANUFACTURE.*

BY FRANCIS H. CARR.

Before telling the story of the adaptation of the original laboratory method of making insulin to large-scale manufacture in this country, I wish briefly to describe what insulin—I will not say is, but does.

The nature and use of insulin have aroused widespread interest, and so much has been written and said of them by those better qualified than myself, that it would be presumption for me to undertake this part of my task did I not feel it necessary for my ulterior purpose. Let me first state, however, that I have taken no active part in the investigations but have been, like yourselves, merely an interested and greatly impressed onlooker.

The history of the discovery of insulin has been told many times, and therefore calls for but passing reference. As in nearly every case of discovery, it was not alone due to the work of one man or of one group of men, but to the gradual expansion of our knowledge over a period of many years, that the consummation has at last been reached of practical application in the relief of human suffering.

Painstaking workers in many lands had explored the paths leading there, some without clear vision as to where the paths might lead. They have traversed many devious routes, had bitter disappointments, and in many cases have died before the ultimate fruitfulness of their work could with surety be foreseen.

As the growth of knowledge widens the field it narrows the track and straightens the road for the happy individual who is at length acclaimed a discoverer. In most respects it magnifies rather than belittles such achievement that so many have previously striven in the same direction, and Banting's wonderful discovery seems no less wonderful when we reflect that over 200 years ago the symptoms of diabetes were observed in an animal from which the pancreas had been removed. But it is during the past forty years, since it first became an accepted fact based upon experiment that the removal of the pancreas causes the typical symptoms of diabetes, that the bulk of the work on this subject has been done, and it was not until between two and three years ago that Banting, a new and enthusiastic young worker in this field, achieved the brilliant success of obtaining a stable product from the secretion of the pancreas which, when administered to a diabetic patient, relieved his sufferings and mitigated the disease.

The following quotation from the Report of the Medical Research Council describes more eloquently than I can the effect of this great consummation :—

"The public have become suddenly aware that a substance named insulin has been introduced to use, as is commonly said, 'discovered,' and that daily miracles are being achieved by its means. Men declining quickly or slowly through stages of weal ness and pain to early death have been brougl within a few days back to full working powei sufferers carried to hospital actually dying of diabete already helpless and unconscious, have been resus tated as by some magic and have been brought ba almost at once to normal life, by help of this remed This boon appears as a sudden gift ; diabetic me women and children in these recent months have be granted alleviation which has been denied to their suffering predecessors during all record time."

The introduction of insulin for the treatment *diabetes mellitus* is one of the greatest contributio and, perhaps, even the greatest contribution, e made, to the medical treatment of a specific disea

Once an invention has been made, there rema the important and often difficult task of render the fruits of that invention available for gene enjoyment, of bringing it within the reach of the v rich, of the well-to-do, and, if possible, of the v poor. It is with the last part of the problem t we are chiefly concerned to-day.

The nature of insulin.

Insulin is known only by its effects on the li organism. We have no other method of identif tion or means of determining its purity. It ca the disappearance of some of the sugar containe the blood. We shall better understand what implies if we consider for a moment the part pla by carbohydrates in the living body. All ca hydrates, whether they be taken in the form of st or of sugar, are resolved by the digestive proc to hexoses and of them the glucose is absorbed the blood. This glucose in part directly under oxidation in the blood to meet the energy req ments of the organism, but after partaking of f the digestive process being soon completed, t tends to accumulate in the blood a greater co tration of glucose than can be tolerated therein, in order to accommodate this the surplus is conv into glycogen and stored in the liver and m available for the bodily needs as they arise. amount of sugar in the blood of a healthy man is maintained at about 0·1 % except after a when it temporarily rises to about 0·15 %. actual weight of sugar in the blood varies from 6 to 9 grams.

Should the removal of sugar from the bloo storage or other process not take place for reason, the concentration of sugar there wil above the level of tolerance, and thus caus symptoms of diabetes. When the blood approaches a concentration of about 0·2 % kidneys, which otherwise do not allow the su pass, can no longer prevent its overflowing, sugar is excreted with the urine. Insulin

*Read at the Annual Meeting, Liverpool, on July 11, 1924.

ubstance secreted by the pancreas which has the ffect, when put into the blood stream, of removing ie excess of sugar from the blood of a diabetic, and lso of reducing the blood sugar of a healthy indiıal below the normal. In what way that sugar is oved—in other words, the exact character of the oohydrate metabolism which rapidly follows an ction of insulin into the blood stream—is as yet clear.

s already stated, it is generally assumed that ɔose is made use of by the body either by direct lation or in the building up of glycogen which is ed in the liver and muscles, and it was at first gested that the disappearance of sugar was due direct oxidation to carbon dioxide, but the iratory quotient, in spite of a transitory rise, general falls after the administration of insulin, has experiment shown that the glycogen in the r or muscle is increased. On the contrary, as ı as the insulin has caused the disappearance of ɔose from the blood, it draws upon the glycogen the liver. Dudley and Marrian found that an ılin-treated rabbit actually contained less than normal amount of glycogen in the liver and etal muscle, the figures found being :—

	Normal rabbit. Per cent. glycogen		Insulin rabbit. Per cent. glycogen
Liver	5·53	..	1·86
,eart	0·26	..	0·54
Skeletal muscle	0·57	..	0·00

atever the explanation may be, the facts are :—

1) That an individual suffering from diabetes has an accumulation of glucose in the blood.
2) That insulin is a substance which causes the rapid removal of glucose from the blood.
3) That the symptoms and suffering of a diabetic are greatly relieved by the administration of insulin.

o far little else is known about the chemical perties of insulin, beyond the fact that it possesses property in a very high degree indeed ; 001 gram of the purest insulin so far prepared cause the disappearance of about 3 grams of ar in 2 hours, or 33 grams, but little more than unce, will account for 1 ton of sugar.

t an age when our knowledge of the methods of ıging about change in organic compounds has ome so extensive, it is remarkable to reflect how le is yet known of the oxidative process by which ıble carbohydrate is utilised in the living cell to e free energy and heat, a process which is so ıarkably controlled that our body temperature is intained at the normal temperature with even ater delicacy than that with which we can regulate temperature of so simple a thing as a water-bath h the most delicate thermo-regulating valve. l yet assuredly the oxidation of glucose to carbon xide takes place *in vivo* according to the same emical laws as it does *in vitro*.

So great a volume of work has been done on this xidation in the living subject that we cannot consider it here, but, in passing, attention may be alled to the work *in vitro* now being carried out in he Carnegie Laboratories for Plant Physiology in Tuscon, by which glucose is shown to oxidise to carbon dioxide and water by bubbling air through it in a buffered mixture of the phosphates of sodium in the presence of iron pyrophosphate, which accelerates the change. What a field of fundamental research of great scientific importance remains here for investigation! As in the case of most real research, the difficulties demand great experimental ingenuity and resource. But they do not appear insuperable when we consider the refinements of method and the achievements attained in other fields of research.

One other fact concerning diabetes of interest to chemists must be referred to. Whereas in the normal condition no ketonic substances are excreted in the urine, they may be found in the urine of a person with diabetes, and also in conditions of starvation and in certain fevers. The ketonic substances are acetoacetic acid, $CH_3{\cdot}CO{\cdot}CH_2{\cdot}COOH$, and acetone, $CH_3{\cdot}CO{\cdot}CH_3$. There is frequently also present what is obviously the parent substance of these two compounds, namely, hydroxybutyric acid, $CH_3{\cdot}CH(OH){\cdot}CH_2{\cdot}COOH$. These substances result from the oxidation of fats. Not only, therefore, is a diabetic unable to dispose of all his carbohydrate, but his fat is not oxidised to the normal end-product. Insulin treatment causes the rapid disappearance of acetoacetic acid as well as of sugar from the urine. It has been suggested that it acts primarily upon the sugar metabolism, and that fat metabolism cannot proceed normally without simultaneous occurrence of the former process, but we have to await the final elucidation of this and a host of other problems of a similar nature. The discovery of insulin has given a new and very valuable method of investigating body metabolism, and opens out a vast field for research.

While insulin is necessary to prevent the accumulation of sugar in the blood beyond the point at which the sugar, so to speak, becomes harmful to the body and interferes with the cell processes, on the other hand too much insulin reduces the sugar to a minimum figure and acts as a poison, causing severe symptoms and ultimate death.

There is, moreover, stored in the pancreas of a normal person insulin much more than sufficient to cause death were it all released from the cells in which it is stored and allowed to enter the blood stream. Insulin appears to exercise its effect in a fixed quantitative ratio; in other words, a given amount of insulin always causes the disappearance of the same quantity of sugar. Since in a normal animal the amount released is so regulated that the blood sugar is quickly brought to a basal level, it follows that the mechanism of release is such that it is stimulated by an increase of blood sugar above the normal. Directly or indirectly, then, an excess of glucose above the basal level in the blood stimulates the release of insulin.

The story of the remarkable activity of insulin in causing the removal of sugar is more wonderful than all that is written in "The Arabian Nights," and when we consider in addition to this the delicate mechanism by which increased amounts of sugar can

set free insulin and in the correct amount, we chemists are indeed lost in wonderment and awe.

If the mechanism of this release failed to act, diabetes would result through there being a deficiency of insulin in the blood, but it is more commonly supposed that diabetes is caused by the failure of the pancreas to form insulin. The question which of these is the real cause still awaits experimental solution.

One of the properties of insulin is that it is very sparingly soluble in water at its iso-electric point, namely p_H 5·2. A small adjustment of the hydrogen-ion concentration either to the acid or the alkaline side of this iso-electric point renders it readily soluble, and it seems likely that the release of insulin from the cells to the blood is controlled locally in the tissues in which it is stored by minute variations of the hydrogen-ion concentration of the body fluid at that point.

Chemical properties of insulin.

The properties of insulin thus far observed are as follows :—As already stated, it is sparingly soluble in water at its iso-electric point, but readily soluble at other points near neutrality. It is precipitated by half saturation with ammonium sulphate and sodium chloride, and by picric acid, phosphotungstic acid, and trichloroacetic acid, and is insoluble in absolute alcohol. As prepared from the ox pancreas it gives a distinct biuret reaction, but Best and Macleod obtained no such reaction with insulin prepared from the skate pancreas. The purest insulin has given negative reactions for phosphorus, tryptophan, and tyrosine, whilst all samples give a well-marked reaction for organic sulphur.

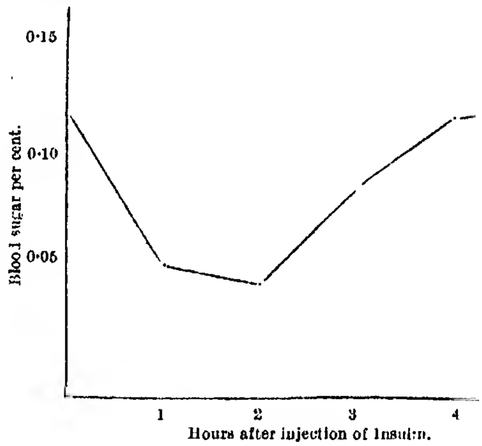
It is almost completely destroyed by $N/10$ sodium hydroxide at 37° in $1\frac{1}{2}$ hours, and is destroyed by $N/10$ sodium carbonate in boiling water in about 10 minutes. Even in neutral solution it is destroyed at 100° in about 10 minutes, but in $N/10$ acid it is not quite completely destroyed at this temperature even after one or two hours.

The active principle will not pass through an ultra-filter of collodion but can be filtered through a porous pot at reactions wide of the iso-electric point. Since both pepsin and trypsin destroy it, it is apparently of protein-like structure.

From the foregoing it is obvious that insulin is a substance of considerable complexity.

Insulin may be determined quantitatively with considerable accuracy by observing its effect on the blood sugar of normal animals. Rabbits and mice have chiefly been used for this purpose. Sufficient insulin will naturally be present in an animal for its normal requirements. If a rabbit is kept for 24 hours without food, it is brought more or less to a standard condition as regards glycogen storage and the amount of sugar in the blood. Under these conditions the blood sugar will be about 0·10%. If a moderate dose of insulin is administered intravenously or subcutaneously, the percentage of sugar in the blood falls and then recovers after several hours, reaching its minimum between one and three hours. The following curve will illustrate what happens.

The amount and time of endurance of represented by the area i n the curve varie tionately to the amount of insulin adm Rabbits, however, have individual variatio the same dose has not identically the sa on different rabbits. The reaction of an i rabbit may also change from time to ti inaccuracies thus introduced are minimised a number of animals for any one test. at first adopted was based upon the ar insulin required to lower the blood su 0·10 to 0·045% within four hours in weighing 2 kg. and after 24 hours' fa follows, however, from what has been said variation in rabbits, that groups of rabbits or less sensitiveness might exist, and th unit dependent upon a fall of blood sugar even in a number of rabbits would not b constant. This has been borne out by ex



Rabbit.

FIG. 1.

and when the matter came up for consider an International Conference on Biological St it was agreed that the unit ought to be fixed, as possible, in terms of a stable standard pre of insulin, which is now in course of pro The work of preparing that sample was entr the National Institute for Medical Researcl

Insulin prepared by the methods abou described is stable, and it has been found t eparations which have been kept in hot clima period of six months give the same figures or as when originally prepared.

The preparation of insulin.

As has already been indicated, insulin is e from animal pancreas. The mammalian p exercises at least two diverse functions, nam secretion of insulin, which finally is utilise blood stream (endocrine), and the secretion of lytic enzymes, which find their way by the pa duct to the intestines (exocrine). Although th functions are performed by the same orga must be looked upon as quite separate. Ne

s, one can readily imagine that at some future ne there will emerge a clear reason why these two nctions are associated in the same gland. To the perimenter, and oven moro to the manufacturer, at association is the source of great difficulty, for e proteolytic enzymes of the pancreas rapidly use the destruction of insulin when present in the me fluid, and the problem of making insulin is gely that of saving it from destruction by this zyme action.

There is evidence that insulin is present in many, not most, of the body tissues, but there are strong asons for believing that it is mainly stored in certain ttered masses found in the pancreas of a tissue fering in structure from the rest of that organ, and own as the "Islets of Langerhans."

In many fishes the "islets" occur in separate es in close relationship with the gall bladder. e cod, for instance, there is a large principal which can readily be detached and so removed the sphero of action of proteolytic enzymes. ormick and Noble in Toronto, and Dudley in country, have obtained very high yields of insulin n this tissue, amounting to 20–30 times the amount ilable from mammalian tissue.

Dr. Dudley has kindly lent me the advance proof a paper which is about to be published, in which shows that as much as 40 clinical units of insulin r gram of islet tissue can be obtained. The diffi- lty of collecting such tissue for manufacturing rposes is very great, however, and each dissected h only yields a very small amount of islet tissue, refore this source of supply is not likely to prove ful on the large scale. Working on dogs, Best, ith, and Scott (J. Biol. Chem., **59**, xxx) have ntly prepared an active blood sugar-reducing nciple from brain, heart and skeletal muscle, od, lung, liver, spleen, kidney, submaxillary, roid and thymus glands.

From these results it appears possible that other l better raw material than ox, pig, and sheep creas may be found. For the present, however, the purpose of manufacture we are confining selves to the use of mammalian pancreas available n abattoirs.

Almost immediately after the death of the animal loss of insulin through proteolytic action begins, although during life the insulin remains in the sues apparently unaffected by the trypsinogen, n after death the latter becomes activated and islet tissuo becomes transfused by dissolved zymes. Their action may, however, be arrested: by the addition of alcohol of such a strength that enzyme is precipitated; (2) by bringing the nperature below zero; (3) by rendering the fluid re acid than p_H 3·5 by the addition of sulphuric hydrochloric acid.

The preparation of insulin comprises extraction and ubsequent purification. During the extraction and early stages of purification every advantage must be taken of these methods of delaying the rate at which its natural destruction proceeds. Once the destroying enzymes have been removed, the substance is stable if kept sterile. In outline the method of preparation consists of:—

(1) Procuring, dissecting, and cooling the pancreas glands as rapidly as possible after the death of the animal.
(2) Grinding or mincing at a low temperature to break up the cells very thoroughly.
(3) Rendering the material acid to p_H 2·5 or alkaline to p_H 7·0, in order to set free the insulin from the tissue on which it is adsorbed.
(4) Extracting it with alcohol of such a strength that but little of the enzyme is dissolved, and as much as possible of the insulin. For this purpose alcohol of 65–70 % strength has so far proved the best solvent.
(5) Clarifying this extract by cooling it to –5°, and filtering or centrifuging it.
(6) Concentrating at a low temperature to 1-10th of its volume, extracting the fat, and filtering.
(7) Precipitating the proteins with ammonium sulphate or with absolute alcohol at p_H 5.
(8) Precipitating the protein mixture successively with alcohol and picric acid, and finally by adjusting the aqueous solution to p_H 5·2. Proteins which are precipitated above and below p_H 5·2 do not merely dilute insulin, but are antagonistic to its action. This purification is consequently of great importance.

Insulin, when pure, may be almost completely precipitated at its iso-electric point, but the presence of accompanying proteins tends to keep it in solution, even at this point. The most useful reagent in effecting this purification is picric acid, used according to the method described by Dr. Dudley. By this means alone 90 % of the inactive protein may be removed from some samples of crude insulin.

Purification is thus effected by combining the use of precipitants such as picric acid and ammonium sulphate with iso-electric point precipitation.

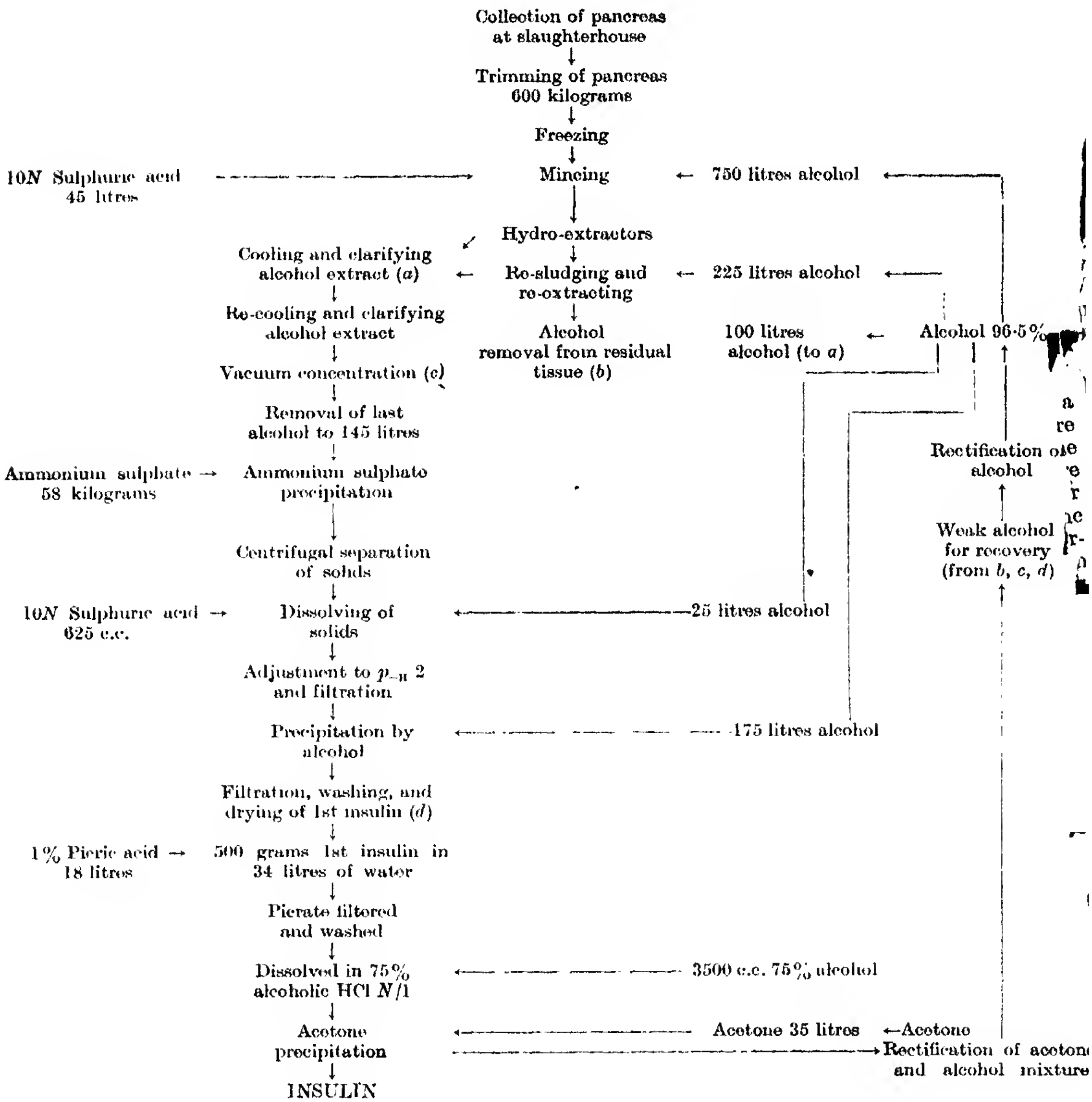
The laboratory method of preparing insulin has been published in detail by many workers. Particular attention may be drawn to the work of Banting, Best, Collip, and Macleod (Trans. Royal Soc. *Canada*, 1922, **16**, 1), Dudley (Biochem. J., 1923, **17**, 376), Dudley and Starling (Biochem. J., 1924, **18**, 147), Doisy, Somogyi, and Shaffer (J. Biol. Chem., 1923, **55**, xxxi; 1924, **60**, 31).

The principles of the method having been described, it will be best to deal at once with the process as interpreted on the large scale.

The large-scale manufacture has been installed as a continuous process. It can be followed by the help of the accompanying flow sheet. The plant has been so arranged as to ensure rapid handling, continuous recovery and strengthening of alcohol, automatic control of temperature, and so forth. Its chief interest lies in its arrangement, which cannot readily be described without the help of a larger number of photographs than can be reproduced in the *Journal*.

When sixteen months ago this manufacture was commenced, the yields obtained were very low, though quite as high as those obtained in other laboratories, being but 50 units perkg. of pancreas. There was also at first a great loss of alcohol. As our knowledge has

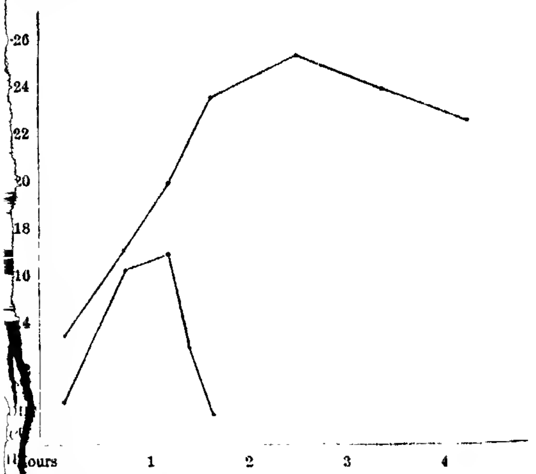
FLOW-SHEET OF INSULIN MANUFACTURE.



extended and the plant has been perfected, it has been possible to increase the yield twenty-fold, and to reduce the loss of alcohol to a very low figure. So great progress could not have been made without the assistance given by communications from many workers in the field, both in this country and in America and Denmark. In particular, mention must be made of the invaluable help given by the National Institute for Medical Research. As the result, within about a year the selling-price of insulin has been reduced by successive stages from 25s. to 2s. 8d. per bottle of ten doses, thus bringing the cost of treatment, at first prohibitive to many, within the reach of all. At the same time we have been able greatly to improve the purity of the insulin as it is issued for use.

The *rationale* of the present treatment of *diabetes mellitus* with insulin is founded upon the assumption that it is desirable to rest the islet tissue of the pancreas in order to re-establish its function. For this purpose, it is obviously desirable to get rid of the abnormal concentration of sugar in the blood for the sake of the general healthy condition of the body tissues. Accordingly, the dietary is adjusted to a low level and insulin is administered. The curves (Fig. 2) illustrate the effects of a large dose of sugar on a normal and on a diabetic individual. After 1½ hours the excess of sugar above 0·1%

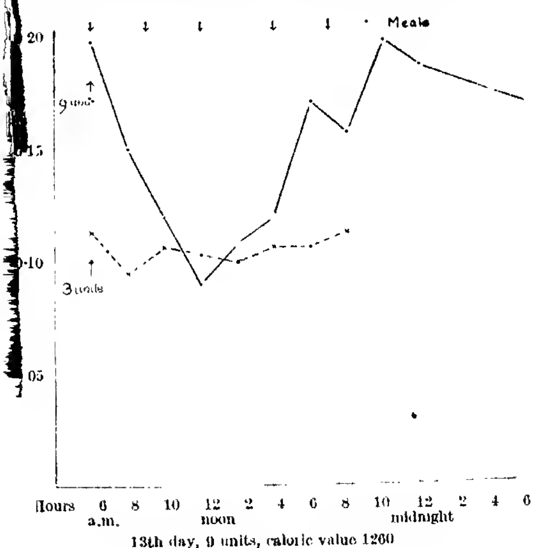
s disappeared from the blood of the normal individual; indeed, the natural supply of insulin has ought the blood sugar a little below normal, and little later the normal will be re-established by



showing diabetic (upper curve) as against normal (lower curve) after ingestion of 40 g. of glucose.

Fig. 2.

wing upon the glycogen stored in the liver. In diabetic, the case is far different, the sugar has en high above the level (0·19 to 0·20 %) at ich it escapes through the kidneys and otherwise,



13th day, 9 units, caloric value 1260
51st day, 3 „ „ „ 1620

Chart to illustrate fall of blood sugar—G. Graham.

Fig. 3.

the detriment of the general cell functions of the dy. Nor has it fallen to the initial figure even er four hours.

The next curve (Fig. 3) illustrates the effect of the ilful regulation of diet with insulin administration a case recorded by Dr. George Graham, and shows how a comparatively normal blood sugar may be maintained in this way. Note the increase of diet and decrease of insulin.

Dr. Graham's object here is to maintain the blood sugar very slightly above the normal, but well below the threshold of leakage. The reason for aiming at a level just above the normal is that the function of the islet cells is naturally stimulated if the blood sugar is 0·10 % or over, but depressed if it falls below this level, neither too much stimulation nor depression being regarded as desirable.

In a few words then, the basis is that in a normal individual insulin pours into the blood in such quantity and at such rate that the sugar content of the blood is well controlled. In a diabetic this is not the case, consequently at least a partial correction may be made by injecting insulin at intervals of several hours, the time of such injection being coordinated with the principal meals. Too much insulin produces effects which are no less serious than those resulting from a shortage; it follows, therefore, that it must be administered with great care. It is important to determine the sugar in the blood and urine at intervals, medical skill being, of course, necessary for the interpretation of the figures observed. Over-dosage with insulin produces serious symptoms demanding immediate treatment, or a fatal issue may result. These symptoms are quickly relieved if sugar or glucose is taken by the mouth. A common objection to the treatment is the inconvenience of submitting patients to frequent injections. These need generally to be given twice daily; it is not impossible, however, that there may be discovered an adjuvant substance to be administered with insulin, having the effect of spreading its action over a longer period of time. It is certain that some preparations of insulin act more quickly than others. When we have more knowledge as to the cause of this, it is to be hoped that it will be possible to supply an insulin which works quite satisfactorily if administered at much wider intervals of time.

Abundant evidence is at hand as to the wonderful results achieved by the treatment. I will content myself with two examples, the first being a case of coma to show the remarkable change in the blood content which accompanies these dramatic recoveries, the second that of a young diabetic to illustrate the wonderful improvement in general health which results from the treatment.

Very severe diabetics are likely to die in a state of coma. The onset of these symptoms had until recently been regarded as proof that death was at hand. With insulin treatment recovery from the comatose condition is not only likely, but probable; numerous cases are on record of people who have thus been snatched from the jaws of death and have been able a few weeks later to return to their homes and daily avocations.

The curves (Fig. 4), show the rapid fall of both sugar and acetone, as well as the increase of carbon dioxide in the blood as the patient was resuscitated.

For the record of my second example I am indebted to Drs. Passmore, Raven, and Poynton, and to the *Lancet*. A child who had been under medical

matters at the present time, the year of the Great Exhibition. Dr. Armstrong had also been the originator of the idea of the extraordinarily able pamphlets, published by the Society, which were being sold at Wembley, and which gave in a popular form to the public a greater knowledge of what the chemists of this country really are than perhaps anything else that could have been done.

During the two years of Dr Armstrong's presidency they had admired at all times the courage he had shown in leading them and in increasing the prestige of this Society. They were very grateful for the amount of time he had sacrificed, for the amount of detail work which he had done at great personal inconvenience, and yet it had been that very detail work which had brought the Society to the high pitch of efficiency and to the best Annual Meeting they had ever had. On behalf of all the members of the Society, without exception, he assured Dr. Armstrong that they were deeply grateful to him and hoped for his continued interest in the progress of the Society.

DR. E. FRANKLAND ARMSTRONG, in acknowledging the vote of thanks, suggested that their thanks were really due to the Local Committee for organising the meeting, and he moved that their best thanks be given to the Local Committee.

MR EDWIN THOMPSON, on behalf of the Liverpool Section, thanked the President for his kind remarks. He thought the meeting had been a success, and it had only achieved that success because of the kind offers of hospitality they had had and the papers that had been presented. Their thanks were due to all who had contributed to the success of the Meeting, and to the University for allowing them the use of its buildings. He hoped the success of the Meeting would be the means of bringing into closer co-operation the University of Liverpool and the Liverpool Section of the Society of Chemical Industry. He also paid tribute to the large amount of efficient work which had been done by the Local Secretary, Mr. Gabriel Jones.

The business then concluded.

The Lecture given by Prince Ginori Conti on "The Larderello Natural Steam Power Plant" will be reported in *Chemistry and Industry*.

Lord Leverhulme's "Messel Memorial Lecture" will appear in a later issue of the *Transactions*.

THE INFLUENCE OF STORAGE AND OF EMULSIFICATION ON THE VITAMIN A IN COD LIVER OIL.

BY J. C. DRUMMOND D.SC., F.I.C., S. S. ZILVA, D.SC., PH.D., F.I.C. AND KATHARINE HOPE COWARD, D.SC.*

The ease with which vitamin A is oxidised even at ordinary temperatures has been observed so often by the authors that it seemed desirable to investigate various samples of cod liver oil with a view to determine to what extent this dietary factor may be destroyed under the ordinary conditions of storage of such oils, and how far it might be destroyed in the process of emulsification to which the oil is often subjected.

Storage of oils.

A number of oils of which the activity had been determined in the summer of 1921 were again tested in the winter months of 1922-23; in order to avoid any error which might be due to a difference in response in the animals in winter and summer months, the oils were again tested in the summer of 1923. Most of the samples were contained in ordinary glass bottles of about 1 litre capacity. In most cases they were little more than half full of oil, and during storage, which had for part of the time been on an open shelf in the laboratory, and for the rest in a dark cupboard, appreciable oxidative changes had taken place, as indicated by the formation of a sticky resinous material at the surface of the oil. The extent to which these changes had affected the composition of the oils themselves can be gauged from the analyses of the samples, which show a marked fall in the iodine values from a normal figure of about 178 to values around 150, and a rise of acid value from less than 2 to 5 and over. The results of testing for vitamin activity are tabulated below.

Oil.	Dosage required for normal growth. July-Aug., 1921.	Jan., 1923.	Sept.-Oct., 1923.
1. Unfiltered Lofoten oil	0·003 g.	0·04 g.	0·02–0·04 g.
2. Unfiltered Kjelvik oil	0·006	0·01	0·04
3. Filtered oil, first fraction Lofoten	0·02	>0·02	>0·04
4. Posetran, Lofoten oil	0·003	0·04	0·02*
5. Coal-fish liver oil	0·003	>0·08	>0·08

* This was the only case observed where the dosage required in the summer was less than that required in the previous winter, and it may possibly be accounted for by the fact that the rats used for the winter test had had a longer preparatory period on the deficient diet than had those used in the summer test.

It is apparent, therefore, that storage of cod liver oils under conditions permitting oxidative changes will tend to reduce the nutritive value of the oils. On the other hand, our previous experience has taught us that when oils are stored so as to reduce to a minimum the contact with air, as by filling the bottle almost to the top with oil and tightly stoppering, they may preserve their vitamin potency unimpaired for at least two years.

Several cases in which a practical application of these observations has been of value have come to our notice. One interesting case was noted by our colleague, Capt. J. Golding, D.S.O., in which a farmer failed to observe any benefit from the administration of cod liver oil to his stock of pigs. The oil was examined by us and found to be an old sample of "cattle" cod liver oil which had been considerably oxidised, and which had lost all detectable traces of vitamin activity.

Cod liver oil emulsions.

The desire to overcome the difficulties of administering cod liver oil alone has led to the introduction of numerous devices for masking its unpalatable nature and to the widespread employment of pre

* Beit Memorial Research Fellow.

arations which can be roughly divided into (a) simple " emulsions, in which the oil is the chief utritive component, and (b) " complex " emulsions, hich contain other foodstuffs such as malt extracts.

(a) *Simple cod liver oil emulsions.*—Preparations f this type are placed on the market in this country y a number of firms. The majority are carefully ade from materials of good quality and actually ontain the amount of oil claimed. The emulsifying gent is usually a gum, and glycerol is in some cases dded. By the kindness of the directors we have een permitted to inspect the processes by which ertain commercial cod liver oil emulsions are made.

The actual process of emulsification employed iffers in detail in different factories, and in most, not all cases, involves considerable admixture of he oil in a fine state of division with air, although e temperature is usually kept low. At first sight, erefore, it appeared probable that the vitamin A lue of the oil would be appreciably diminished by e process of emulsification. Furthermore, certain rieties of gums employed for the purpose of making he emulsions give well-marked reactions for " oxidses," the presence of which might be likely to accelrate the loss of vitamin by oxidation. In order to ain definite information on this point a sample of cod ver oil of ascertained potency was selected from our tock and made into emulsions in the dispensary of niversity College Hospital by Mr. Hampshire, to hom we owe our thanks for his kind help. Emulions containing rather under half their weight of od liver oil were made under similar conditions ith: (1) gum acacia; (2) gum tragacanth, and 3) Irish moss (carageen). Samples of the fresh mulsions were tested immediately after preparation, hilst other portions were stored in filled, welltoppered bottles and either exposed to light n an open shelf, or kept in a darkened cupboard. he stored samples were tested at the end of nine nonths. The results are given below.

Daily dose required to give growth in experimental at of about 100 g.:

1 Original oil, 0·02 g.

2. Emulsion 50% oil should therefore be 0·04 g. f no destruction occurs. Dosage found:—

Agent	Original emulsion.	Emul. kept in dark.	Emul. kept in light
1 Irish moss	0·08g.	0·08g.	>0·8g.
2 Acacia	1·0	—	
3 Tragacanth	0·04	0·01	No activity

These figures show clearly that the emulsification ith Irish moss caused approximately a 50% reducion in the vitamin value of the oil. No further fall ccurred as a result of nine months' storage in the lark, but a slight decrease was noted in the sample xposed to the light. In the case of the acacia mulsion serious inactivation occurred, and so much mulsion was used in this test that none remained to est after storage. The initial drop is, however, so big that a small additional decrease would be of little onsequence. The tragacanth emulsion showed no ppreciable loss of vitamin activity except after storage for several months exposed to the light. The cause of this has not yet been made clear. It is interesting to compare the degree of initial destruction on emulsification with the response given by the emulsifying media for the presence of " oxidases ":—

	Loss of vitamin A on emulsification.	" Oxidase " reaction
Irish moss	++	+++
Acacia	+++	++
Tragacanth	—	—

Certain commercial emulsions contain tragacanth as an emulsifying agent, so that if " oxidases " do play any part in reducing the potency of emulsions of cod liver oil, the employment of this gum is a factor for safety. Others contain acacia or a mixture of acacia and tragacanth. Apart from this, however, the grinding of gums prior to their use in the commercial manufacture of emulsions frequently generates so much heat that the "oxidases," if present, must be, to a large extent, destroyed.

Another series of tests were made on a sample of cod liver oil before and after it had been made into a commercial emulsion. The results in this case indicated little appreciable loss of potency.

Two other well-known commercial brands of cod liver oil emulsion were carefully examined by us with the following results:—

Sample.	% of oil by weight found.*	Vitamin dosage in grams. Fresh emulsion	After storage for 9 months in dark	in light
A	39·4	0·04	0·04	0·04
B	35·5	0·04	0·04	0·04

* Determinations of oil in such emulsions present some difficulties. These figures show that the emulsions are probably built up on a 40% formula of the type indicated above.

These results indicate that storage of such emulsions, whether in light or dark, does not appreciably affect the vitamin value of these products, provided that they are kept from contact with air in filled and well-stoppered bottles. Furthermore, although no tests of the vitamin A value of the oils used in making such emulsions were actually made in these two cases, it would appear safe to assume from our own experiments on tragacanth emulsions that no serious loss of vitamin occurs during their manufacture. This view is supported by the fact that such preparations are practically always made from high-grade Norwegian liver oils obtained from the Lofoten area. From our wide experience of these oils we can give their approximate vitamin value in terms of " dosage-in-grams required to give growth in a 100 g. rat " as 20 mg. Assuming no destruction in preparation of a 40% emulsion, therefore, the vitamin value of such preparations would be about 0·05 g., a figure much of the order actually found.

(b) " *Complex* " *emulsions.*—Under this title are included a variety of products, chief of which are the malt and cod liver oil emulsions. Generally speaking, we have found these preparations, of which we examined six different kinds, to possess a vitamin value roughly proportional to the amount of oil they contain. This is an indication that the methods of commercial preparation cause little loss of physiological potency. Furthermore, with one exception, they were found to preserve their activity under the same storage conditions that are described above. It must be remembered, however, that practically all these preparations contain less oil than the " simple " emulsions, and that some of them may

contain as little as 15%. This fact should be borne in mind when these products are being considered from a vitamin standpoint.

Summary.

1. Cod liver oil may lose a considerable proportion of its original vitamin A value in storage under conditions that permit oxidative changes.

2. Emulsification of the oil with emulsifying agents, such as gums, may, in certain cases, cause a loss of vitamin activity. There is some evidence that such loss is less a consequence of the admixture with air than of the presence of oxidising agencies ("oxidases") in the gums used.

3. An examination of certain commercial preparations of cod liver oil emulsions indicated that little or no loss of vitamin A occurs during emulsification.

4. No appreciable loss of vitamin A value occurs on storage of such emulsions for periods of nine months, provided opportunity for oxidation is prevented.

5. More complex cod liver oil preparations, such as malt and cod liver oil products, appear to contain vitamin A, roughly speaking, in proportion to the amount of oil they contain. The processes by which the well-known brands are made would appear to have little deleterious action on the vitamin A.

6. Since oxidation is the chief factor concerned in the inactivation of vitamin A, it is obvious that storage of cod liver oil, and of products containing that oil, should, as far as possible, be effected with minimum exposure to air, at as low a temperature as possible, and in the dark.

The thanks of the authors are due to the Medical Research Council for a grant from which the expenses of this research were defrayed.

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NOTE ON THE ACCELERATING INFLUENCE OF AN AZO DYE IN VULCANISATION.

BY T. J. DRAKELEY, A. ZEITLIN, AND L. H. WILLIAMS

Azo dyes are being introduced for the colouring of rubber, and in view of the fact that these are prepared by the coupling together of organic compounds, many of which are powerful accelerators of vulcanisation, it seemed desirable to determine whether a typical dye of this class would influence the process.

It may be noted that the colour bases of basic dyes, in common with most basic materials, possess accelerating properties. But, with very few exceptions, the principal azo dyes are not basic, hence no *a priori* conclusion can be drawn as to their accelerating properties.

The rubber used in the investigation was selected from the same batch of standard thin pale crêpe, and all the samples were vulcanised in a steam-heated "daylight" press at a pressure of 50 lb. to the sq. in. (147°). The dye employed was that obtained by coupling diazotised 2-naphthylamine-1-sulphonic acid with β-naphthol; it was insoluble in water, and free from mineral matter. The effect of the introduction of about $2\frac{1}{2}$ to 5% of the dye on the vulcanisation of the mixes given below was determined.

(*A*) *Pure rubber-sulphur mix.*—The following mixes were prepared: A.1, rubber 90, sulphur 10; A.2, rubber 87·75, sulphur 9·75, dye 2·5; A.3, rubber 85·5, sulphur 9·5, dye 5·0. Twenty-four hours were allowed to elapse between the mixing operation and the vulcanisation. The latter was conducted in ring moulds, which were introduced into a heated press with hot plates so that no rise was given. To ensure that the results should be strictly comparable, three samples, one from each batch, were vulcanised together. Five days after the vulcanisation, ring test pieces were cut, and were tested on the Schopper machine. From the stress-strain curves the following values for the extension were determined.

TABLE I.

Extension per cent. at a load of 600 g. per sq. mm.

Cure	A.1.	A.2.	A.3.
60 minutes	1205	1145	1090
90 ,,	1060	1025	990
120 ,,	940	925	905
135 ,,	904	890	875
150 ,,	874	865	853

The above results are plotted in Fig. 1, which shows that the extension for a fixed load decreased Fig. 1 from A.1 to A 3. That we are dealing with an

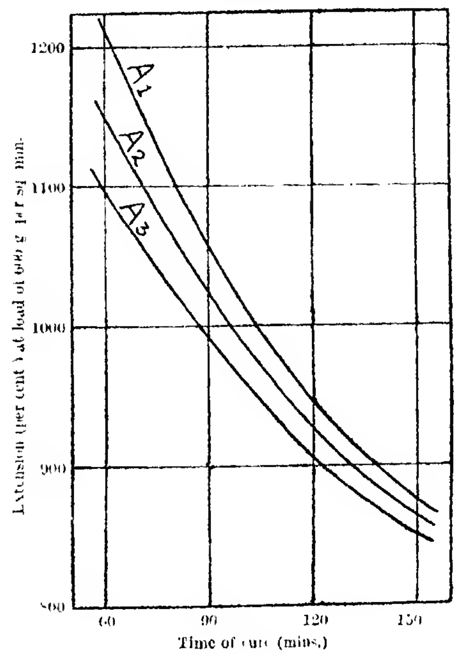

FIG. 1.

acceleration as opposed to a merely reinforcing action of the dye is confirmed by the determination of the vulcanisation coefficient. For instance, the following

ɛ the coefficients of vulcanisation for the 120 min- ɛs' cure, after correction for the sulphur present in ɛ dye: A.1, 3·52; A.2, 3·73; A.3, 3·89.

(B) *Rubber mix containing a small quantity of zinc ide.*—The mixes B.1, B.2 and B.3 were similar to 1, A.2, and A.3, respectively, but contained an dition of 2·5 parts of zinc oxide. The experi- ental observations were made as described eviously, and the following table gives the tensions:—

TABLE II.

Extension per cent. at a load of 600 g. per sq. mm.

Cure.	B.1.	B.2.	B.3.
60 minutes	970	930	890
90 ,,	860	840	820
120 ,,	795	770	760
135 ,,	770	750	735

On plotting these values, a diagram similar to g. 1 is obtained. It is apparent that the zinc ide has not markedly activated the accelerating operties of the dye.

(C) *Heavily-filled mix.*—In order to test the influ- ce of the dye on the curing of a heavily-filled mix, e mixes detailed in Table III. were made.

TABLE III.

	C.1.	C.2.	C.3.
Pale crêpe	140	140	140
Sulphur	15	15	15
Zinc oxide	20	20	20
Barytes	30	30	30
Whiting	30	30	30
Dye	—	5	10

The cured samples were tested in the manner eviously described, when the results given in able IV. were obtained.

TABLE IV.

Extension per cent. at a load of 600 g. per sq. mm.

Cure	C.1.	C.2.	C.3.
60 minutes	940	924	924
90 ,,	850	835	820
120 ,,	805	790	775
150 ,,	760	750	740

On plotting the values in Table IV., diagrams milar to those in Fig. 1 are obtained. It will observed that the accelerating influence of the ye has been reduced by the fillers, but is still ob- rvable. The decrease may possibly be due to the bsorption of dye by the fillers, or to the enclosing of e dye by particles of fillers.

(D) *Influence of the dye on the vulcanisation of an celerated cure.*—To determine the effect of the ye on an accelerated cure, the following mixes ere made: D.1, rubber 200, sulphur 4, zinc oxide 5, iphenylguanidine 3; D.2, same, with dye 5; D.3, me as D.1, but with dye 10. Samples of each batch ere cured for 25, 30, and 40 minutes, and rings were sted on the Schopper machine. The corresponding urves for each batch were found to be coincident, us indicating that the powerful accelerating ıfluence of the diphenylguanidine had masked the maller effect of the dye.

From the foregoing investigation, it would appear at the dye employed acts as a very feeble accelerator in non-accelerated mixes. It has been impossible to determine whether the dye itself causes the accelera- tion. It may be that (at the temperature of the vulcanisation) a trace of the dye suffers slight de- composition accompanied by the production of a degradation product possessing the observed acceler- ating properties. The effect, however, is so small that in ordinary practice it may be entirely ignored. In accelerated cures, the influence of the dye is totally inappreciable.

The thanks of the authors are due to the British Dyestuffs Corporation for providing supplies of the dye and diphenylguanidine.

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DETECTION OF PERSULPHATE IN FLOUR, AND A RECENT BLEACHING AGENT FOR FLOUR.*

BY JAMES MILLER, F.I.C.

Probably the most common agent used for bleaching flour is oxides of nitrogen—"electric gas". this is readily detected by the well-known colour reaction with naphthylamine hydrochloride and sulphanilic acid. Potassium or ammonium persulphate probably comes next in importance, the persulphate being usually detected by means of a solution of benzidine in alcohol.

In view of the readiness with which per-salts liberate iodine from potassium iodide solution, it seems surprising that use has not been made of this reaction for the detection of persulphate in flour.

If a few grams of a flour containing persulphate be gathered on a microscope slide, then flattened and gradually immersed in a 10% solution of potassium iodide for about 10 seconds, withdrawn and allowed to stand, the particles of persulphate begin to show up as brown spots within one minute, owing to the liberation of iodine: half an ounce of persulphate per sack of flour can be readily detected in this way.

Another bleaching agent for flour has been recently introduced under the name of "Novadelox-B." This seems to consist of a mixture of benzoyl peroxide, acid calcium phosphate, and tricalcium phosphate, and its bleaching action is, no doubt, attributable to the benzoyl peroxide. The properties of this sub- stance have been described by Farmer (J., 1921, 84 T). It is stated to be a powerful antiseptic, and has been used for the treatment of burns and ulcers: its internal use has been abandoned on account of its poisonous action on the blood.

* Read at a meeting of the Manchester Section on May 2, 1924.

The crude product melts with decomposition at about 98° ; the pure compound melts at 103°—104°. Gradual decomposition commences at a temperature much below the melting point, and as it proceeds the reaction accelerates to such an extent that in a warm place explosion may result. Mixing with inert material renders the substance more stable, and this may be one reason for the presence of calcium phosphate in the mixture under consideration.

If a little benzoyl peroxide be added to potassium iodide and starch solution, no immediate colour is produced, but on shaking and allowing to stand, iodine is slowly liberated and a blue colour gradually develops ; this reaction takes place at once if the mixture be boiled and cooled.

For the detection of benzoyl peroxide in flour, the same reagent is used as for the detection of persulphate, viz., a 10% solution of potassium iodide, but as the reaction takes place very slowly in the cold, it is necessary to use heat.

About 5 g. of the flour contained in a porcelain dish are mixed into a paste with the reagent, the paste is spread over the dish and heated on a boiling waterbath for five minutes. After cooling, the presence of benzoyl peroxide is revealed by dark spots on the under-side of the cake ; half an ounce per sack is readily detected.

Benzoyl peroxide can be detected in a flour containing both benzoyl peroxide and persulphate, by extracting the latter with water and applying the above test to the residue after draining on filter paper.

The benzidine test, applied as described above for persulphate, gives with a flour containing benzoyl peroxide, on standing for about 15 min., dark spots which to the unpractised eye might be confused with those given by persulphate.

A mixture of benzoyl peroxide and flour in the proportion of half an ounce per sack gave the potassium iodide reaction with undiminished intensity after standing for 15 weeks.

Since reading the above, loaves have been made from flour containing ½ oz. and ¾ oz. of benzoyl peroxide per sack respectively. The crumb of the loaves was examined by the potassium iodide test and the reaction for benzoyl peroxide was obtained in both cases, indicating that the whole of the peroxide had not been decomposed during the baking process.

The crumb of a loaf made from flour containing ¾ oz. of "Novadelox-B" gave a negative result for benzoyl peroxide.

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NOTE ON THE BLEACHING ACTION OF HYPOCHLOROUS ACID.

BY S. R. TROTMAN.

Some time ago a criticism was published by Mr. R. L. Taylor (J., 1923, 79T) of some statements made by me with regard to the bleaching action of hypochlorous acid. Taylor maintained that my results were explained by the fact that hypochlorous acid, prepared by passing chlorine into water containing chalk in suspension, always contained calcium hypochlorite. In his paper entitled "Notes on hypochlorous acid and chlorine, with comparisons of their bleaching action" (J. Soc. Dyers and Col. 1922, 96), Taylor states that "to enable either chlorine, or hypochlorous acid, to bleach linen some hypochlorite must be present as well, and it is evident that by the addition of calcium carbonate to either chlorine water or hypochlorous acid the requisite amount of hypochlorite is produced." In a footnote, it is stated that if hypochlorous acid is shaken with calcium carbonate the filtered solution subsequently gives a precipitate with ammonium oxalate. This is all the evidence I can find for Taylor's insistence on the fact that the bleaching action of hypochlorous acid is due to the presence of hypochlorites. I do not think that the statement is warranted by Taylor's own experiments.

When Taylor speaks of hypochlorous acid he means presumably, that prepared by his method of distilling a mixture of bleaching powder and boric acid. I have prepared many lots of the acid in this manner, distilling both under ordinary and reduced pressures. I find that the distillate always has a p_H value of about 4, that it invariably has a slight odour of chlorine, and that the presence of free chlorine is confirmed by Taylor's arsenious acid method of titration. That is, I am of opinion that Taylor's hypochlorous acid contains traces of free hydrochloric acid and chlorine.

Naturally, when this acid is shaken with powdered calcium carbonate, some calcium is dissolved. If the mixture is filtered the p_H of the filtrate is about 6·0. If this filtrate is kept carefully, its p_H remains constant for a long time, and the acid does not dissolve any more calcium when shaken with calcium carbonate. But if the filtrate is kept in a warm room or exposed to a strong light a p_H of 4 is again apparent. The acid then dissolves more calcium.

If hypochlorous acid is prepared by the action of chlorine on water containing suspended chalk, the filtrate has a p_H of about 6 and does not dissolve calcium when shaken with chalk, as long as it is kept under suitable conditions. In one experiment hypochlorous acid made in this way was kept in contact with chalk for 24 days. The dissolved calcium was exactly the same at the end as at the beginning of the experiment.

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(Continued from p. 236 T.)

The President in presenting the Messel Medal poke as follows:

The Messel Medal, founded in memory of Dr. Rudolf lessel, is conferred this year on Viscount Leverhulme. r. Messel was an example of that rare combination f a chemist, a chemical engineer and a man of usiness—a pioneer of our industry; he invented a ew process and brought it and the industry conected with his process, the manufacture of sulphuric cid, to a technical and commercial success. In lecting Lord Leverhulme to receive the Medal your ouncil wishes to pay tribute to him as the founder f one of our greatest chemical firms, as the leader f one of the most important industries based on hemical science, and above all, as a leader of men nd an Empire builder in the very widest sense of he term. Lord Leverhulme's career is so familiar o us all that I need not describe it to-day; you now him to be a man of inexhaustible energy, ibrating with ideas and possessed of the highest eals. he might be described, if one may coin the hrase, as the greatest door opener in British ndustry. No one can have made more opportunities or the individual young men of his staff to grasp r done more for the technical and material progress f industry. Himself primarily a salesman, he can n turn act as financier, architect, technical chemist nd what not else, not neglecting the love and atronage of art, and his technical knowledge in ach profession is such as to qualify him beyond oubt as a full member of the professional Institute.

Industry, let us say chemical industry, cannot ive by the brains of chemists alone; their products ust be financed and sold, the factories in which hey work must be planned and built with due egard to the economic geography of their situation, onsidering always the raw materials which must be roduced and brought to the works. The wares ust be presented in an attractive form and made nown to the public. In every one of the provinces f activity I have mentioned, Lord Leverhulme has ound his *metier*, and so in the briefest number of ears has built up an organisation which is world ide, both in fact and in fame. He has that long xperience that doth attain to something like rophetic strain, and his prophetic vision and his ireless energy have often made him most successful hen the difficulties appeared greatest.

Lord Leverhulme has built up a technical industry, uilt it first by dint of his own personal effort and is own hard work, and secondly by his encouragement and application of every form of science, our own science of chemistry above all. He will permit me to recall one name to-day, that of a chemist who stood close beside him as his right hand man for many years, a former President of our Society, Mr. John Gray. We have often heard Mr. Gray relate how quick was Lord Leverhulme's insight into the technical problems which daily confronted them in early days at Port Sunlight, and how unerring was his judgment in choosing the right course. Those of us who work with him to-day know that time has made no change in this power of going to the heart of things, and that no expenditure of time or money on technical progress or investigation is stinted when a good case for it has been established.

Lord Leverhulme has not confined his attention to the financial, commercial or technical sides of the great undertakings he controls. He has not forgotten the human element; he has realised, as every wise man in time realises, that getting and spending are not the only duties of mankind. He has for many years taken a great interest in the happiness and the health of those who spend their lives in the industry. Port Sunlight is well known as a splendid example to all those who control important works; Lord Leverhulme has also taken a prominent part in profit-sharing schemes, in the organisation of industrial hygiene and in a variety of other efforts to enable those who are employed by his companies to attain to a high standard of life, including in this phrase not only comfortable and healthy homes but some appreciation of art and literature and that moral and ethical conduct without which business is merely sordid.

In the year 1891 the application of William Lever was approved by the Council for election to our Society. To-day its list of members bears no name more respected, more honoured by us, or more fitted to receive the Messel Medal than that of Viscount Leverhulme.

The President then handed the Medal to Lord Leverhulme.

Lord Leverhulme said: I was simply overwhelmed when I received your invitation to become the recipient of the Messel Medal this year, and I need not tell you how great a pleasure it is to me to be with you to-day and to meet not only scientists, but scientific business men. I am very much like an amateur musician, I think; the amateur musician is always considered by his musical friends to be a business man, and by the business men to be a musician. Similarly I do not quite know where I am on science and business.

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SECOND MESSEL MEMORIAL LECTURE.

Science, Religion, and Workshop.

By THE RT. HON. THE VISCOUNT LEVERHULME, LL.D.

Delivered at the Forty-third Annual Meeting of the Society at Liverpool, July 10, 1924.

When I was honoured with the invitation to be with you here to-day to receive the Messel Medal and to deliver the Messel Lecture for 1924, I felt very much inclined to shirk the responsibility on the ground that my knowledge of chemistry is confined to some evening class instruction I took in chemistry, under the guidance of a teacher, some fifty-seven years ago in Bolton. The effect of those lectures was to convince me of the truth of what the poet Pope wrote :—

"A little learning is a dangerous thing ;
Drink deep, or taste not the Pierian spring."

At the time, namely 1867, I was a grocer's apprentice, and could attend the chemistry class but one night a week, another night being devoted to shorthand, another night to taking lessons in drawing, and a fourth night each week to instruction in French. I am sure you will all agree that this was not even tasting the Pierian spring, let alone drinking in the shallowest sense. But if I did not acquire more than a smattering of chemical knowledge, I acquired a profound veneration for the work of the chemist, and when, many years later, I became a soap maker, I resolved, and have acted upon that resolution ever since, to surround myself with the skill of the chemist in solving all the problems of the manufacturer, and to endeavour to break through the old "rule of thumb" methods that prevailed in the soap industry.

You will see, therefore, that my first impulse, on receiving this generous mark of your confidence in me, was to explain my inability, but the invitation contained such a delicate compliment that it would have been churlish and ungracious on my part to have refused. I was very much like the gentleman who, in the old days of the hansom cab, on arriving home with no money less than a £5 note in his pocket which the cabman was unable to change, was pleased to observe, in his dilemma, a gentleman approaching. Raising his hat, he explained very politely to the stranger the difficulty he was in and asked him if he could change the £5 note? The gentleman, no less courteously, raised his hat and replied that he was sorry he could not do so but that he thanked him for the compliment.

I am not proposing to weary you with the fables woven around the art of the soap makers of Phœnician days, nor the discovery of soapworks among the ruins of Pompeii, nor of classic stories of Nausicaa and her maidens.

The invention of the art of soap making is shrouded in the mists of antiquity, but the science, as distinct from the art, of soapmaking is less than a century old.

I am content to believe for a certainty that by the time the cave man arrived and homes were formed in caves then would come spring cleanings, and if the cave woman was not able to seek the aid of soap, that to maintain household cleanliness was a pretty hopeless task imposed upon her. As long as home was amongst leafy glades of forests, and man's bed the bough of some tree rendered safe sleeping quarters by a strong grip maintained by prehensile tail, then soap was a negligible quantity in the economy of the family home. With every advance in the home comforts of life from the cave to the cottage and palace, there came an ever-increasing demand for soap and all saponaceous compounds. And the olive tree, coconut tree, palm oil tree, and the fat of animals were requisitioned to supply the demands of the soap maker's art.

It is disconcerting to our insular pride and love of first place priority in all developments to learn that it was not until some six centuries ago that soap was first introduced into the daily life of the people of the British Isles.

No doubt the proud, haughty Roman conquerors had brought soap into Britain with their Roman legions, but its use would be confined to Roman patricians, governors, generals, and their wives and daughters. We of British stock were not finding it easy to provide even coarse food and scanty clothing and had no opportunity to supply ourselves with the eleganceies and comforts of life. Perhaps this accounts for the natural instinctive abhorrence and repugnance to soap of the British small boy. And is there not the story of the "rough diamond" labourer who had met with a serious accident to his head, which necessitated an operation at the hospital, whose hair on his scalp was so matted with dirt that the surgeon was constrained to enquire, "Do you never wash your head, my good fellow?" and the good fellow replied, "Naw, I'd as soon think of washing my feet as my head."

However, once soap was introduced, its virtues for cleanliness personal and domestic were speedily recognised, and it is estimated that to-day the consumption of soap in Great Britain, per head of the people, is as high as or higher than that of any other people or country in the world.

This present-day British love of soap has been in evidence only for some half-century or so, but soap must have been more or less in daily use in France for over a century prior to coming into its own in Great Britain, for in 1793 the insurgent women of Paris, as stated in Carlyle's "French Revolution," made their plaintive battle cry "Du pain et du savon." It is largely due to the research

chemists of the United Kingdom that the conversion of the art of soap making into the science of soap making during the last century has been achieved. Not that British chemists have been the pioneer explorers or sole discoverers in the search for a scientific basis for the soap maker's art. But British soap makers have led the world in seizing upon those improved methods which the science of chemistry has placed at their disposal, in their service of the public. And to-day British soap at home and overseas enjoys the entry into the markets of the world, as being higher in quality and lower in price than the soap produced by any other nation, and this reputation has been honourably and laboriously won by hard work and persistent effort.

So now we find in the twentieth century of the Christian era the art and science of the soap maker in ideal combination, an important element in the life of civilised peoples.

It has been often stated that cleanliness is "next to godliness," and, notwithstanding the retort of the housewives living in the manufacturing towns of Lancashire and Staffordshire that in their town it was "next to impossible," there is sound logic under the statement that cleanliness is really and truly "next to godliness."

But this truism brings us to consider whether science or religion has accomplished most for the progress and civilisation of mankind.

Don't let me create any wrong impression as to whatever views I may hold on the relativity—I think that is the modern expression—of science and religion. Each has its right and proper place in the real permanent happiness, well-being, civilisation, and progress of the world, but our English language so easily lends itself to loose methods of thinking, apart from our British way of muddling together, in a kind of "scrambled egg" manner, totally dissimilar truths, that clear thinking on the relative ...ions of science and religion are necessary and ... more needed than to-day.

...ience and religion cannot be made into scrambled ... in the economy of life. Religion is not in ...ict with science, nor is science in conflict with ...on. Religion must ever be the compass and ... through life's voyage with its storms and ...ns.

...t for some eighteen centuries the Bible has been ...l by professors of religion upon mankind, not ... as a guide setting forth the Sermon on the ...t, the principle of the Golden Rule and the ...en Commandments as codes and rules given us by religion to guide us through life in our social relationship to each other; but also that the Bible's Eastern fables and illustrations, coloured with the graphic imagery and poetry of Eastern peoples, must be accepted as scientific truths that could never be challenged without bringing down with them religion, with its codes and guides for moral conduct, in devastating ruin.

As we know, the Christian Church burnt at the stake ... Italian philosopher, Giordano Bruno, or tortured ... threatened to torture with rack and thumbscrew ...e pioneers of science and truth, such as Galileo and others, who had the courage to wish to separate the chaff of impossible claims to scientific guidance from the real wholesome grain of the moral truth and indisputable reality of the ethical essentials of life given us in the Bible. It has been this bigoted attitude of the Church through at least sixteen centuries of the Christian era, that is to say, from the second to the eighteenth century, that has produced a disastrously sterilising effect on the benefits science would have lavished with generous hand on mankind. It has been science, in spite of all persecution arising out of mistaken interpretation of the teachings of the Bible, that has been the vitalising power in raising the condition of mankind to its present altitude, and it is to science we must look for still greater advances and still higher levels of comforts and elegancies of life the future should have in store for mankind.

Science and men of science, once freed from the thraldom of the Church's wrong interpretation and maladministration of the Bible, have made more progress in the raising of the level of comfort and happiness of mankind in the last two centuries than was achieved in all the preceding centuries of the world's history.

Professors of religion and professors of science must learn to go arm in arm together through life to raise and elevate mankind higher and higher above the brute beast and nearer and nearer to the angels.

In the past centuries Europe has seen nations enfeebled almost to the point of collapse by excess of religious zeal and blind separation from the scientific truth of what, for want of a better word, we have named "nature." And to-day some countries of Europe, most notably Russia, are enfeebled to the point of collapse by scorn and contempt for religion, dispersal and murder of its advocates, and by denial of God Himself. It has been truly said that whoever denies God has to face the difficulty of explaining the existence of mankind.

Religion, it is said, languishes from lack of new problems to solve in life, but professors of religion and searchers after real solid basic truths of religion and the Bible are finding each day fresh ethical problems requiring solution for the moral and social life of mankind, and betterment of the human race.

It is true that to follow the teachings of the Bible intelligently and faithfully requires no new discovery or guidance, but with each development and progress of mankind clearer religious knowledge is required and is essential to moral stability and rectitude of character and to community life.

Religion, like science, must progress by reason of the wise solution of new problems arising and requiring solution at each step forward made by mankind. Just as the climbing of mountain peaks reveals at each new summit higher peaks above, in endless progression, so also to the eye of science and religion new vistas and new visions of heights yet to be scaled and explored with their secrets to be laid bare reveal themselves as every advance is gained.

There can be no divergence from the basic laws governing man's research and discoveries as between

religion and science. Just as it is the fact that the Ten Commandments, the doctrine of the Sermon on the Mount, and the principle of the Golden Rule are as true a moral guide to-day as they were when first revealed to man, yet we must not ignore the fact that there was a date when they were for the first time revealed to man and that prior to that date mankind could only act ignorantly of these essential moral laws. Does not this fact agree with the identical corresponding position occupied by science to-day?

The stars shone from the heavens before men of science placed the telescope at the disposal of the astrologer and thereby converted him into an astronomer. The air was the same air before the modern chemist searched out the truth of its chemical composition of oxygen and nitrogen; water was the same water before the chemist discovered that it consisted of hydrogen and oxygen and so converted the capped and robed alchemist, with his crucible and cauldron and wizard's surroundings of stuffed and suspended crocodiles and snakes and his search after the philosopher's stone into the modern analytical chemist who banishes belief in magic and lays bare for us the immutable laws of the physical universe by investigation of facts and research after truth.

Life may have lost somewhat of its charm of poetry, tradition, and fairy story and song. Life may have become more matter-of-fact, and consequently have lost somewhat of its romance when the chemist resolved air into 78 per cent. or over of nitrogen, 21 per cent. of oxygen, and 1 per cent. or under of other gases, than was the case at the time when air to our fathers was known only as the breath of heaven that rustled the leaves of trees, the waving corn, and that fanned our faces when in gentle mood; and that equally at other times, when in angry mood, could be the hurricane or the storm that levelled mighty oaks to the ground, overturned houses and drove ships and sailors, despite their skill, to destruction.

Also when the chemist resolved water into two parts of hydrogen and one part of oxygen, he did not add to the poetry of life in sea or lake, river or brook, clouds or rain. When the scientist harnessed for service of man that unknown power we call electricity, he detracted from the poetry and mystery of the lightning-flash. But then the scientist, by his probing into what we call vaguely the secrets of nature, if he has not contributed thereby to the poetry, song, and day-dreams of life, has rendered life more liveable by giving, through knowledge, greater control over the forces of nature.

The night has become as the day, the link boy has been replaced by the incandescent lamp, the faggot and tallow candle by the electric light. In short, if life has lost somewhat of its poetry, it has more than made up for this by becoming infinitely more liveable and by life itself lengthening whilst its rightful joys and pleasures have deepened and broadened.

This does not mean antagonism between science and art, but rather that the artist does not move quite as quickly as the scientist, because art is founded largely on traditions of past ages and the interpretation of old masters. The modern artist has to adapt himself to the new light science has thrown on life. He is at present like a man who has been living in the shades and shadows of the woods and forests, and who has now the full glare of brilliant sunshine dazzling his vision. He cannot see, until his eyes become accustomed to the change, as well as he saw previously in the semi-darkness. But the artist in painting, sculpture, or architecture is rapidly recovering his vision for beauty in modernity, and his poiso in relation to the beauty of scientific truth.

And equally will this be the case with the professors of religion. They may to-day be a little blinded by the flood of light with which the modern revelations of science have dazzled mankind in a rapidity of sequence that it was inevitable must prove disturbing to ethical balance.

But if professors of religion have not kept pace with the advances of science in the ethical and moral sphere, still less have the professors—if I may apply this academic phrase—of industrialism in modern manufacturing actvities. When one considers the revolutionary change that has been created by new and better methods of production placed at the disposal of manufacturers by inventors, we manufacturers must confess with shame that improved methods of production have not resulted in equally improved conditions of life for the workers in factories.

It almost looks as if, in climbing the mountain peaks, hand in hand with the scientists, the manufacturer long ago had reached for his ethical progress what is known in forestry as the timber line and that, until the manufacturer can overcome limitations of his outlook on the human element in production, he may be a drag on science in its desi and efforts to confer better living conditions o mankind.

It is recorded that on the high borders of the timb line limit of mountain peaks some twenty to th rings have been counted upon a gnarled and twi forest tree scarcely four inches in height—so th had taken twenty to thirty years to produce u four inches in height of timber.

And when we consider all the storms of snow wind and struggle for existence that the st unconquerable vitality of the forest tree has resi and that it has, in spite of almost impossible condit of life, achieved even some growth, however s then instead of scorn for this tiny forest tree of twenty years of age we have feelings of admirati and respect for its courage, vitality, and persistenc And we ought to have the same feelings towards o manufacturers in spite of little progress made in th ethical relationship with the human element in th factories and workshops. There has been so growth and progress, gnarled and stunted, but s growth and advancement are evident on all sides

The manufacturers, during the last 200 yea had to meet the calls of new and better machine economical in production but making ever-grow demands for more and more capital. Their wh energies were, like the tree at the timber lin

sorbed during the eighteenth and nineteenth cen-ries in a never-ending struggle against adverse nditions, and in facing the competition of the whole orld, with limited capital and ever-increasing mands for more capital to provide new and better ildings, plant, machinery, and more ample stocks.

What surprise then if the eighteenth and nineteenth ntury manufacturers, dragged along by discoveries science, should, by the exigencies of the laws of lf-preservation, be only able to produce a gnarled d twisted stunted growth in the organisation of eir relationship to the human element in productive terprise.

We already, on the dawn of the twentieth century, e in the first twenty years of its history a greater ogress towards a higher realisation of the import-nce of better relations with humanity in industry an was made in the preceding two hundred years.

But the possibilities of economical production that n be achieved by giving even more attention to e welfare of the man behind the machine than to e care of the machine itself has yet to be fully alised. The manufacturer who neglected the care his mechanical implements of production would be ughed at and scorned as an example of waste and of efficiency. But the manufacturer who neglects give thought and care to the welfare and happiness the men and women employed in his productive ctories would be neither scorned nor laughed at as example of waste and inefficiency, but might even n a high regard and respect as a keen, hardheaded siness man with no maudlin sentiment about him, d rather as a thrifty model to imitate than a ngerous example to avoid.

It seems to myself that what we manufacturers eatly need is what is known in chemical science as a talyst to join together in united power for welfare, ogress, and prosperity so-called capital and labour.

The world's further industrial progress requires a el to discover the ethical catalyst to achieve y in the science of humanity such as Messel tigated and developed in the science of chemistry. ce is rightly often described as knowledge applied e phenomena of nature. Nature has no greater omena than what we call human nature, for in ords of the Lancashire man, "There's nowt so as folk."

e main facts to guide research for the right l catalyst have been known long ages ago, bly hundreds of thousands of years before s committed to stone the Ten Commandments for n's guidance. But these main ethical laws are rely the alphabet of the science that makes sible the living together of human beings in mmunities and their harmonious working for the efit not of selfish selves, but on lines of enlightened -interest that seeks the good of self on the solid is of unselfish work for others.

All motives spring from the law of self-preservation t has been deeply planted by an all-wise Creator each and every human breast; otherwise human ngs long ages ago would have ceased to continue to st. To quote the words of Shakespeare: "Self-e, my liege, is not so vile a sin as self-neglecting."

But narrow, selfish methods of self-preservation have always failed to achieve even their own narrow, selfish aims and objects. It has been only by the application of the principles of the Sermon on the Mount and of the practice of the Golden Rule that self-preservation in its widest and truest sense is possible.

Material science has outgrown disproportionately spiritual science. Let us remember that, as the poet Goldsmith has affirmed, and as experience has proved :—

"All that Freedom's highest aims can reach
Is but to lay proportion'd loads on each;
Hence, should one Order disproportion'd grow,
Its double weight must ruin all below."

Prof. Armstrong, in his thoughtful Messel Lecture given two years ago, gave us a vivid picture of Rudolph Messel, whose life-work and memory this Society has honoured itself in honouring, and there is one sentence therein that seems to me to be worthy of inscribing in letters of gold in the board room of every manufacturing business enterprise and activity. These words describe Rudolph Messel as :—

"Generous and ever thoughtful of others, unselfish to a degree, he had little thought for himself and a hatred of all display; living among them, he knew his workpeople and was in sympathy with them; hence his popularity and power."

A few paragraphs further on we learn that Messel told Prof. Armstrong that he had been enabled to abandon the use of special appliances for the supply of gases in due proportion in one of his processes by having his attention called by his workman-foreman to the fact that the plant worked better when air was supplied in excess. Surely we could have no better illustration of the direct and important benefit of the "Messel touch," and his rule of knowing his work-people and keeping himself in sympathy with them.

Prof. Armstrong, in another part of the same lecture, informs those, like myself, ignorant of the laws of chemical action and reaction :—

"That it may now be asserted that hydrogen and oxygen cannot interact, and that to determine inter-action a third component must be introduced into the system."

As this fact is true and an accepted law of mere chemical elements and their interaction, it is still more true of the human elements in the workshop.

And surely this "catalyst," to ensure interaction, can best be provided by religion and the teaching of the Sermon on the Mount and practise of the Golden Rule. What the business world requires to-day is a Messel, a Newton, or a Faraday of religion to investi-gate this pressing human problem of the modern workshop.

Professors of religion are quite detached from even the suspicion of personal interest or greed of gain, biased thought, in investigating and exploring impartially and impersonally all avenues likely to lead to the discovery of the true "catalyst" for human relationship in the workshop.

At first thought it would seem that sympathy might be found to be the catalyst that would induce

interaction in the human elements of production called capital and labour. But just as Messel the scientist must have met with many disappointments in chemical research, so will the ethical scientist inevitably meet with corresponding but more distressing disappointments in his researches into the solution of ethical problems, the greater difficulties of which are inevitable because of the ever-changing nature and variations in types of humanity and their resulting, ever varying, response to the same influences even under the same circumstances.

In other words, hydrogen and oxygen, when they are made to interact by a suitable electrolytic process, must, as far as my chemical knowledge carries me, always result in the production of water in definite proportions of two atoms of hydrogen to one of oxygen.

But human sympathy with, say, "A" may result in increasing "A's" power of resistance to adverse circumstances, whilst the same sympathy towards "B" may result in the weakening of "B's" personal power of resistance to adverse circumstances. Every wise father and mother has studied these variations in responses to sympathy and endeavours to guide their training and actions accordingly.

There is no, shall I say, "catalyst" known to us —other than religious truths—to induce interaction between humans that can equally be depended upon to give so closely similar results under similar circumstances with similar human elements than the teachings of the Sermon on the Mount and the practice of the Golden Rule.

I remember hearing the following story when quite a youngster, relating to the wife of a cotton manufacturer who, even in those early days, took a personal interest in the workers at her husband's cotton mill. This well-intentioned lady heard that the twelve-year-old daughter of a spinner in the mill was ill, so she at once made a visit to the home, the door of the cottage was opened by the wife of the spinner, who invited the lady inside and set her best chair for her to sit in. Inquiring about the daughter, the mother replied, "Ay oo's none weel but th' doctor says it's nowt much nobbut oo's o'ergrown hur strength and a wik or fortni't at Blackpool would put hur reet." "Well, won't you send her to Blackpool?" "Eh, missus, it 'ud take a heap o' brass for that and we connut afford it." "Do you know anyone your daughter could board with in Blackpool?" "Oo ey oo could board with Missus Ainscough; I know hur weel. She keeps a lodging house and oo'd be all reet wi' hur." "Well, look here, I'll pay all expenses of railway fare and board for a month, so send your daughter to-morrow whilst the summer weather is on, for a month to Blackpool." "Weel, Oi'll think about it, but Oi connut say neauw." And so the benevolent cotton millowner's wife was chilled as if a bucket of cold water had been thrown over her by this reception of her solution of the difficulty the spinner's wife had in providing ways and means for following the doctor's advice.

But as soon as the millowner's wife had left her cottage the mother called in her friends and neighbours and said, "Oi've just had the gaffer's missus in asking after our lassie, and when Oi told hur there were nowt much wrong wi' hur and t' doctor wanted us to send hur to Blackpool for a wik or two, oo said oo'd pay all t' expenses of railway fares and lodging-money for hur for a month, and Oi told hur Oi'd think about it, but Oi've thowt and Oi've thowt, and Oi connut see what gaffer's missus can make out of sending our lassie to Blackpool."

Yes, humanity is always looking for selfish unworthy motives as attached to every helping hand extended in sympathy.

The fact is we are all like minnows swimming in the world of our own little brook. It is a sma selfish world and each minnow is absorbed in tl tasks of its daily life and food supply. What c these minnows know of the great oceans of li beyond the brook which feed the clouds with water which in turn come down in grateful showers on hillside, valley, and meadow, and, after providing needed moisture for abundant harvests for man, finally reach the brooks and rivers and hence return to the seas from which they came.

It is not the selfish efforts of each minnow and their absorption in their daily tasks of life and food supply that is all-important, but the great ocean the clouds and the rain, without which the broo would soon become no better than a dry gutter an all minnows perish. The things of real importanc to each of us are not the things that are seen, br the things that are not seen. Every manufacture sees and knows intimately his plant, machinery an the bricks and mortar of his workshop, but he do not equally have visible to his consciousness tl mind of those associated with him in the worksho and yet the mind and soul of those associated wi him are as all-important to the efficiency of l productive enterprises as is the great ocean to very existence of the minnow.

Whilst we are living in the age of opportu it is equally true we live in the age of uncertai If we could only link up together this great of opportunity free from uncertainty, then we citi of the British Empire—the Empire of opportuni with certainty in application of the truths of Christian religion in their bearing on human then we should liberate forces for welfare and ha ness in the twentieth century more powerful greater than ever known in previous history mankind.

Take one well established scientific fact— there can be no intake without correspondin outflow—the very spirit of the modern busine mind, hard as granite and keen as blade of ste seems to be founded on a belief in the very opposi thesis, namely, taking in all that can be got a giving out as little as may be. To get the great amount of work in the longest hours for the minim pay possible is thought "good business" by t hard-headed business man. And equally to give t smallest amount of work in the shortest hours the maximum pay obtainable by force or thr of strikes is thought to be "good business" organised labour unions on behalf of the employee.

We know that both are contrary to scientific uths and that there can be no permanent intake ithout corresponding outflow.

Such policies make of mankind a morass of bog · a dead sea of barren shores incapable of yielding ›mfort or happiness.

Our scientists have devoted themselves hitherto ainly to the creation of better means for cheaper oduction and to harnessing the forces of the ıysical world to man's service. These have been ıe lines along which modern science—and especially ıemical science—has explored and progressed.

And the very existence of civilised life in towns d cities has only been rendered possible by the earches of chemists and others into the physical s of the material world to ensure that mankind ght be enabled to live in harmony with these laws. ut the most important branch of all knowledge — ıankind and his human nature—has been entirely eglected, and not one human in ten thousand nderstands the basis of those laws that govern hical life and govern it just as certainly as does ıe law of gravitation govern the physical world.

Even in regard to physical life, it is doubtful as many as one human in ten thousand would ›rrectly assign on their relative values the respective ›sition of eating, drinking, and breathing. Most ›uld place the order as just given regardless of the t that humans can exist for seven weeks or longer ithout food provided they receive air and water, for seven days without water provided they receive r, but cannot exist for seven minutes without air.

Equally true is it that few manufacturers realise at to labour under conditions that give happiness d contentment to the human mind, enables the ly to perform its daily task with ease and long urance; but to entail on the worker conditions labour that destroy happiness and produce dis- ent—that then the efficient performance of the y tasks becomes impossible. I believe the ving experiment has often been tried on walking rsions with children and in other forms on many ric occasions by generals in high command with adult troopers, or by hardened Arctic explorers their men, when their men were living under tions of existence almost beyond human rance—relief from fatigue being founded on ›ying the mind on happiness and so bringing ved endurance and strength to the body. To ibe the experiment most easily tried by any of I will take the case of very young children, but response is the same in all cases where the policy adopted of interesting the mind beyond the igues and pains of the moment. A teacher has scribed how that taking his class of very small ys a long walk into the country, so long as the rney was outwards into new scenes none com- ained of being tired or wished to return home- rds, but almost immediately the return journey gan first one and then another of the kiddies mplained of fatigue and some even asked to be rried, as they declared they could not walk any nger. A brain-wave came to the teacher—so he gathered sticks lying around and made for each kid a hobby-horse—chose for them a leader and so, each kid astride his own stick as a hobby-horse, they all pranced gaily home, their previous weariness forgotten in the exhilaration of play, and all regretting when the school-house was reached.

Modern workshop conditions of production are essential to the clothing, housing, transportation and feeding of humans under modern civilisation. But workshop life soon becomes brain fag and weariness. Many suppose that the discontent of the modern workshop operative is always in the direction of a desire for shorter hours and greater pay than those they are at that moment receiving, and so thereby to attain better conditions of life.

But this is only partly true, for this discontent is just as keenly felt to-day—nay, even more so than a century ago, when labour toiled for twelve hours a day as compared with the usual eight hours now, and when wages were one-third or one-quarter the average wage of to-day, with the then price of bread higher than to-day, whilst conditions of modern life are infinitely better than the ratio of increase of wages would appear to indicate. So higher wages and shorter hours are no substitute for lack of mental stimulus towards happiness and contentment. A century ago the village blacksmith sang and whistled at his work, though under-paid and under-fed. The modern mechanic does not feel inclined for either. The old stage coach driver cracked his jokes with guard and ostlers, inn-keepers and bar tenders. Not so the modern motor or tramcar driver. For modern life becomes grey without relief or brightness. As to work, the physical toil of the village blacksmith was at least double that of the modern mechanic, and the exertion required to hold and control a team of four horses is much greater than the exertion required from the motor or tramcar driver. The late Mr. Gladstone on one occasion stated that in his youth he had inquired as to which horses on the stage coach routes out of London were worn out the sooner. Was it the horses dragging the coach up Highgate Hill or the horses taking the coach along the level road through Slough? And to his astonishment he found that it was the horses on the easy level road to Slough that were worn out soonest and had to be replaced first, and that it was the horses on the road with the heavy pull up the Highgate Hill route that lasted longest. Therefore, it was monotony that killed. Horses could better endure the heavy collar work up Highgate Hill followed when over the top by the trot down with easy collar and loose traces. And it is monotony of work that kills men as well as horses, for humans are infinitely more liable to corrosion from monotony than horses.

No thought is given to the mental weariness of the human in workshop efficiency. The forces of Niagara ran to waste for countless ages before their potential power was realised and before they were harnessed to the service of mankind. But there is greater potential power for service of mankind in the cultivation of a sound mental outlook and application of knowledge to the human element in

workshops than in all the Niagaras and Victoria Falls or other latent water power the world contains.

And future progress in efficient production can only make further advances by the cultivation and maintenance of states of mind and happiness in workshop employees.

Past ages have seen mankind absorbed on various ideals of brute force, militarism, and conquest. All these ideals have proved unproductive of happiness even to the victorious conquerors. The fact is that only in the performance of service to others and duty to our country can lasting happiness be found. This is just as true to-day as it was a century and a quarter ago, when Nelson hoisted to the masthead the signal "England expects that every man this day will do his duty."

This is a democratic age, and there is no power so absorbingly attractive as the force of a democratic ideal. But democratic ideals would not save modern life if we took away from the twentieth century city modern drainage and water supply—and other knowledge that chemical research had placed at the service of man, for then pestilence, disease, and death would kill off the congested populations of our large modern cities, and civilisation would perish more rapidly than ever did destruction follow victorious conquering armies in past ages, despite democratic ideals. These conditions affect us all—those who live in mansions in Mayfair no less than the slum dwellers—and democratic ideals would not save us. It is only by the knowledge of chemistry and bacteriology that modern civilisation continues to exist at all under modern conditions.

What is wanted to-day, nay, is even still more essential than these, is that there should be corresponding researches undertaken and knowledge and discoveries attained in the ethical life of mankind as in the physical life. The so-called modern socialistic or communistic upheaval is as old as community life itself. All the modern suggested "short-cuts" to welfare and happiness of the people have been tried over and over again and always ended in increasing and never in decreasing human misery and wretchedness.

And yet as far back as records exist of ancient community life in the ages past with all peoples, the basic truths of the Bible when applied to community life have invariably resulted in making possible the attainment of the greatest prosperity, the widest diffusion of happiness with the deepest most abiding joy and the most efficient life attainable by human beings.

Thousands of years before the Christian era we find almost all the moral guides laid down in the Bible had formed the basis of every efficient religious system the world has ever known. The Advent of Christ only laid greater emphasis on these ancient guides for mankind, while adding thereto one hitherto unrecognised outstanding governing truth—the power of gentleness. There was, as far as my knowledge goes, mainly this one new truth, this one new ethical principle brought by Christ to the world, that is not to be found in most of the older systems of religion nor in the Bible prior to the advent of Christ.

Christ for the first time founded His religion on the overwhelming power of gentleness. The religious systems of the world prior to the advent of Christ were founded on the power of force and the strength of the physical man. Community life according to these older systems of religion demanded on "an eye for an eye, a tooth for a tooth," a system of revengeful punishment. It was the Head and Founder of the Christian religion that first directed mankind's attention to the far greater strength and irresistible force of the power of gentleness.

We Christians neglect in the daily relations of community life this fundamental basis of the Christian religion and believe as firmly to-day as ever in the world's history that whilst it may be true that "thrice armed is he who hath his quarrel just," the modern doctrine that "four times he who gets his blow in fust" has best chances of ultimate victory. And this after centuries of the world's experience of its utter unsoundness.

We note this mistaken ethical outlook on life equally trusted in by professors of religion as by business men under our so-called but misnamed Christian religion. It has been well said that whilst this policy may, if it succeeds, "get even with" one's opponent, the higher power of gentleness carries one far ahead of all opponents. Until this power of gentleness is acknowledged as the fundamental truth of the gospel of Christ's teachings and becomes the basis of the teachings of the Clergy of our Christian Religion, our so-called Christian Religion can show no advance upon the old worn-out religions that have preceded it.

It is little wonder that science has outstripped religion in the service of mankind. We have no corresponding neglect by professors of science of the basic laws of the physical world. It is little more than two centuries ago since men of science placed at the service of man the discovery of the law of gravitation. It is less than one century ago since men of science placed at the service of man the discovery of the power of electricity. It is less than half a century ago since men of science placed at the service of man their discoveries of internal combustion engines, a discovery that has made possible the conquest of the air, and of flight through the air hitherto available for birds only. It is less than a quarter of a century ago since men of science placed at the service of man their discoveries in radioactivity, wireless telegraphy, and wireless telephones.

But these great discoveries of science once placed at the service of man and their solid foundation of truth firmly established, man has never failed to apply them to his daily community life, with the result that in less than two centuries of science the world has been made a better world physically for mankind, especially for mankind living in cities and towns, than all the preceding centuries from the time of man's first advent on this planet.

This is true only of physical life—in the moral and ethical life man has made no such corresponding advancement. Brute force, costly armaments and wars, revenge and cruelty have by means of the discovery of science been made more brutal, more

ruel, more powerful, until their ruinous modern ostliness is to-day the only effective check on their perations.

Now let us suppose that men of science after the iscovery of, say, the law of gravitation, or the ervice of steam or electricity, had treated these iscoveries as not fundamental truths of science be applied with confidence in their stability. ould we not have had chaos and confusion in the orld of science, as we have confusion and chaos in e world of religion ?

Is it not a fact that Bishops and Clergy of all nominations and forms and variations in the aching of our Christian religion have almost iversally acted, and some even spoken, as if they lieved that the teachings of Christ, as expounded His Sermon on the Mount, and His teachings of power of gentleness, were not fundamental ristianity ? Have not we, poor ignorant laymen, oping vainly in the dark for ethical guiding prinples, been told by Bishops and Clergy of all so-called ristian denominations, that modern community e cannot be founded on these principles nor successl business be established on their practice ?

The man of science does not "wobble" on the sic law of gravitation. On the contrary, he builds hole series of movements and actions founded on truth of the law of gravitation. The man of nce does not limit the action of the law of gravita- to certain circumstances that appear favourable s successful action. On the contrary, he declares inevitable results that will follow any disregard man of this basic law under any and every circumnce of life. He declares with no uncertain sound if the maintenance of the dykes in Holland were lected, the operation of the law of gravitation ld result in the submergence of Holland under inrushing waters of the ocean ; that if, by careless alculation, the engineer planning bridge or voir misjudged wind and flood pressure and t to be supported, there would be no exception operation of the laws of gravitation and that ng bridge or bursting reservoir embankment swiftly bring death, suffering, and ruin on nt sufferers.

the teachings of the Sermon on the Mount e practise of the Golden Rule are just as cold l laws for the "man of the world" as is the gravitation for the man of science, there is peal to sentiment or to emotionalism in either. o equally with all the teachings of Christ. centuries religion has been viewed as an appeal the emotions, and not as expounding cold basic s to govern humanity in relation to individual and mmunity life. Yet such laws of religion are olutely free from all sentimental emotionalism.

We require to-day more than ever to realise that ist was the greatest Ethical Scientist the world ever produced, and that His teachings are ntific ethical truths that govern the conduct of . That to neglect or disregard these scientific ical truths can only bring speedy disaster on mand as certainly as would disregard of the law of vitation. The direct result of the teaching of men of science is that neither individuals nor nations fool with the law of gravitation, whilst as the direct result of the introduction by the Church of emotionalism into religion and neglect of the teachings of Christ there has been substituted, for the cold, scientific, immutable and immovable ethical teachings of Christ, a certain maudlin emotionalism which brings the Christian religion into disrepute with thinkers, scientists, and practical business men.

In all my readings of the Gospels I have failed to find one single occasion when Christ, in His teachings of the laws of religion, acted other than as a man of science in his teachings would have acted, when considering with full knowledge the inevitable unchanging and eternal action of the laws of science.

The neglect of the scientific truths of Christ's doctrines and the substitution of sentiment and emotionalism therefore has no foundation in Christ's teachings, and it is for Clergy and Ministers of all shades and variations of denominational religion to recognise the scientific basis of the Christian religion; not till then will the progress of mankind towards the realisation of the fullest measure of happiness and well-being in community life be possible.

There is nothing savouring of materialism in this view. But, in fact, our Christian religion as taught and preached to-day is not so much in danger from errors of materialism as from errors of maudlin sentimentalism and emotionalism.

Neither is there danger to Christianity to be feared from what is called denominationalism. Just as flowers, trees, grass, and all varieties of plants derive their life and growth from the same Divine source—sun, rain, air, and earth—and yet are not from that fact prevented from producing an infinite variety of flowers, trees, grass, and plants without schism, infidelity, or departure from the laws of the Divine source from which they derive their life and growth. And just as the man of science can produce an infinite variety of movements and types of machinery suited to all purposes for the service of man, yet each founded on strict fidelity and conformity to the laws of gravitation, and other physical laws, and without schism, infidelity, or departure from the laws of science, so can there exist denominationalism in religions founded on the teaching of Christ without schism or infidelity or departure from the Divine laws of religion.

It was intended by our Creator that there should be infinite variety in the physical world and no uniformity, and so it was intended, in my humble opinion, that there should be infinite variety and absence of uniformity in the religious world. And yet, with strictest obedience to the basic laws that govern either and both. The basic laws of the Creator in both the religious and scientific truths of the Universe are too powerful, too great, and too grand to be limited to any one single approach.

In a few months I go to the Congo, and shall be living for a few weeks amongst a people whose life has not yet, in their native forests, developed beyond what we call "the Stone Age." Witchcraft there takes the place of science. If it rains more than they require, then they search out a witch doctor to stop

rain. If they suffer from drought, they search out a witch doctor to bring rain. If disease and death seize a village, some enemy has bewitched them, and they seek out a witch doctor to create a more powerful fetish to break the witchcraft of the enemy.

To primitive man every volcano, lightning flash, or thunder peal, every tree, sea, river, lake, or mountain is a god, and just as primitive man is always cruel and revengeful, so is the primitive man's god cruel and revengeful. Primitive man mixes up science and religion, and is unable to interpret the phenomena of the physical world other than on lines of his primitive witchcraft religion. When a twentieth-century man visits the Congo with motor-car, steamboat, or aeroplane, the Congo native classes all together as "white man's magic."

Perhaps to fortieth-century man the scientific and religious knowledge, say, of us who live in the twentieth century, will appear just as crude and immature as appears to-day that of the Congo native to us of the twentieth century.

And yet there will be no change in the Divine Laws governing life either in science or in religion nor governing humanity. It will be merely a better knowledge of these laws and a greater fidelity and obedience to them that will raise the fortieth-century man to a pinnacle from which he will see twentieth-century man's religious and scientific knowledge to have been founded on colossal ignorance.

And so this grand old world will progress, but always and only along lines of all well-defined basic laws and immutable immortal truths.

The lines by Prof. Carruth will express my meaning better than any feeble words of mine :—

"A fire mist and a planet,
A crystal and a cell;
A jellyfish and a saurian,
And caves where cave men dwell;
Then a sense of law and beauty,
And a face turned from the clod—
Some call it Evolution—
And others call it God."

DISCUSSION.

THE PRESIDENT asked Prof. Armstrong to propose a vote of thanks to Lord Leverhulme.

PROF. H. E. ARMSTRONG said that they had just listened to a very remarkable address, one which was destined to be heard not only in the Society but throughout the world. Lord Leverhulme had not only shown himself to be a philosopher, but a scientific Christian, and his address had been extraordinarily full of literary charm. He had coined a very remarkable phrase, a very biting phrase, which was likely to live, in speaking of the Church's maladministration of the Bible.

He believed that the original donor of this lectureship would have looked upon their choice of the Medallist as the greatest step forward the Society had ever taken towards achieving its inevitable purpose, that of uniting chemical science with industry, in leading the two to march as twin brothers with only one end in view. It would have been easy [illegible] have maintained an academic succession, to have given a narrow interpretation of science, but instead they had wisely taken science as meaning wisdom, real knowledge, vital knowledge, knowledge made effective. Let them just consider what Lord Leverhulme had done. A man who had made the experiments he had made, experiments on a very large scale, more often than not with success, must be possessed of the scientific mind, must have the gift of imagination, must be a logician, a man worthy to be called into the fraternity of science.

Viscount Leverhulme had done them the honour of accepting the award of the Messel Medal in recognition of his services to science in making it available for the public good by the exercise of his gift of imagination and of his all-compelling organising power. He had that day been given the Freedom of their Corporation; they asked him henceforth to be a warrior in their ranks. He had organised an industry; they asked him to help them organise their science, and aid them in bringing together the various unassociated, if not scattered, conflicting elements, and in uniting them under one flag under one roof.

It was not necessary to ask the members to return their thanks to Lord Leverhulme. They had done so already in a very marked manner, and he was sure that Lord Leverhulme would go from the meeting with the feeling that he had indeed done a great work on behalf of the Society.

LORD LEVERHULME said that he was overwhelmed by the far too generous words they had applied to him in proposing the vote of thanks, and he was very conscious of his unworthiness of them. He was very grateful for the patient hearing they had given him in dealing with a subject he had found, when he had come to attempt to deal with it, to be overwhelming. The object he had had in view in undertaking the task would have been accomplished beyond [illegible] wildest ambition if it succeeded, in a world of indus[illegible] during the twentieth century, in securing attention [illegible] consideration to the man behind the machine. [illegible] the nineteenth century the attention of industry [illegible] been devoted to the machines. He believed th[illegible] the twentieth century onwards their greatest achi[illegible]ment would be to pay even more attention to the [illegible] behind the machine than to the machine itself.

A MODIFIED THERMO-REGULATOR

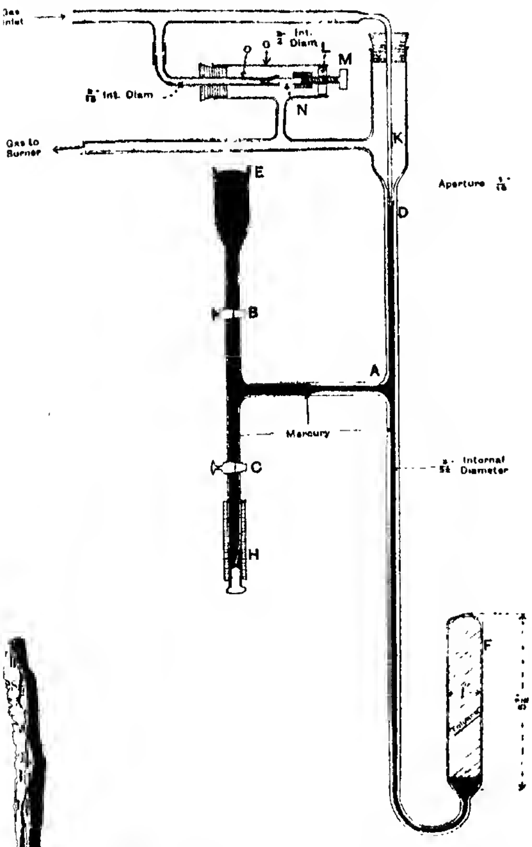
BY J. HUME, B.SC., A.I.C.

For certain dilatometric experiments it was necessary to have some means of keeping the temperature of a water-bath constant for long periods after successive small increases of temperature. To this end a thermo-regulator was devised, as shown in the diagram.

To a thermo-regulator of the usual type for gas heating a side-tube was attached at A, carrying two stop-cocks, B and C, and extending to about 1 in. above the level of D.

The apparatus was filled at atmospheric temperature with toluene and mercury to the extent shown

…mmersed in a bath at a temperature below the …west temperature required for the experiments, …d the stop-cock, B, was opened slightly. (As …e temperature required was below atmospheric, …ore mercury flowed into the tube, AD.) When …e mercury rose to D, the cock, B, was closed. …he bulb, F, was then immersed in the bath to be …sed for the experiments, and was connected to the …s supply and to the burner. The by-pass, G, …as opened very slightly and the burner lighted. …s the apparatus was set for a temperature lower



… the first working temperature, mercury had to …awn off, and this was done by opening cock C …e. The level of the mercury at D was allowed …l very slightly and cock C was closed. The …rature of the bath was then allowed to rise …ar as it would, and the process repeated till the …uired temperature was reached. During this …liminary adjustment, a rough calibration was …de by sticking a narrow strip of paper on the …e at D, and marking the level to which the …rcury fell and noting the consequent rise in …perature of the bath. It was then a simple …tter to raise the temperature by any amount …wn to a tenth of a degree at a time, and to keep …constant for any required length of time. The …rmometer used was graduated in tenths of a …ree, and could be read to 0·02°, and on this no …iation in the temperature of the bath could be noted, once equilibrium was reached after each alteration of the mercury level.

It was found to be difficult to manipulate the cock, C, so as to draw off a small enough quantity of mercury, so a short length of rubber pressure-tubing, H, was plugged at one end and slipped on to the nozzle below C. The nozzle was previously filled with mercury and the tubing was put on, using a piece of fine copper wire to allow air to escape, as is done in connecting up gas burettes and pipettes. When it was necessary to raise the bath temperature, the cock, C, was opened and the pressure tubing, H, pulled downwards to a slight extent, causing the mercury at D to fall. If it fell too far, it could be raised accurately to any desired level by pinching the pressure tubing and then closing the stop-cock.

If the necessity occurred to lower the temperature, mercury was admitted through B, till the level at D was too high. Then fine adjustment was obtained by using the cock, C, and the pressure-tubing, H.

When the regulator was used over a great range of temperature, a point was reached where the tube, K, could not pass sufficient gas. To overcome this difficulty an easily controlled by-pass valve, as shown at G, was fitted in place of the usual screw-clip and rubber-tubing. This valve was made by taking a piece of wide glass tubing with a side-tube, and fixing into one end of it with sealing wax a nut, L, with a bolt, M. To the point of the bolt was fixed with pressure-tubing a very gradually tapering piece of glass rod, N, which was ground into the end of the glass tube, O. By means of this valve, the rate of flow of gas could be altered by very small amounts.

The apparatus was used with great success over a range of temperature from 6° to 40°. For temperatures below 20° tap water at 4·5° to 5·5° was run into the bath, using a constant-level siphon inflow, and water was run out by means of a constant-level siphon outflow. This constant flow of cold water through the bath, working in conjunction with the flame controlled by the thermo-regulator, kept the temperature constant within the limits mentioned. The bath contained about 12 litres of water, and was, of course, fitted with an efficient stirrer.

When working at temperatures below atmospheric, drops of condensed moisture from the under-side of the bath frequently extinguished the flame, until it was protected by a small disc of tin-plate supported about 2½ in. directly above it.

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THE ANALYSIS OF COMMERCIAL BUTYL ALCOHOL.

BY C. H. SPIERS, M.A., B.SC.

At one period butyl alcohol, from the butyl alcohol–acetone fermentation, was marketed in a hydrous form nominally containing 90% by volume of butyl alcohol. This commercial alcohol contained, besides water, acetone and ethyl alcohol as impurities; also isopropyl alcohol was sometimes

present. The product varied in composition between fairly wide limits. The following figures represent the compositions of two samples :—

	Composition by volume. A.	B.
Butyl alcohol	85 0	90 0
Ethyl alcohol	7 0	2 5
Acetone	1 0	1·0
Water	7 0	6 5

The presence of ethyl alcohol and acetone renders the determination of the butyl alcohol by ordinary fractionation and dehydration processes exceedingly tedious and at the best unreliable. Indeed one process, reputed to give accurate results and taking a day or more, revealed the presence of ethyl alcohol in a synthetic mixture free from it. The main difficulty perhaps arises from the apparent impossibility of separating ethyl alcohol, b.p. 78°, from the constant boiling point mixture of butyl alcohol and water, b.p. 92°, even with the most efficient still-heads.

Some preliminary experiments showed that butyl alcohol could be determined reasonably accurately by a process of distillation with benzene. The work, however, was interrupted before the method had been exhaustively tested. Since butyl alcohol is now a solvent produced on a considerable scale, it is thought that the publication of the results obtained may be of use.

Young and Fortey (Chem. Soc. Trans., 1902, 81, 739) describe the following mixtures of constant boiling point :—

Constituent.	B.p.	Percentage composition by weight. Alcohol.	Benzene.	Water.
Ethyl alcohol, benzene, water	64 86°	18 5	74 1	7 4
Ethyl alcohol, benzene	68 24°	32 36	67·64	—
Isopropyl alcohol, benzene, water	66·51°	18·7	73 8	7 5
Isopropyl alcohol, benzene	71 92°	33 3	66 7	—
Benzene, water	69 25°	—	91·17	8 83

On the other hand, butyl alcohol forms neither a ternary constant-boiling mixture with benzene and water nor a binary mixture with benzene.* All the above boiling points are well below that of benzene and that of the constant-boiling mixture of butyl alcohol and water; so that if sufficient benzene be added to crude butyl alcohol and the mixture fractionated, all the lower alcohols and the water (and also the acetone) should pass over before any butyl alcohol distils and the latter would then only have to be separated from any excess of benzene that has been employed. This should be an easy matter with over 36° difference in the boiling points. Further the weight of liquid left in the still, after distilling to the mean temperature between the boiling points of butyl alcohol and benzene, should be equal to the weight of butyl alcohol present in the sample (Young and Fortey, *ibid.*, 1902, 81, 752).

Method.—A suitable weighed quantity (100 c.c.) of the alcohol is mixed with a suitable weighed quantity of benzene and the mixture slowly fractionated through an efficient still-head. The distillate up to 100° is weighed. The weight of the butyl alcohol present in the original sample is the difference between the weight of the benzene and crude butyl alcohol and the weight of the distillate to 100.°

The amount of benzene to be added must be gauged by the specific gravity of the sample, which gives some idea as to the water content. 100 c.c. of benzene will carry over 8·42 c.c. of water in the absence of ethyl alcohol, and 8·7 c.c. of water and 27 c.c. of ethyl alcohol if ethyl alcohol is present. The process may also be used in the preparation of anhydrous butyl alcohol.

Experimental.

The following experiments were carried out with a Raschig column 68 cm. long. The rate of distillation was 30—40 drops per minute, except in expt. 1, where the rate was 20—30 drops per minute.

Composition of liquid.		Benzene added.	Total weight.	Distillate to 100°.	Weight of butyl alcohol. By diff.	Actually present
	g.	g.	g.	g.	g.	g.
Butyl alcohol	81 2	44·4	125 6	44 8	80 8	81·2
Butyl alcohol Water	81 2 9 95	133·55	224 7	144·4	80·3	81·2
Butyl alcohol Water Ethyl alcohol	81·1 9·95 3 95	133·45	228 45	147 4	81·05	81 1
Butyl alcohol Water Ethyl alcohol Acetone	81·15 9·95 4 0 4 0	133·2	232·3	152·05	80 25	81·1

There is an extremely rapid rise of temperatur[illegible] between 80° and 117°. The rate of distillation wi[illegible] of course, depend on the efficiency of the still-he[illegible] Thus with the above column a rate of 1–2 dr[illegible] per second does not give such a good separat[illegible] of the benzene and butyl alcohol. It will be [illegible] served that the method gives the content of b[illegible] alcohol with an error of less than 1%.

To determine the lower alcohols and acet[illegible] the benzene distillate can be treated as descr[illegible] by Young and Fortey (*loc. cit.*). The acetone [illegible] the aqueous solution thereby obtained can be de[illegible]mined by any of the standard methods, whilst [illegible] alcohol can be determined by means of the ta[illegible] of Bushill (J., 1923, 216 T).

These experiments were carried out at H.M. Chiswick Laboratory, D.E.S., during 1917, and the author's thanks are due to Prof. J. T. Hewitt, the director of the laboratory, for his helpful advice and for permission to publish these results.

* Young and Fortey show that isobutyl alcohol, b.p. 108 06°, does not form a ternary constant-boiling mixture and that the binary mixture of benzene and isobutyl alcohol boils at 79 84°. Butyl alcohol would therefore not be expected to form either a binary or a ternary constant-boiling mixture.

TRANSACTIONS

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HE ACTION OF AQUEOUS SULPHUROUS ACID ON LIGNOCELLULOSE.

BY C. F. CROSS AND A. ENGELSTAD.

The production of wood cellulose (pulp) by the sulphite process may be regarded as having been tablished as an industry in 1884: the retrospect 40 years of extension and development justifies critical estimate of the industry as still lacking scientific foundation. Notwithstanding the hievements of the pioneers and the fruitful work a long succession of distinguished technologists, e present-day industry can only be recognised as an borated triumph of chemical engineering.

The primary factors of the process, which are in e main of the domain of pure chemistry, remain defined, that is, in such terms as conform with st principles, and would be set out in textbook m as the ultimate facts and the basis of the lustry in the scientific sense. In evidence, we e only to compare the treatises dealing with the ustry—of which we need only cite the most nt. "Sulfitzellstoff," by Richard Dieckmann, in, 1923,* with those which deal, *e.g.*, with the stries of fats, oils and soaps, of starch, sugars, fermentation, and more particularly with the nical literature of synthetic products.

hat the basis of the process and the industry is ly empirical is shown in the methods employed factory control of the main operation These not based upon the cellulose or main product, pon the lignone-complex (by-product), nor upon rect reaction (sulphonation) which conditions its tion from the cellulose in the soluble form; pon indirect observations upon the inorganic ts employed which more or less, or approxi- y, measure the progress of the reaction in gester in terms of active reagents (SO_2 CaO) pearing, or converted into new combined forms. s the "Mitscherlich" test of the liquor off sample) consists in adding ammonia and ring the volume of precipitated calcium sulphite: st is criticised and modified by Oeman, who a solution of calcium chloride (3%) made kaline with ammonia, which is calculated to recipitate not only the lime in combination as sulphite, but the free sulphur dioxide still present so as calcium sulphite. These tests and the ferences from them have been discussed by Klason, aegglund, Hartof and others, with an accumulation technical literature, in a sense, out of proportion ith a matter of only indirect import.

Moreover, the discussion rather turns upon the ontrol of the process for the avoidance of defective lines of reaction, than for the maintenance of the normal optimum. It is an obvious criticism that this must be secured on positive lines, and primarily on the progressive resolution of the lignocellulose, measured in terms of factors which can be accurately estimated. In this direction nothing is simpler than to measure the residual lignone in the blow-off samples of pulp The washed pulp reduced to a standard wetness by pressure is chlorinated, and after full reaction, the hydrochloric acid formed is determined by titration. In the investigations which are the subject of this paper this test has been found to furnish the basis of a close control, and associated with the determination of the sp. gr. of the liquor, simultaneously blown off and freed from sulphur dioxide by boiling, to give complete and adequate representation of the progress of the digestion process.

In these investigations we have first set ourselves the task of ascertaining what are in effect the reactions which take place between the lignone complex of coniferous wood (lignocellulose) and aqueous sulphurous acid.

From a review of the literature it appears that such systematic investigation, notwithstanding its fundamental importance, has never been undertaken: not only so, but even the textbooks, and the leading authorities in this branch of technology are at variance in their statements on the subject. We cite the following:—

C. Schwalbe ("Chemie der Cellulose," 1911) states, as known, from the patents and publications of Pictet and Brelaz (1883—1885) that a 5–7% solution of SO_2Aq at a range of temperature 88°–100° attacks wood completely, only the cellulose remaining undissolved, but that "carbonisation" of the cellulose takes place with extraordinary ease, even at 90°, since the sulphuric acid produced attacks the cellulose at the pressure employed. The mention of this process occurs in connexion with the Classen method of treating wood with aqueous sulphurous acid for the production of fermentable carbohydrates, and the context carries the suggestion that, as the only differences between the conditions of the two treatments are those of intensity, the Pictet resolution depends upon the intensification of the hydrolytic and deoxidising actions of the sulphur dioxide, with a contribution to the former by the sulphuric acid produced.

The author, it should be stated, may be merely recording a mistaken view for which we (Cross and Bevan) may be responsible, for in our treatment of the Pictet-Brelaz process (1885) the information supplied to us did not warrant the adoption of a direct sulphonation of the lignone complex as the main reaction involved. On this particular point, more-

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over, we cite a later and more definite statement by H. Ost ("Lehrb. Chem. Technologie," Ed. 8, 1914, p. 475):—

"Schwelligesäure allein schliesst Holz nicht genügend auf, der Kalk ist notig zur Bildung des Sulfonsalzes und zur Neutralisation der stets vorhandenen Schwefelsaure welche als frei Saure den Zellstoff schwärzen würde."

On the other hand, A. Klein (Verh. Zellstoff Papier Chem., 1908, p. 50) makes the general statement that with free sulphurous acid and wood substance, interactions take place of similar order to those of the bisulphite process; and that in the latter an important function of the base (CaO, MgO) is to prevent secondary reactions and decompositions, the products of which cause discoloration of the pulp and liquor.

This statement, which is definite and correct in general terms, is not accompanied by reference to specific investigations, and of such we can only find in the literature a note of a research carried out in 1907 by Seidel (Diss., Dresden), who appears to have employed the acid (SO_2Aq) at much higher concentration (17% SO_2), and to have obtained very imperfect resolutions of the lignocellulose.

As we are not attempting a complete bibliography we cannot notice many publications, which have a certain relevancy; we have cited such as have conveyed to us the conviction that a systematic reinvestigation is required, as a contribution to the very foundations of one of our most important industries. This conviction has been much strengthened by experience of the present state of our knowledge of wood cellulose. Primarily "bisulphite pulp" is a paper maker's raw material, and such control of cellulose quality as the pulp makers have acquired, is directed by and to structural characteristics.

The arrival of viscose, however, erected a new standard based upon chemical constitution, and critical selection according to this standard has also revealed, per contra, the generally low level of quality in this respect of the bisulphite pulps now produced. There is one other consideration upon which a critical revision of the industry is called for, and that is that we still accept the waste of the larger proportion of the by-product as inevitable. Seeing the importance of the lignone complex in the plant world, it remains to us as chemists and therefore economists to continue our endeavours to convert this present waste to industrial value.

We have now to record the preliminary results of our systematic investigations, that is of the interaction of aqueous sulphurous acid (5–8% SO_2) and the lignocelluloses, of these mainly coniferous (spruce) woods, but with incidental comparisons of beech and the simpler prototype of the lignocelluloses, viz., jute. It has also been necessary to investigate the behaviour of the normal cotton cellulose when exposed to the conditions of digestion both with aqueous sulphurous acid and with the standard liquors of the bisulphite processes.

At this juncture, however, we have to limit this record, in view of recent developments which promise to elucidate more completely the mechanism of the reactions, and especially in regard to the production of pulp or cellulose.

At the same time to introduce and call attention, as of precedent interest, to the communication of Dorée and Hall which follows this. By this record of a full investigation of the main by-product, the lignosulphonic acid, it is established clearly (1) that sulphonation is a direct reaction of sulphurous acid as such upon the lignone complex, or rather a specific component group of the complex; (2) the secondary effects, differentiating the by-products of the sul- phurous acid and bisulphite processes, are those of the degree of sulphonation, de-oxidation of ... groups, and condensation of the sulphonated compl...

These points may be usefully illustrated by t... results of a reaction which we studied in the ea... stages of the investigation.

Assuming a certain constitutional analogy betw... the more characteristic groupings of lignocellul... (jute) and cinnamic aldehyde, we investigated t... interaction of this aldehyde and aqueous sulphuro... acid at 100°–110°.

Cinnamic aldehyde and aqueous sulphurous acid.

6·3 g. of the aldehyde and 2·17 g. of SO_2 (mol. ra... 1·4 : 1) in 30 c.c. of aqueous solution were diges... for 24 hours at an average temperature of 110° i... stoppered glass tube.

The products were (A) yellow solution; (B) s... crystals in suspension; (C) dark coloured m... evidently fused at the temperature of digestion.

Of the SO_2 taken, 78·4% is accounted for in co... bination. In A 2·056 g. and in C 0·126 g. as H_2S... B was free from sulphur and identified as ... styryl or cinnamyl alcohol. The weight, 0·243... would represent the production of 0·1766 g. H_2... (conversion of SO_2 to SO_3): in A was determi... 0·160 g. H_2SO_4 produced in the digestion. ... combined SO_3H in A was equivalent to reaction ... 55·8% of the original aldehyde.

The derivatives present were (*a*) the sulp... acid, giving soluble barium salts on boiling ... barium carbonate, (*b*) the additive compound ... aldehyde hydrogen sulphite, decomposed on b... Of the total combined, one-fourth was in ... (*a*) form.

The black cake (C) weighed 2·584 g., 40% o... original weight of aldehyde fusible in wat... 90°–100° and consisting of a mixture of cryst... and tarry condensation products, it has no f... interest than in completing the statistics ... reaction.

Notwithstanding the low molecular ratio of ... sulphurous acid reacting, the degree of reaction ... considerable, and is evidence of an intense co... bining relationship of the acid and the acr... aldehyde groups. Although obvious that benz... CH : CH groups cannot react, the simple aldehy... benzaldehyde, was put under observation ... identical conditions of treatment. After react... there was no evidence of change and the sulph... acid formed, in small amount, was not more t... the equivalent of 3·5% of the aldehyde conve... into alcohol.

These results will be found to have a direct bearing on the main subject of this and the following aper. This main subject is the sulphonation of the gnone complex by interaction with aqueous sulhurous acid, and it is evident that with the aracteristic constituent ketohexene groups, with unsaturated aldehydic side group, which we ve always adopted (Cross and Bevan, "Cellulose" 90, p. 202), and of which cinnamic aldehyde is an alogue, this reaction would be the direct and ajor factor also of the bisulphite processes. On e other hand there are various secondary effects tained in the industrial processes of digesting od with bisulphites; and we have made observas of the reactions with the aqueous and uncomd acid of compounds, which may be presumed e present, formed or liberated as by-products the wood complex.

Dextrose and aqueous sulphurous acid.

Dextrose ($C_6H_{12}O_6$, H_2O) 77·0 g., and SO_2 30·6 g. 450 c.c. (6·8% SO_2), *i.e.*, mol. ratio approximately were heated for 26 hours at 110°.

Of the products 1·017 g. were insoluble. Of this % was soluble in carbon bisulphide and fully ified as sulphur.

Sulphur-oxygen compounds.

rect determination of SO_3 showed the formation ·69 g. Determination after complete removal sidual SO_2 and full oxidation gave an additional . Boiled with barium carbonate in excess the te contained only the barium equivalent of the acid formed (determined by distillation and ion). After oxidation the SO_3 in this filtrate determined and calculated to the original nted to 2·5 g.

is shows the presence of sulphur-oxygen deriv of by-products, not forming salts with barium traces only of sulphonic acids.

breakdown of the dextrose is shown by the solids. These were approximately estimated , and the loss therefore as 70 61 9·0 g.

determination of the residual dextrose by tation and calculation from the alcohol gave 55 g. Phenylhydrazine with onenth part of the original gave a precipitate cold (hydrazone) of 0·234 g.; also in the filtrate 100° (osazone), 1·691 g. The osazone once ised from alcohol had m.p. 203°. The roduct accompanying the residual dextrose ed to the residue, evaporated from the ralised barium carbonate solution, the appear of caramel. It was of no immediate interest haracterise the by-products further.

he reactions determined are of direct bearing the processes of wood digestion whether with lphites or the uncombined acid.

n view of the fact that the by-product liquor the industrial process (bisulphite) contains 1·3% of fermentable hexoses, and that under in conditions of digestion, production of sulphur served, this is more simply explained as resulting direct deoxidation of sulphur dioxide by the organic by-products than by the assumption of complex interactions involving the formation and decomposition of acids of the polythionic series.

Terpenes and aqueous sulphurous acid.

Since the terpenes and condensed derivatives are characteristic secondary components of the wood complex, it was of interest to make observation of any interaction with the aqueous acid.

A tube containing 31·7 g. of turpentine and 375 c.c. of the aqueous acid (8·0% SO_2) was sealed, and heated for 26 hours at 110°. The evidence of reaction was the presence of sulphur, and the hydrocarbon was turbid. Since the reaction contact between the aqueous acid and hydrocarbon could only be small as in the case of the benzaldehyde (*supra*), the presumed conversion to cymene would be small in amount. The production of sulphur was a definite index of a secondary reaction of this order taking place in the cellulose process.

Normal cellulose and aqueous sulphurous acid.

In view of the sensitiveness of the cellulose complex to acids, it is *a priori* obvious that any acid process of digestion of a raw fibrous material for the separation of cellulose, must determine a certain degradation of the cellulose in the course of its isolation.

(*a*) As a preliminary observation a large cutting of a normal bleached calico was enclosed in an extemporised cage of lead tubing, and exposed in a digester to the ordinary conditions of the bisulphite process. At the conclusion of the digestion, the product was carefully removed from its surrounding of "boiled chips," well washed and dried for examination. The cellulose was converted into a fine powder of minute dimensions. On analysis by the standard method the following were determined: Moisture in air-dry state 7·85%; α-cellulose 77·5, β-cellulose 20·7, γ-cellulose 1·8, calculated to 100 of dry cellulose.

The elementary composition was determined by combustion and gave the following figures calculated on ash- and moisture-free substance:—C 43·4; H 6·35%; $5(C_6H_{10}O_5)H_2O$ requires C 43·5, H 6·3%.

(*b*) Similar results were obtained on digestion with the aqueous acid (8·0% SO_2 - free from SO_3) at 110° (pressure 5·4 kg. per sq. cm.)

(*c*) 200 g. of bleached cotton cloth (mull) were digested with excess (10 litres) of a 2% SO_2 solution at 99·5° (pressure 0·23 kg. per sq. cm.) for 12 hours. The cotton lost in weight 15 g., *i.e.*, 7·5 %, and the resistance of the fabric was reduced to 11·9% of the original.

In view of these results it appears important to enquire into the degree of degradation of the natural wood cellulose, in the course of a normal digestion with bisulphites. It is well known to technologists of the craft that the process requires most careful regulation in the last phases of the digestion to conserve the normal optimum of "strength" in the pulp (fibre).

It appears to be an obvious inference from the results above detailed that the wood cellulose,

exposed as it is to long contact with sulphurous acid at the high temperature of the bisulphite processes (125°–145°), must be protected in an important measure by its association with the lignone complex, and in proportion as this is removed to its final minimum (1·0–2·0%), the attack on the cellulose must advance *pari passu*.

This discussion, however, brings us to the most important objective of our investigation, which is to determine the optimum of the conditions of controlling the sulphonation of the lignone by the aqueous acid, to the maximum of conversion, with the least effects of degradation of the cellulose (fibre)

For reasons stated (*supra*) we reserve our full story of the investigations, especially as regards the cellulose or pulp, until we have completed a new series which involves new conditions of action deduced from our first series of experiments.

This first series comprised something like 100 trials carried out in a digester, which is a drawn steel tube, lead-lined, with available volume 14,000 c.c.; this enabled us to treat 1600 g. more or less of spruce chips For such weight the digester was charged with 11 litres of the aqueous acid previously treated where specified for the removal of free sulphuric acid.

The digester is a cylinder around which was wound a spiral of chrome-nickel wire carrying current for the thermo-electric heating, which gives very close control of temperature and pressure. All the factors of digestion being noted, at the conclusion of the digestion, the entire contents of the digester were treated in such a way as to give a complete quantitative account of results both in liquor and by-product and pulp. The pulp was examined more especially by the method of chlorination and by the determination of α- and β-cellulose, and in certain cases by special methods.

The main purpose of our preliminary investigation being the elucidation of the reactions of the digestion process, interest rather centred in the by-product, and the supply to Messrs. Dorée and Hall from time to time of such quantities as were needed for the investigation of constitution, with the larger quantity required for testing in relation to industrial applications.

In regard to these, a number of which have been studied, there are also developments resulting from our new method of digestion, and here again the complete story is reserved for the same reason, viz., that later experience of new forms of the by-product is contributing to the elucidation of the special characteristics of the complex lignonesulphonate in relation to the degree of condensation and its physical properties as a colloid.

As a record of this preliminary investigation we give an abstract of the detailed laboratory report of Dr. Berhom, research chemist, who carried out the operations. All yields are calculated as dry products per cent. original dry material.

Series 1–9.—SO_2 varied from 7·5 to 10·5%. No treatment for removing SO_3. Temperature 100°–115°: duration 18–60 hours. Pulp: average of yields 45%—varied from a free fibre to unresolved chips—and in colour from yellow to brown.

Series 10–14.—SO_2 8·1–8·5%. SO_3 estimated, and converted to Na_2SO_4 by equivalent $NaHSO_3$. Temp.: 100°–115°: Time 26–51 hours. Pulp: yields average 43·5%. Great advance on previous series in regard to colour and disintegration of chips. In one case equal in appearance to the standard of the mill (bisulphite process). But all difficult to bleach.

Series 14–19.—Conditions as above. With hard wood (aspen) and jute fibre, *i.e.*, other types of lignocellulose. The effects were similar. Jute full resolved to ultimate fibres (yield 55% only) with 6% SO_2Aq at 110°–15 hours' digestion.

Series 20–42.—Spruce wood (chips). SO_2 at 6·5–8·5%. Treated for SO_3 to Na_2SO_4. Time varie especially in the phase < 100°, 12 to 48 hours. Pulp yields average 47·5%, but resolution of wood mostly incomplete.

Series 43–44.—SO_2 4·1–4·5% (as in bisulphite liquors)—Temp.: 110° to 140°, 11 to 12 hours. Pulp: very imperfect—wood mostly unresolved.

Series 45–50. *With bisulphite liquor as used in* –4·5% total SO_2 0·5% combined (CaO). The were actually tests of efficiency of the laborato digester and conditions, and as the results in pulp effect were very inferior to those of the mill digeste it was evident that reaction-mass and the conditi of circulation of the liquor have to be reckoned w as factors. It was therefore important to carry the SO_2Aq digestion under mill conditions (7-t digester). The digester with the charge of chi and the complement of solution prepared by absorb SO_2 blown off from bisulphite digesters in w (7·1% SO_2) was kept under close observation dur the digestion (28 hours), the results of analy (blow-off samples) at 2 hour intervals being record for future comparisons.

The pulping effects were satisfactory: the wh charge was finished through the mill operatio there were no "screenings"; the finished sheets from the dryers were of good fibre qual the colour, however, was low and in bleaching consumption of "chlorine" was outside the econ limit.

Series 51–63.—Reverting to the laboratory co tions, the pulp produced under the optimum co tions previously determined was washed and retn to the digester for short treatment with ne sodium sulphite (varied from 0·1 to 5·0% Na 2 hours up to 140°. Determination of yields showed a progressive reduction from 47·5 to 41·5%; with, however, an increased resistance to the mercerising test (17·5% NaOH), viz., from 91·5 to 93·2.

The degree of purification of the cellulose, however, was still unsatisfactory.

A mixed process (*a*) with the aqueous acid, (*b*) with the neutral sulphite (Na_2SO_3), carried out as above but without washing the pulp, gave similar resu with no advance in the degree of purification of cellulose.

Series 63–70.—Observations were made to dete mine the influence of the degree of subdivision of t wood substance; *e.g.*, "mechanical wood pulp" (

round spruce), (2) graded saw dust, and (3) wood neal. In these forms the attack extended in a very iarked degree to the cellulose, without facilitating ie specific lignone reaction of sulphonation. The sults are of some theoretical importance in regard the constitution of the lignocellulose complex; the iarked change of reaction relationship to the acid etermined by mechanical subdivision is a new point f evidence of a physically constituted lignocellulose.

In regard to the practical purpose of a pulping rocess it is clear that the standard form of "chips" he optimum mechanical preparation of the wood. n the meantime a special digester of 1·8 cb. m. city constructed on the exact plan of the 7–15 ton sters . the mill had been installed. With ges 300 kg. of spruce chips the scale of operas ished a close comparison in regard to the and reaction in the digester, with the results ordinary mill process. In a series of operations, y followed by way of control analysis of blow-off es (liquor and pulp), the working advantages and tions of the process have been exactly defined.

important result of the change of condition the laboratory digester—of small capacity, lined, and with no circulation of the digestion r, was the small observed increase in the SO_4 uced. This was from the 0·0 (by treatment of liquors) to 1·0—1·3 g. per litre; whereas in the ratory process the increases, always a multiple e above, reached in some cases 8·5 g. per litre.

e actual mode of action of sulphuric acid involves mber of factors which require investigation; as the textbooks are satisfied with comprehenut loose descriptions of effects, ascribed to the out without such investigation (*supra*).

improvement in regard to this factor no doubt buted to the general improvement of the s as a pulping process, over the laboratory

improvement was confirmed by further operan the mill digesters of 7 tons capacity.

in the close study of the operations on the d scale we were able to define a point or phase marked a limit of reaction, and at the same time oduce a new factor of reaction, which has ined another and more favourable attack from

above brief outline of systematic research s by implication the logical steps of develop- the present position of controlled treatment process.

sults of the further investigations of the and the process in terms of products (cellu- lignone derivatives) are, however, reserved ater communication.

the pleasant duty of acknowledging the collaboration of Dr. B. Berbom, we would that he has been personally responsible for the us work of the programme of laboratory rch outlined in the paper.

e also acknowledge the efficient work of Mr. E. hrystall in the above, and in the investigations ded in the following paper.

The above researches planned in 1921 were started in February, 1922, and represent an important section of the plan of critical revision, for which the Latham Fellowship was instituted.

Since the Fellowship fell vacant in 1923, Mr. Hall was appointed, and as Dr. Dorée offered to associate himself with the research work, it was a favourable opportunity for extending the investigations of the constitution of lignocelluloses in which we have been associated (Cross and Dorée, "Researches on Cellulose," IV., 1922).

The work recorded in the following paper is a worthy fulfilment of the purpose of the Fellowship.

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THE LIGNOSULPHONIC ACID OBTAINED BY THE ACTION OF SULPHUROUS ACID ON SPRUCE WOOD.

BY CHARLES DORÉE AND LESLIE HALL (*Latham Fellow*, 1923-24.)

In the ordinary bisulphite process the wood is resolved by the action of calcium bisulphite at 110° 150° the lignone appearing in solution as a calcium lignosulphonate, but it has hitherto not been considered possible to effect a satisfactory resolution with sulphurous acid alone unless a certain proportion of a base is present. In fact, it is generally held that the basic oxide (CaO, MgO, Na_2O) is the determining factor of the sulphonation reaction.

A process has, however, recently been developed under the patents of C. F. Cross and A. Engelstad (E.P. 12,943, 1922), in which spruce wood is heated with a 7% solution of sulphurous acid, previously freed from sulphuric acid, at 100°—110°, with satisfactory results. The patent relates chiefly to the specific characteristics of the by-product liquor and of its main constituent, which offer advantages in respect of technical industrial applications. The matter was prosecuted in these directions only after it had been established that the main reaction in the digestion process is a sulphonation of the lignone complex, a fact which is in opposition to the categorical statements of leading authorities.

The low temperature of the digestion (below 110°), and the apparent simplicity of this method of resolution, led us to hope that the free lignosulphonic acid thus obtained would afford a simple and less condensed material for an investigation into the nature and constitution of wood lignone than the complex by-product of the bisulphite processes upon which all previous work has been done. The results obtained are given in the present paper.

The new liquor, on preliminary investigation, was found to differ from calcium bisulphite liquor in its tanning qualities and in its capacity to form gels. It may be mentioned that in addition to the lignosulphonic acid, or its salts, both dextrinous and

sugar substances, organic acids and, in the case of the new liquor, considerable quantities of free sulphuric acid are present.

It might be argued, as has been done by Wislicenus (Koll.-Z., 1920, 27, 209), that the lignone constituent isolated from the lignocelluloses in this way, or by digestion with sodium hydroxide, as for example with the straw lignin of Beckmann, Liesche, and Lehmann (Z. angew. Chem., 1921, 34, 285), and the flax lignin of Powell and Whittaker (J. Chem. Soc., 1924, 125, 35) could not, considering the complexity of the plant substance, ever be homogeneous. In all these cases, however, a product has been obtained which, after such purification as is possible, passes through a series of chemical changes apparently as a definite compound. The composition of the various lignosulphonic acids obtained by different workers varies considerably, however, as shown in the following table.—

Table I.

	Composition of the sulphonic compound	Number of methoxyl groupings
Lindsay and Tollens, Annalen, 1892, **267**, 341.	$C_{26}H_{30}O_{12}S$	2
Seidel, Mitt. Techn. Gew. Mus., 1897, **7**, 119.	$C_{26}H_{30}O_{12}S$	2
Streeb, Diss., Gottingen, 1892	$C_{36}H_{48}O_{22}S_{2}Ba$ ..	3
Klason, Ark. Kem., Min. Geol., 1908, **3**, No. 5, 1	$C_{40}H_{44}O_{17}S_{2}Ba$.	ca. 1
	$C_{40}H_{44}O_{17}S_{2}Ba$ ..	ca. 4
Melander, Cellulose-chem., 1921, **2**, 41, 69.	$C_{21}H_{27}O_{11}SNa$	
	$C_{21}H_{27}O_{10}SNa$	
	$C_{21}H_{20}O_{11}SNa$	
	$C_{21}H_{25}O_{11}SNa$	
Honig and Fuchs, Monatsh., 1918, **39**, 1.	$C_{45}H_{50}O_{18}S\ Ba$ ..	4
	$C_{40}H_{44}O_{17}S_{2}Ba$ ..	1
	$C_{74}H_{114}O_{49}S_{2}Ba$ ..	3
Konig, Cellulose-chem., 1921, **2**, 105. ..	$C_{36}H_{40}O_{22}S_{4}Ba$	

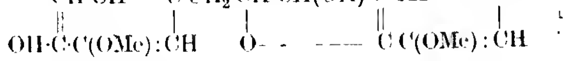
The usual methods of purification employed with calcium bisulphite liquors consist in fractional precipitation with sulphuric acid, or with salt solutions, fractionation of the barium salts, etc.

Taking advantage of the colloidal character of lignosulphonic acid, we employed for the preliminary purification of the sulphurous acid liquor and isolation of the main by-product, a prolonged dialysis whereby some 40% of the total solids present were removed and a lignosulphonic acid free from sulphuric acid, hexoses, and pentosans was obtained, completely water-soluble, if dried at 40° (see p. 260 T). The acid after fractionation had the unit formula $C_{26}H_{30}O_{12}S$, two methoxyl groupings being present. This C_{26} unit persisted throughout a series of transformations.

As will be seen from Table I., this composition agrees with the old formula of Lindsay and Tollens, but differs from the modern ones. The difference, however, lies chiefly in the lower percentage content of sulphur, viz., 5·5 as against approximately 7·3% (Klason). A portion of the sulphur in these acids is stated by Melander to be combined as sulphite ester. In accordance with this the purified acid used by us on reduction with zinc and hydrochloric acid yielded 7% of the total sulphur present as hydrogen sulphide. If this be taken as a measure of sulphite ester its amount is therefore not great.

Klason has stated (Ber., 1920, 53, [B], 1864) that the calcium bisulphite liquors contain sulphonates of an α-lignin $C_{20}H_{20}O_{6}$ (aldehyde) and a β-lignin $C_{19}H_{18}O_{7}$ (acid). Pine lignosulphonic acid was found to consist approximately of 60% of α- and 40% of the β-compound. These were separated by utilising the capacity of the α-lignin to form an insoluble compound with β-naphthylamine. In repeating this method of fractionation on a large scale with the acid $C_{26}H_{30}O_{12}S$, we found that at least 96% reacted as α-lignin, which is additional evidence of the homogeneity of the acid obtained by the new process, and points to some resemblance in properties to α-lignin. If the sulphonic derivative of $C_{20}H_{20}O_{6}$ be assumed to be $C_{20}H_{22}O_{9}S$, this formula would become, calculated on a C_{26} unit $C_{26}H_{29}O_{12}S_{1\cdot3}$ as compared with the $C_{26}H_{30}O_{12}S$ found by us.

We have thus to take into account Klason's constitutional formula for α-lignin, which is derived from the supposed condensation of two molecules of coniferyl aldehyde to a compound of the following structure:—



which it will be noted is of purely aromatic type.

In attempting further to connect the C_{26} acid with derivatives previously obtained, we recall the action of baryta water on the barium salt obtained from bisulphite liquor, studied by Honig and Fuchs (Monatsh., 1920, 41, 215). A number of new barium salts were formed which were insoluble in water, and of complicated composition, but in addition there was isolated one characteristic soluble barium salt possessing marked tanning qualities, the yields varying from 30 to 90% of the total. The atomic ratio of Ba to S in this salt was 1 : In repeating this experiment on the C_{26} acid we obtained a similar soluble barium salt, but the yield was only 11% and the atomic ratio Ba to S approximately 2 : 1 (see p. 261 T).

We may summarise the results obtained from examination of the reactions and derivatives of acid $C_{26}H_{30}O_{12}S$ described in the experimental in the following formula:—

$C_{21}H_{15}O_{2}(SO_{3}H)(OH)_{2}(CH_{2}OH)(CHOH)(CHO)($

The probable presence in the complex of the groups shown, enables the whole of the oxygen present be accounted for with the exception of two a which in the light of previous evidence may w present in a pyrone nucleus.

In the further investigation of the by-prod regard to constitution useful results were obt from a study of the action of dilute n Previous work has shown that lignin reacts wit nitric acid. Thus Oeman (E.P. 103,651, 1917) b oxidation of bisulphite liquors found that a substanc containing nitrogen was precipitated which could b used for dyestuff purposes. Powell and Whittake (J. Chem. Soc., 1924, 125, 359) state that flax ligni (isolated by means of caustic soda solution) whe treated with concentrated nitric and sulphuric acid at 0°, gave a nitro compound soluble in alcoho and acetone. Extensive oxidation took place eve at this temperature, the empirical change bein represented by the transformation of the ligni $C_{45}H_{48}O_{16}$, into $C_{42}H_{39}O_{22}N_{3}$. The original ligni

ntained four methoxyl and five hydroxyl group-gs, whereas the nitro compound contained three ethoxyl and six hydroxyl groupings.

Fischer and Schrader (Ges. Abh. Kennt. Kohle, 21, 6, 279), again, using 5N nitric acid and lignin lated by Willstatter's method, obtained a nitro mpound $C_{32}H_{37}O_{21}N_3$, containing 3 methoxyl groups, hydrogen atoms which could be titrated against kali, and 4 hydroxyl groups capable of acetylation. The dialysed acid $C_{26}H_{30}O_{12}S$ when heated on the ater bath with a 5% solution of nitric acid was gorously attacked, a clear red solution resulting. he sulphonic acid grouping was converted entirely to sulphuric acid. After dialysis to remove ineral acids the solution yielded an orange powder the composition $C_{26}H_{30}O_{18}N_2$ containing one ethoxyl grouping This substance was acidic, acting with barium carbonate to give a salt $_{26}H_{28}O_{18}N_2Ba$, and the presence of a carbonyl rouping was shown by its ability to condense with ne molecule of phenylhydrazine, although the action was to some extent abnormal in that three olecules of water were apparently eliminated:—

$$C_{26}H_{30}O_{18}N_2 + C_6H_5N_2H_3 = C_{32}H_{32}N_4O_{15} + 3H_2O$$

similar reaction, however, takes place between polyhydroxycaramelan $C_{21}H_{28}O_{10}(OH)_8$ (Dorée Cunningham, Chem. Soc. Trans., 1917, 111, 589) phenylhydrazine, three or more molecules of er being eliminated during the condensation.

he results of our experiments with this nitro pound, described later, enable us to infer to e extent the nature of the changes that have n place during the action of nitric acid:—

$$C_{21}H_{15}O_2\left\{\begin{array}{l}SO_3H\\(OH)_2\\CHOH\\CHO\\CH_2OH\\(OCH_3)_2\end{array}\right. \xrightarrow[\text{nitric acid}]{5\%} C_{22}H_{22}O_5\left\{\begin{array}{l}(NO_2)_2\\(OH)_3\\CO\\COOH\\COOH\\OCH_3\end{array}\right. \xrightarrow[\text{nitric acid}]{32\%} C_{20}H_{24}O_{12}\left\{\begin{array}{l}(NO_2)_2\\(COOH)_6\end{array}\right.$$

Lignosulphonic acid $C_{26}H_{30}O_{12}S$. II. Nitro compound $C_{26}H_{30}O_{18}N_2$. III. Nitro compound $C_{20}H_{30}O_{28}N_2$.

carbon grouping in the nitro compound (II.) nsider arises from the presence of a CHOH ing in the original lignin (I.), the aldehyde ng of which is oxidised to carboxyl. The carboxyl probably arises from a primary lic group The loss of a methoxyl grouping oxidation with nitric acid is difficult to n It may be due to the presence of the ing CH(OH)OMe which on oxidation would give formic acid with the loss of one atom of carbon. This loss apparently did not take place in the case of the nitro derivative. A similar change in the number of methoxyl groups in the complex was observed both by Fischer and Schrader and by Powell and Whittaker.

The special reactions of the nitro groupings present in the compound $C_{26}H_{30}O_{18}N_2$, given below, enable conclusions to be drawn as to their character and throw some light on the constitution of lignone itself:—

1. The compound gave a deep red colour with alkalis and on heating with these evolved ammonia, although only some 30% of the nitrogen present was actually obtained in this form.

2. On treatment with benzoyl chloride and alkali in the usual way a benzoyl derivative $C_{47}H_{44}O_{17}$ was obtained, the nitrogen atoms being removed in the process and two hydrogen atoms added:—

$$C_{26}H_{30}O_{18}N_2 \rightarrow C_{26}H_{29}(C_7H_5O)_3O_{14}.$$

3. On reduction with zinc and hydrochloric acid a nitrogen-free ketone $C_{25}H_{28}O_{17}$ was formed containing an additional carbonyl grouping for each nitrogen atom eliminated:—

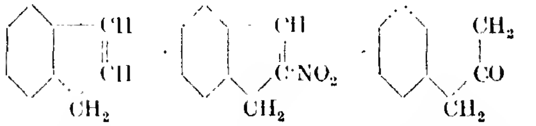
$$C_{25}H_{30}O_{13}(CO)(NO_2)_2 \rightarrow C_{23}H_{28}O_{11}(CO)_3.$$

A remarkable insoluble zinc compound was formed as an intermediate product in this reduction.

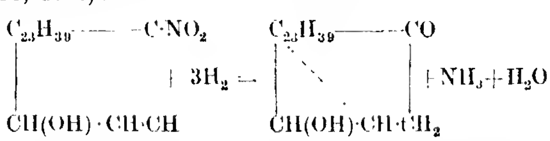
The ready nitration of lignin under the action of 32% nitric acid has led Fischer and Schrader to infer the presence of phenolic nuclei in the lignin complex, though no evidence is brought forward as to the aromatic character of the nitro groupings in the compounds obtained by them.

The properties of the nitro compound (II.) just described lend no support to the assumption of benzenoid rings in the lignin complex.

The reactions recall rather the observations of Wallach (Annalen, 1904, 336, 1; 1905, 340, 1, etc.), Pesci (Gazzetta, 1886, 16, 227), Wieland (Ber., 1903, 36, 2558), and others on the action of nitrous gases on unsaturated terpenes, whereby, by the elimination of nitrous acid, unsaturated nitro compounds are formed. These on reduction yield saturated ketones. Isosafrol, methyleugenol, α- and β-phellandrene, and indene, for example, behave in this way. Indene gives β-hydrindone thus:—



and the complex terpene cholesterol $C_{27}H_{46}O$ treated with concentrated nitric acid in the presence of glacial acetic acid gives a nitro compound which on reduction with zinc and acid passes to the saturated ketone dehydrocholestanonol (Windaus, Ber., 1903, 36, 3754):—



The resemblance disclosed by these observations to the nitrogen-containing substance from lignone

is striking and leads us to infer that the double linkings which are points of reactive activity in lignone are situated in reduced (hydroaromatic) rings.

The explanation we put forward of the changes observed is as follows:—Lignin as it exists in wood is a substance resembling in its properties the α-lignin $C_{20}H_{20}O_6$ of Klason. It is possible that the β-lignin, always found in the calcium bisulphite liquors, is a derived product formed from lignin during the cooking process. Its absence from the sulphurous acid liquors may be accounted for by the generally milder conditions employed in this process. The lignin complex

$$C_{21}H_{15}O_2(SO_3H)(OH)_2(CHOH)\cdot(CH_2OH)(CHO)\cdot(OMe)_2$$

contains in the nucleus hydroaromatic rings in one, or two, of which the two unsaturated linkages are situated. During cooking one of these is saturated by the sulphurous acid probably $-CH:CH-$ becoming $-CH_2\cdot CH(SO_3H)$. This conditions the removal of lignin as a lignosulphonic acid.

On oxidation by dilute nitric acid the sulphonic group is removed as sulphuric acid and at this linkage, and by a change similar to that observed with the unsaturated terpenes, the conversion from sulphonic acid to nitro-derivative and from this, by reduction, to a saturated ketone takes place as follows:—

$$\cdot C(SO_3H)\cdot CH_2\cdot \rightarrow \cdot C(NO_2):CH\cdot \rightarrow \cdot CO\cdot CH_2\cdot$$

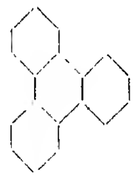
The lignosulphonic acid showed great stability when oxidised by more concentrated nitric acid. With acid of *d* 1·5 a violent reaction set in with the production of oxalic acid in fairly large amount. A considerable proportion of the organic matter present (some 20%), however, was converted into an acid (III.) $C_{26}H_{30}O_{28}N_2$. This product was obtained in better yield by using acid of 32% concentration (5*N*).

The survival of the C_{26} unit points to a great stability of the lignone complex, recalling that of the complex terpenes of the cholesterol series and may be held to support the argument for a complex hydroaromatic nucleus. Oxalic acid also is not uncommonly formed from hydroaromatic compounds on oxidation, as, for example, in the case of quercitol.

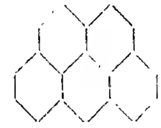
The remarkably high percentage of oxygen present in this nitro-acid makes it difficult to give any theory as to constitution. We have made many preparations of the substance, and also converted it from one salt to the acid and to other salts, but in every case the empirical composition remained unaltered, so that we can merely note this very unusual composition.

The reactions of this nitro-acid (III.) correspond to a formula $C_{20}H_{24}O_{12}(COOH)_6(NO_2)_2$. The nuclear C_{20}, together with the evidence just cited, recalls the constitution suggested for lignin (Z. angew. Chem., 1923, **36**, 149) by W. Schrauth, who regards it as based upon a reduced benzophenanthrene derivative $C_{18}H_{30}$ (IV.).

Schrauth demonstrates that by the condensation of three molecules of 5-hydroxymethylfurfuraldehyde a derivative of (IV.) containing two methoxy groupings could be formed. Two such units linking together give a C_{40} unit which is identical in composition with products isolated from lignin by Fischer, Klason, and others.



(IV.)



(V.)

Our results are in agreement with the general conclusion as to the presence of hydroaromatic ring systems in the lignone complex, of a stability recalling those of the complex terpenes of the cholesterol group; but the connecting oxygen atoms involved in Schrauth's formula do not make for stability, and we have been able to account for the oxygen atoms of the C_{26} unit acid in other ways. A ring system such as (V.) would be in better agreement with our results.

EXPERIMENTAL.

The material used in this research was the concentrated liquor from the process described in E.P. 12,943, 1922, containing therefore the lignone and other components of the non-cellulose of the coniferous wood. Analysis of a particular specimen gave the following figures: Total solids, 30·5; ash, 1·3; free sulphuric acid, 3·8%. The liquor possessed a slight odour of sulphur dioxide and furfural.

Comparison of the properties of the new product liquor with one from the calcium bisulphite process, each concentrated to 34% total solids:

	7% SO_2	Calcium bisulphite
1. Nature of the solids	Not hygroscopic	Not hygrosco.
2. Total solids left after dialysis (one day)	63·7% ..	64·2%
3. 10 g. liquor with 10 g. conc. hydrochloric acid	Ppt. at once ..	Ppt. after 5
4. 5 g. liquor with 10 g. glacial acetic acid	No ppt. ..	Completely
5. 10 g. liquor with 30 g. alcohol ..	No ppt. .	Completely
6. 10 g. liquor with 10 g. saturated brine	Thickened and pptd. after 15 minutes. ..	No change.

Isolation of the lignosulphonic acid, $C_{26}H_{30}O_1$

The liquor was diluted with water and subjected to dialysis in cellulose parchment bags for a week, during which time the whole of the sulphuric acid and the sugars were removed. The dialysed solution was then evaporated to dryness, the solids being kept below 50°: dried at higher temperatures °–10 they became insoluble in water. The acid formed a brown, non-deliquescent powder, freely soluble in water and alcohol-water mixtures, but insoluble in ether, in 96% alcohol, and in other organic solvents.

Specimens of the acid obtained by fractionation with ether from aqueous alcoholic solution gave on analysis*: C = 55·1, H = 5·5, S = 5·5, OMe = 11·3%.

* NOTE.—The analytical figures given in this paper are calculated on ash-free substance. It should be mentioned that the ash in many of the preparations was high, varying from 6% in the original purified acid to 1% in some of the derivatives. It consisted largely of silica derived from the lining of a new digester and was retained with great persistency through many chemical changes.

$C_{24}H_{24}SO_{10}(OMe)_2$ requires C = 55·1, H = 5·3, S = 5·6, OMe = 11·0%.

The acid gave 1·2% of furfuraldehyde on distillation with 12% hydrochloric acid.

Reduction of the lignosulphonic acid with zinc and acids.—A hot 10% solution of lignosulphonic acid was treated with zinc dust and dilute acid (acetic or hydrochloric) until the evolution of hydrogen sulphide had ceased. The solution was filtered, dialysed to remove salts, and then evaporated to dryness as described above. The product still contained 5·2% of sulphur, that is at most 7% of the combined sulphur was removed by this treatment.

The barium salt of lignosulphonic acid.—A 10% solution of lignosulphonic acid was boiled with excess of barium carbonate. After standing, the solution was decanted into a tall cylinder, the last traces of the carbonate allowed to deposit, and the barium salt precipitated in four fractions by means of alcohol. Each fraction was dried at 100° before analysis. The following results were obtained :—

Fraction.	Yield, %.	S, %.	Ba, %.
1	63	4·8	7·7
2	13	4·9	8·1
3	13	5·1	7·0
4	3	5·2	4·7
Calc. for $C_{42}H_{46}S_2O_{24}Ba$,		S = 5·1	Ba = 10·9

he residual liquid on evaporation to dryness gave rther quantity of a light brownish-yellow powder, aining barium, very soluble in water and alcohol önig and Fuchs (Monatsh., 1920, **41**, 215) treated lution of the barium salt of lignosulphonic acid the bisulphite process with baryta water and ined a very characteristic soluble barium salt to h they gave the formula $C_{18}H_{30}O_{10}SBa$.

n repeating the preparation using 50 g. of the 5·4 g. of soluble barium salt were obtained, h, as regards qualitative tests, resembled the aration of Hönig and Fuchs, but analysis gave 23·9, S = 2·9%, whence Ba : S = 1·92, whereas g and Fuchs found for three different preparations Ba : S = 0·97, 0·89, and 0·87.

β-naphthylamine compound of the lignosulphonic Klason (Ber., 1920, **53**, [B], 706) found that solution of calcium lignosulphonate is treated ne of β-naphthylamine hydrochloride a conion product is precipitated to which he ascribed rmula

$$C_{18}H_{19}O_5\cdot CH\begin{cases} SO_2\cdot O \\ \quad\quad | \\ CH \quad NHC_{10}H_7 \end{cases}.$$

g the acid C_{26}, an almost quantitative yield of a pound was obtained, containing S = 4·6, N 1%, $C_{26}H_{30}SO_{12}.C_{10}H_9N$ requires S = 4·5, N = 2·0; $C_{26}H_{30}SO_{12}.C_{10}H_9N - H_2O$ requires S = 4·6, N = 2·0. It was decomposed by caustic alkalis and by yridine with the liberation of β-naphthylamine, and ppears therefore to be a simple salt (*cf.* Hintikka, ellulosechem., 1923, **4**, 93).

The benzoate of the lignosulphonic acid.—5 g. of gnosulphonic acid were dissolved in 80 c.c. of 10% odium hydroxide solution and treated with 18 g. of enzoyl chloride in the usual way. The reaction roduct was poured into water, and the solid which parated, after washing, was dried in a vacuum at 40°. The benzoate formed a light brown powder, insoluble in water and alcohol and slightly soluble in pyridine. The result of the analysis agreed with the presence of three or four hydroxyl groups. Found C = 65·0, H = 5·6, S = 3·0%. $C_{26}H_{27}SO_{12}.3(C_7H_5O)$ requires C = 64·7, H = 4·8, S = 3·6%. $C_{26}H_{26}SO_{12}.4(C_7H_5O)$ requires C = 66·0, H = 4·7, S = 3·3%.

Attempts to prepare the corresponding acetate were unsuccessful, since sulphur dioxide was evolved in some quantity on treatment of the lignosulphonic acid with acetylating agents.

The bromine derivative of the lignosulphonic acid.—10 g. were dissolved in a mixture of 20 c.c. of water and 60 c.c. of glacial acetic acid. An excess of bromine in acetic acid was then added with cooling. Some hydrobromic acid was evolved. The product was poured into ether, the light yellowish precipitate washed with ether to remove acetic acid and then dried in a vacuum at the ordinary temperature. Found S = 3·6, Br = 26·7%, Br/S = 2·9. $C_{26}H_{29}SO_{12}Br_3$ requires S = 4·0, Br = 29·8%.

The phenylhydrazine derivative of the lignosulphonic acid $C_{26}H_{30}O_{11}S(N_2H\cdot C_6H_5)$. 5 g. of lignosulphonic acid dissolved in 30 c.c. of water were added to a solution containing 5 g. of phenylhydrazine, 2·5 g. of acetic acid, and 6·5 g. of sodium acetate in 30 c.c. of water. An abundant red-brown precipitate was formed at once, which after standing was filtered off, washed, and dried in a vacuum. Found C = 59·1, H = 5·9, N = 4·3, S = 4·5%. $C_{32}H_{36}O_{11}N_2S$ requires C = 58·5, H = 5·5, N = 4·3, S = 4·9%.

The presence of one reactive carbonyl group per 26 carbon atoms thus indicated was approximately confirmed by oxidation of the acid with Fehling's solution. 0·2913 g. of acid gave 0·1000 g. of cupric oxide; whence CHO = 6·3%. $C_{25}H_{29}SO_{11}CHO$ requires CHO = 5·1%.

The action of oxidising agents on lignosulphonic acid. (i) *Nitric acid (5% concentration). Nitro compound A.* $C_{25}H_{27}N_2O_{17}(OCH_3)$.

One part of lignosulphonic acid was heated on the water bath with 20 parts of 5% nitric acid. After a few minutes a vigorous reaction set in with foaming. The heating was continued for four hours, after which the bright red liquid was dialysed for one day to remove the sulphuric acid formed, and excess of nitric acid. On evaporation a light orange non-deliquescent powder remained. Yield 60% of the original acid. The compound was very soluble in water, but insoluble in pure organic solvents. With dilute aqueous alkalis it gave a deep red solution, which on warming evolved ammonia in some quantity.

For analysis it was dried at 50° in a vacuum. Found C = 47·4, H = 4·6, N = 4·2, OMe = 4·4%. $C_{25}H_{27}N_2O_{17}(OCH_3)$ requires C = 47·4, H = 4·6, N = 4·3, OMe = 4·7%.

This nitro compound dialysed much more rapidly than the original acid. It was completely precipitated from solution by gelatin and gave reddish-brown precipitates with salts of the heavy metals and the alkaloids. It was also precipitated from aqueous solution by the addition of excess of a mineral acid.

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The barium salt, which is soluble in water, was prepared as follows: A solution of 1·4 g. of the nitro compound A in 20 c.c. of water was heated on the water bath with excess of barium carbonate. No ammonia was evolved. The filtrate containing the barium salt was precipitated by alcohol and the brownish-red precipitate dried at 100°. Found Ba 17·9%. $C_{26}H_{28}N_2O_{18}Ba$ requires Ba 17·3%.

When a solution of this barium salt was treated with baryta water, a light brown precipitate was formed, and on heating on the water bath, ammonia was slowly evolved. The precipitate was readily soluble in acids.

Distillation of the nitro compound A with caustic soda solution.—A weighed quantity of the compound was distilled with $N/2$ sodium hydroxide solution, the distillate being collected in standard acid. The result indicated that 29% of the nitrogen present was evolved in the form of ammonia.

Phenylhydrazine derivative, $C_{32}H_{32}N_4O_{15}$. This substance was prepared as in the case of the corresponding derivative of lignosulphonic acid. It formed a dark red powder insoluble in water and alcohol. Found C 53·9, H 5·3, N 8·1%. $C_{32}H_{32}N_4O_{15}$ requires C = 53·9, H = 4·5, N 7·9% i.e., $C_{26}H_{30}N_2O_{18}$ + $C_6H_5NH.NH_2$ = $C_{32}H_{32}N_4O_{15}$ + $3H_2O$.

Benzoylation of the nitro compound A.—The nitro compound was treated with benzoyl chloride and caustic soda in the usual way. The product formed a yellowish-white powder, insoluble in solvents, and was nitrogen free. On heating it softened at 80°, but did not show any definite melting point. The analysis points to a tribenzoyl derivative.

Found C = 64·4, H 5·5%. $C_{47}H_{44}O_{17}$ requires C = 64·1, H 5·0%.

These figures indicate a substitution of 3 hydrogen atoms by benzoyl groupings accompanied by loss of N_2O_4 and probable addition of 2 hydrogen atoms in their place.

$$C_{26}H_{30}O_{18}N_2 \longrightarrow C_{26}H_{29}O_{14}(C_7H_5O)_3 + N_2O_4.$$

Reduction of the nitro compound A.—A solution of the compound acidified with hydrochloric acid was treated with zinc dust and the mixture heated on a water bath. A dark brown precipitate rapidly formed and the reduction was allowed to continue until no further precipitate was formed. The liquid, together with the precipitate, was then poured off from the excess of zinc into a tall cylinder and the precipitate washed with acidified water by decantation until the washings were colourless. The residue (which was found to contain 26% of zinc), was dissolved in $N/2$ caustic soda and made acid with hydrochloric acid. The voluminous precipitate produced was filtered off, washed, dried at 50° and finally in a vacuum. In this way, the reduction product was obtained as a dark brown powder free from nitrogen and zinc, insoluble in water, acids, and organic solvents, but readily soluble in alkalis and sodium bisulphite to a red solution.

Found C = 50·5, H 4·6%. $C_{26}H_{28}O_{17}$ requires C = 50·9, H = 4·6%.

Preparation of phenylhydrazine derivative of above reduced compound.—In order to prepare the phenylhydrazine derivative from this compound, 2·3 g. were dissolved in a 5% solution of sodium bisulphite, and to the resultant solution 4 g. of phenylhydrazine and 5 g. of sodium acetate dissolved in 60 c.c. of 20% acetic acid were added. After standing, the red-brown precipitate was filtered off, washed with dilute acetic acid and then with water, and then dried first on a plate and finally in a vacuum. The phenylhydrazone (wt. 1·25 g.) contained only a trace of sulphur.

Found N = 9·5%. Calc. for $C_{41}H_{46}O_{14}N_6$, N = 9·5%.

(ii) *The action of 32% nitric acid on lignosulphonic acid. Isolation of an acid* $C_{20}H_{24}N_2O_{16}(COOH)_6$.

When 40 g. of lignosulphonic acid were treated with 200 c.c. of 32% nitric acid, the mixture became warm and nitrous gases were evolved with foaming. After heating for two hours on the water bath the excess of nitric acid was removed by repeated evaporation with water. On cooling, the red liquid was separated from crystals of oxalic acid which had formed and neutralised with barium carbonate. The filtrate (230 c.c.) contained the soluble barium salt, which was separated into four fractions.

Fraction 1 was deposited on allowing the solution to stand. Fractions 2 and 3 were obtained by the successive addition of 20 and 60 c.c. of alcohol. Fraction 4 consisted of the residue obtained by evaporating the final filtrate to dryness.

These fractions were dried in a vacuum and analysis gave the following figures:—

Fraction.	Yield, g.	Found. N, %.	Found. Ba, %.
1	3 3	2 12	34 7
2	3 8	2 10	31 3
3	4·7	2 03	30 6
4	4 8	—	25 1

Fraction 2 gave on analysis C = 25·3, H = 2·[illegible] Calc. for $C_{26}H_{24}N_2O_{28}Ba_3$, C = 25·5, H = 2·0, N = 2·3, Ba = 33·6%.

The reactions of the barium salt fraction 2 were as follows:—

1. With solutions of lead, iron, mercurous, [illegible] brucine, and β-naphthylamine salts yellowish-[illegible] precipitates were obtained.
2. Warmed with caustic soda, ammonia evolved.
3. On treatment with zinc and hydrochloric [illegible] the red colour of the solution changed to y[illegible] but on boiling and allowing the product to stand reverted to the original colour.
4. On fusion with caustic potash oxalic acid [illegible] produced in some quantity, but no evidence for production of aromatic compounds could be obtained.
5. A cold alkaline solution of potassium permanganate effected complete oxidation to oxalic acid.

Preparation of the free nitro-acid $C_{26}H_{30}N_2O_{28}$.—The barium salt was dissolved in water and treated with the calculated quantity of sulphuric acid and the filtrate evaporated to dryness. The product formed a dark red, very deliquescent powder, which was dried at 40° and in a vacuum. Found C = 38·3, H = 3·7%. Calc. for $C_{26}H_{30}N_2O_{28}$, C = 38·1, H = 3·6%.

The lead salt was prepared from the free acid by the addition of lead acetate acidified with acetic acid.

he light brown precipitate was dried at 95°. It was nly slightly soluble in water or acetic acid. Found Pb = 47·5%. Calc. for $C_{26}H_{24}N_2O_{28}Pb_3$, Pb = 44·1%.

The action of alkaline potassium permanganate nd ozone on lignosulphonic acid under a variety of onditions led only to the production of oxalic acid nd formic acid respectively, no evidence of the ormation of more complex compounds being obained.

We are indebted to Mr. E. R. Chrystall for the llowing results of experiments with chromic acid.

Analysis of sample of liquor employed.—Total lids, 32·8; free sulphuric acid, 4·6; total sulphur, 35; ash, 1·0%.

Four samples of the above liquor were treated with olution of chromic acid equal to 15, 30, 45, and 0% of the lignone solids, diluted so that the final soluion contained 10% of lignone solids. The solutions re kept for two days. The 15% solution remained uid. The 30 and 45% solutions were gelatinous one day and the 60% in two days. The lignone lloid was then dissolved in caustic soda and rated with Fehling's solution.

The same oxidised products were treated with a tion of phenylhydrazine acetate and the products mined.

he hydrazine solution reacted readily in the cold the gelatinised lignone colloid, and after stirring standing overnight became entirely transformed a red-brown powder which could be readily red and washed. It was weighed on a tared and dried at 100°. The hydrazone from the sed lignone did not fuse at this temperature as the corresponding derivative of the untreated ne. The results are recorded in the table given w:—

Solution.	Glucose equivalent of lignone solids. %	Hydrazone % on lignone solids. %	% Cr_2O_3 in the ash.
liquor	86·5	56·3	—
	84·3	98·4	7·7
	61·5	111·0	9·0
	52·0	118·4	13·4
	47·5	144·8	18·4

results are in agreement with those obtained action of nitric acid. The fact that the ty to reduce Fehling's solution steadily falls ncreasing oxidation by chromic acid indicates he aldehydic grouping is being converted to yl, whilst the marked increase in the yield of one confirms the development* of carboxy ngs at first by simple oxidation of a CH(OH) ng, but later probably by the opening up of systems and the production of new points of activity.

Summary and conclusions.

Aqueous sulphurous acid is able to resolve the ferous wood substance giving as the chief nonulosic product a lignosulphonic acid, $C_{26}H_{30}O_{12}S$.

2. This acid differs from those previously obtained from the calcium bisulphite process in containing a lower proportion of sulphur, 5·5 against 7·3%. It shows, however, a general resemblance in properties, *e.g.*, in its reactions with baryta, but the products, though of a similar type, are specifically different.

3. The acid was purified by prolonged dialysis of the by-product liquor and on fractionation by β-naphthylamine, behaved as a homogeneous substance resembling the α-lignosulphonic acid of Klason.

4. A study of the reactions of the acid $C_{26}H_{30}O_{12}S$ has led to the dissected formula $C_{21}H_{19}O_2(SO_3H)(OH)_2(CH_2OH)(CHOH)(CHO)(OCH_3)_2$, in which all the oxygen atoms but two are accounted for.

5. The action of dilute (5%) nitric acid leads (*a*) to the removal of the sulphonic group as sulphuric acid, (*b*) to oxidation of the CH_2OH and the CHO groupings to carboxyl, while the CHOH grouping becomes CO; (*c*) at the same time nitration takes place, resulting in the formation of a nitro compound $C_{26}H_{30}O_{18}N_2$.

6. The reactions of the nitro groups differ entirely from those of, for example, the nitrophenols. Thus on treatment with alkali the nitrogen is removed as ammonia, and on reduction also ammonia is produced and a nitrogen-free ketone $C_{26}H_{28}O_{17}$ is formed, containing three carbonyl groupings, each nitro group having been replaced by carbonyl.

This reaction is well known among the unsaturated terpenes, nitration taking place at the unsaturated linking.

7. Further oxidation with fuming nitric acid or better with acid of 32% concentration, gives oxalic acid, and an acid $C_{26}H_{30}O_{28}N_2$ shown by experiment to be $C_{20}H_{24}O_{12}(COOH)_6(NO_2)_2$.

8. The persistence of the C_{26} unit through all these changes with a resistant nuclear unit of the order of C_{20} leads us to the conclusion that the nucleus of lignone is hydroaromatic in character, consisting of a complex of reduced rings somewhat resembling the reduced benzophenanthrene hydrocarbon obtained by Schrauth (*loc. cit.*). This theory involves the general absence of oxygen linkings, the attachment of the side groups, including the CHO grouping, directly to the carbons of the ring, and the presence of double linkings in the reduced ring, for which evidence has been obtained.

One of us (L. H.) desires to thank the Council of the Society of Chemical Industry and Sir Thomas Latham for his selection as Latham Research Fellow, and for the opportunity of carrying out the above investigation.

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THE MODE OF RETENTION OF NITROGEN IN ELECTRIC ARC WELD METAL.

BY E. J. B. WILLEY, M.Sc.

It has long been known[1] that nitrogenised irons and steels show a decided decrease in ductility, accompanied by a corresponding increase in hardness and tenacity as compared with the normal products of everyday use. Andrew[2] has shown that the

[1] Beilby and Henderson, Chem. Soc. Trans., 1901, **79**, 1250. Braune, Rev. Mét., 1905, **2**, 497.
[2] J. Iron and Steel Inst., 1912, **2**, 210; see also Colver-Glauert, Memoir to Commissioners of the 1851 Exhibition, 1908.

presence of 0·25% of nitrogen causes a total suppression of the critical changes which occur in normal steels, and a profound modification of the mechanical properties of the metal follows as a result of the carbides being kept in solution. As Tschichevski[3] has pointed out, by analogy with phosphorus, nitrogen may be expected to exert some of the deleterious influences so characteristic of the cause of "cold-shortening" etc.

Fortunately the quantity of nitrogen present in irons and steels is usually so small as to be without any apparent effect on the metal, but where it is present in considerable amount it becomes a source of great trouble and is difficult to remove (*cf.* Andrew, *loc. cit.*). The nitrogen, which is invariably found in all welds made by the electric arc process, is believed to be the principal cause, along with oxygen, of the somewhat undesirable characteristics (the brittleness in particular) of the metal thus produced, which have limited greatly the application of an otherwise useful and simple welding process.

Consequently an investigation into the chemistry and physics of the reactions between nitrogen and iron in the electric welding process is likely to provide information of considerable value, both to the pure chemist and to the welder, who is faced with the problem of devising a denitrogeniser for use under ordinary industrial conditions.

The salient facts relating to the combination of nitrogen and iron may first be stated.

(1) Three compounds of nitrogen and iron are known, namely (*a*) ferrous nitride, Fe_4N_2, which was first investigated by Stahlschmidt[4] and more fully by Fowler[5]; (*b*) two compounds of the formulæ Fe_3N_2 and FeN, which are presumably triferrous and triferric substituted ammonias and were obtained by Guntz.[6]

(2) None of these compounds has hitherto been obtained by direct union of the elements in question, and indirect means have always been found necessary. The two compounds prepared by Guntz are very unstable and it does not appear to the author that they need be considered for the purposes of this investigation.

The presence of nitrogen in weld metal, as well as the comparative constancy of the content, is very interesting in view of the facts expressed above, and it is obvious that the conditions are of a somewhat novel nature in view of this circumstance. Andrew, by prolonged heating of iron in nitrogen under great pressure, succeeded in preparing alloys containing 0·30% of the element, but his experimental conditions are obviously not comparable with those obtaining in welding practice. It is difficult to conceive of the nitrogen being in solution in the iron, since Jurisch[7] has shown that the gas is only slightly soluble in iron and that the solubility is proportional to the square root of the gas pressure. Hence it would appear that the nitrogen must definitely be combined with t[he] iron, either as a nitride (in solid solution), or el[se] in some system comprising iron, nitrogen, and oth[er] elements.

Paterson and Blair[8] have published some figur[es] for the nitrogen and oxygen contents of weld metal and they suggest that the nitrogen may be prese[nt] as a result of the exposure of the iron, while molte[n,] to active nitrogen produced by the arc. Von Lepe[l] seems to have had an idea that electrical influence[s,] apart from purely thermal considerations, play [an] extremely important part in the oxidation of nitrog[en] to nitric oxide by the well-known arc process, but [his] views were ignored until the researches of Haber a[nd] his school became recognised. Haber and Koenig working with high-tension alternating-current arc[s,] and Morden,[11] Holwech,[12] and Holwech and Koenig using short direct-current arcs, advanced mu[ch] experimental evidence in favour of the view that [an] active form of nitrogen is formed by passing the g[as] through an arc, and Lowry[14] showed that measurab[le] quantities of oxides of nitrogen were obtained [by] passing nitrogen through an ozoniser and mixing t[he] gas as rapidly as possible with oxygen. The la[st] named advanced much evidence in support of t[he] view that active forms both of nitrogen and oxygen, differing respectively from Strutt's w[ell] known form[15] and ozone, are obtained by the act[ion] of the electric discharge upon the gases in questi[on.] It is to be noticed that Strutt[16] has also obtai[ned] active nitrogen at ordinary pressures.

According to Strutt[16] the production of ac[tive] nitrogen is a function rather of the current den[sity] than of the voltage, and in welding practice the c[on]ditions for its formation may to a certain extent [be] regarded as favourable when the diameter of [the] welding electrode ($\frac{1}{8}$ in. or so) and the cur[rent] conditions (40–50 volts and 100 ampères and o[ver)] are considered.

It does not appear to the author that Pat[erson] and Blair's view (*loc. cit.*) that the nitrogen in [the] metal may be due to the effects of the active gas [on] the molten metal, is likely to be realised whe[n one] considers the effects of the hot metal upon the a[tmos]phere in its vicinity. Convection currents, ow[ing to] the intense heat of the arc and the fluid weld [metal,] will be very pronounced and will tend to carry t[he] gases (which presumably will contain the activat[ed] nitrogen) upwards and away from the metal surfaces, and the transformation of the active vari[ety] to ordinary nitrogen will be very rapid. Probabl[y a] considerable proportion of the activated oxygen a[nd] nitrogen will combine to form oxides of nitrog[en] which, being comparatively stable, may be carri[ed] round again to the surface of the metal and there a[ct] upon it.

[3] J. Iron and Steel Inst., 1915, II., 47.
[4] Pogg. Ann., 1865, **125**, 37.
[5] Chem. Soc. Trans., 1901, **79**, 285.
[6] Compt. rend., 1902, **135**, 738.
[7] Stahl und Eisen, 1914, **34**, 252.

[8] J., 1919, 328T.
[9] Ber., 1903, **36**, 1251.
[10] Z. Elektrochem., 1907, **13**, 725; 1908, **14**, 689.
[11] Trans. Amer. Electrochem. Soc., 1908, **14**, 113.
[12] Z. Elektrochem., 1910, **16**, 369.
[13] *Ibid.*, **16**, 789.
[14] Chem. Soc. Trans., 1912, **101**, 1152. Trans. Faraday Soc., 1913, **9**.
[15] Proc. Roy. Soc., **A**, 1911, **85**, 219, 577; 1911, **86**, 56; 1912, 262; 1912, **87**, 179.
[16] *Ibid.*, **A**, 1916, **92**, 438.

üller and Barek[17] have, however, shown that e oxide is decomposed upon contact with heated ıls, but whether or not the same would apply itrogen peroxide (to which the nitric oxide from the would be oxidised by the air away from the arc f) they do not state.

ı the present research the author has endeavoured eal with the problem by investigating the pro-s obtained when an iron arc is burned in atmos-es of nitrogen and of air. It appeared very able from the outset that iron nitride might be ed in quite appreciable quantities when an iron s burned in nitrogen. The outer zone of the arc e, which consists (in the case of first-class rodes) largely of metallic vapours, would be in act with active nitrogen produced by the arc. se, together with the minute particles of iron tered from the electrodes, might react to give nitride, as stated above. Futhermore, the ection currents would tend to carry the products y from the actual arc zone, thus preventing mposition. This hypothesis was tested in the wing experiments (Fig. 1).

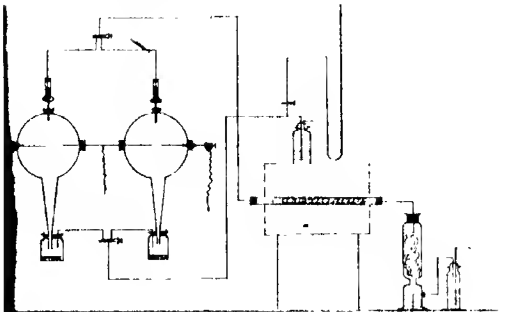

FIG. 1.

rogen from a cylinder was passed through sulphuric acid, up a soda lime-calcium chloride tower, through a furnace which could be d to bright redness and which was packed with lic copper, the stoppers being protected from ng by using a long tube (6ft.) and shielding well asbestos, then *via* the two-way tap to the large way 1500-c.c. bulbs. Small tubes packed with wool were placed on the uppermost tubulures he bulbs to prevent the possibility of small icles of iron being carried up into the gas stream. electrodes were placed horizontally as shown, consisted of No. 8 S.W.G. Armco iron wire 8% Fe). Attached to the long limbs of the s were two bottles containing sand to receive large pieces of iron which fell away by reason he electrodes melting, and the gas was then led y by means of the two-way tap to a Dreschel le containing strong sulphuric acid and thence to osphere. A manometer was also fitted as shown. electrodes were placed in parallel and arranged at the electrode unit had in series a steadying ance, the whole being connected *via* a high-on switch (voltmeter and ammeter leads were taken off appropriately) to the 220-volt D.C. supply. In this way the two arcs could be run in turn, one bulb cooling down while the other was burning, the two-way tap permitting of the necessary diversion of the gas stream. One electrode in each bulb was fixed rigidly by means of a rubber stopper, whilst the other passed through a piece of pressure tubing which fitted tightly into a larger hole in a rubber stopper passed through the tubulure. In this way a gland was obtained which was capable of withstanding pressure up to 9 in mercury and yet permitting of easy manipulation of the iron rod. Ebonite knobs were screwed to the ends of the movable electrodes and terminals sunk in these were attached the leads. The arc could thus be regulated to any desired length. In use, the apparatus was first filled with nitrogen and the gas stream run until no appreciable amounts of oxygen could be found in the issuing gas when examined by the Haldane apparatus. (Oxygen was the chief impurity to be guarded against, as it was particularly desired to secure its absence.) One of the arcs was then struck and allowed to burn in the nitrogen until the bulb became too hot to permit of its being touched by the hand, which usually took about five to seven minutes. This arc was then broken and the second one struck, the taps being turned to direct the gas stream as desired. In the first series of experiments no appreciable rise of pressure was allowed to occur in the apparatus.

The arcs burned well for some time, clouds of fine particles, resembling the motes in a sunbeam, being carried upwards and round to the sides of the bulb adjacent to the electrodes and away from the arc, finally settling on the bulb walls.

No appreciable quantities were carried out in the issuing gas, since only a faint reaction for iron was obtained from the sulphuric acid in the Dreschel bottle even after the arcs had been run for a considerable period. After the electrodes had been in use for about an hour or so they ceased to function well and the arc commenced to hiss and much spluttering took place. When this occurred the experiment was stopped and the electrodes were replaced by fresh ones.

It was found that a steady and satisfactory arc could be obtained by adjusting the resistance and arc length to give a P.D. of about 38—40 volts at the electrode ends and using a current of about 5 amps.

After a sufficient quantity of the deposit had accumulated the apparatus was opened up and the black material from inside brushed out into a weighing bottle, the nitrogen content being subsequently determined by the method described by Hurum and Fay.[18] This in reality differs little from the method advocated by Paterson and Blair (*loc. cit*) for the determination of nitrogen in weld metal, but the excess of acid is determined iodometrically. This obviates the necessity of using methyl orange or methyl red as indicator, both of these being unsatisfactory with dilute solutions such as are employed

anorg. Chem., 1923, **129**, 300.

[18] Chem. and Met. Eng., 1922, **26**, 218.

(*i e.*, $N/20$ acid, $N/50$ alkali or sodium thiosulphate). Prior to the actual analytical work connected with these experiments, a large number of blank determinations were carried out to ascertain what allowance was necessary for the traces of alkali etc. which inevitably pass over into the distillate etc., and Armco iron which had previously been heated to bright redness in a stream of pure hydrogen was employed as the standard metal with which to work. This might reasonably be supposed to be free from nitrogen.

In addition to this, the method was tested thoroughly against ammonium salts and other nitrogen compounds in which the nitrogen can be determined by Kjeldahl's method, and fresh blank determinations were carried out for every new supply of the reagents used.

The black substance collected from the bulb walls was found to contain 0·24% of nitrogen in the first experiments, 0·27% in the second, and 0·25% in the third series. This is very interesting as showing that some absorption of nitrogen by the arc vapours etc. does take place, and steps were forthwith taken to ascertain, as far as was possible, the precise nature of the nitrogen-bearing substance. If the nitrogen be chemically combined with the iron it is difficult to conceive of its being anything but a nitride, but there is always the possibility of its being adsorbed upon the very finely divided deposit.

Upon the substance being boiled for two hours with water in the distillation apparatus, a trace of ammonia only could be detected in the distillate, and upon dissolving the material in the flask and determining the nitrogen as usual, no alteration of the content of this element was found. With alkali in the distillation flask some ammonia was evolved equivalent to 0·064% of nitrogen, and the residual material still contained some nitrogen (0·172%), the sum of the two figures equalling the original value for the nitrogen content (0·236%, found previously 0·24%). Prolonged boiling resulted in the whole of the nitrogen being evolved as ammonia.

When the substance was heated to dull redness for 90 minutes in pure hydrogen, the issuing gases being bubbled through absorption bottles containing a known amount of standard acid, nitrogen amounting to 0·164% was evolved as ammonia, as was shown upon titrating back the acid, and the residual material contained 0·075% nitrogen; since the sum of these two figures equals (within the limits of experimental error) the original figure for the sample used (0·24%), it is to be concluded that no loss of nitrogen as such took place. The whole of the nitrogen was evolved as ammonia upon more prolonged heating.

Upon heating a quantity of the substance under identical conditions in a current of nitrogen, the whole of the nitrogen in the sample was given off, none being found upon analysis of the residue.

These facts are all in accordance with the view t the substance in question consists of a mixture 2% of iron nitride and about 98% of iron. Attem to separate any nitride by means of a magnet fail as did similar efforts based upon the insolubility iron nitride in nitric acid mentioned by Fow (*loc. cit.*). His statement is rather difficult to und stand, since it is the reverse of what would be pected, but he qualifies it by mentioning that concentration of the acid appears to be the m factor to be considered. The quantity of substa available did not permit of elutriation experime being performed.

Further experiments in this direction, are, howev in progress.

The electrodes used in these experiments w examined for nitrogen, but only 0·004 % was fou as the mean of several concordant analyses.

The tips between which the arc had burned w found to contain 0·050% N in one case and 0·06 in another, no difference in the nitrogen conte being detectable between the anode and catho In practice, however, it is very difficult to dec where the "tip" ends and the rest of the electr begins, and this may mask a possible differenc the nitrogen contents of the anode and cathode respectively The presence of nitrogen in the products thus having been established, it was thou that an equilibrium of sorts comprising the sys iron nitrogen-iron nitride might exist in vicinity of the arc, bearing in mind the somew remarkable constancy of the nitrogen conten the product obtained. If this be so, since the mation of the nitride will obviously be accomp by a decrease in the volume of the nitrogen pre an increase in the pressure of the gas should dis the position of equilibrium to a second point co ponding with an increased yield of nitride, acco to Le Chatelier's theorem of mobile equilib Strict equilibrium of the type obtained in classical reactions as the hydrolysis of ethyl ac could not be expected on account of the elect influences present,[19] but the matter was thou worthy of investigation.

Two more series of experiments were there carried out in which the pressure of nitrogen in apparatus was allowed to rise to 4½ and 9 in. mercury respectively, the other experimental det being as before. 0·27% of nitrogen was found the resulting products, thus showing that the incre of pressure does not greatly affect the arc conditi and that the equilibrium is not very sensit This is rather to be anticipated for the reas given above, *i e.*, that true chemical equilibrium hardly to be expected in the cases where electr influences play an important part, and also in v of the comparatively slight pressure employe

[19] Allmand, "Applied Electro-Chemistry," p. 192.

(To be continued.)

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E MODE OF RETENTION OF NITROGEN IN ELECTRIC ARC WELD METAL.

BY E. J. B. WILLEY, M.Sc.

(*Concluded from p.* 266 T.)

ince the foregoing experiments favour the view t activation of the nitrogen is capable of bringing ut chemical combination of the gas and the iron, as thought that pre-activation might conceivably l to greater yields of the nitride, and this accord- ly was put to the test. The purified nitrogen s led by means of the two-way taps to Siemens nisers, approximately 22 cm. in length and placed parallel in the secondary circuit of a spark coil ig a current of 7000 volts and 0·07 amp. The isers communicated directly with the reaction s, since Lowry (*loc. cit.*) has shown that the e nitrogen obtained in this way is unstable in the course of a few seconds reverts to the nary form. For use, the apparatus was filled nitrogen as before and the coil was started. igorous discharge was obtained in the ozonisers the arcs burned well when struck.

he product in the bulbs was collected and nined as before, proving to contain 0·24% of ogen. This would indicate that the activation no effect upon the reactivity of the gas under circumstances of the experiment, and is probably to the extreme rapidity with which the active will be produced by the arc. The transition n the inactive to the active form will be nearly antaneous and hence pre-formation of the latter ety would not be expected to have much effect n the amount finally present. The author is bted to Prof. Briscoe for pointing this out to . The next series of experiments was devoted study of the action, if any, of nitrogen which been activated by passing it through the ozoniser n metallic iron heated to various temperatures. activated gas was led direct to the electric stance furnace which contained a small silica t carrying fine Swedish iron wire which had viously been carefully cleaned by washing with er, then with distilled water, and drying it at ° in the steam oven. The temperatures employed re that of the laboratory and 500° approximately. g. samples were used and the duration of the riments was two hours in each case.

he choice of 500° as the furnace temperature made from the following considerations:—

) The formation of iron nitride has been shown by Fowler (*loc. cit.*) to be a slightly exothermic reaction. Hence in accordance with general principles it may be expected to take place better at lower rather than at higher temperatures.

i) On account of the thermal decomposition of iron nitride mentioned by Fowler, too high a furnace temperature must again be avoided.

(iii) Since chemical reactions tend to increase in velocity with the temperature, too low a temperature must be avoided in this case if there is to be appreciable combination of the elements in question.

(iv) Since activated nitrogen appears to suffer catalytic reversion to the inactive form under the influence of hot surfaces, this must as far as possible be minimised by the use of a moderate temperature.

Hence 500° was chosen as an average temperature at which to work, and it would appear that some indication as to combination or otherwise of the iron and nitrogen should be obtained in a two-hour experiment.

Upon analysis, minute traces of nitrogen only were found and the controls employed (the ozoniser not being run for these, all other things being kept equal) gave the same results. Hence it would appear that activated nitrogen does not combine with iron when the latter is simply heated in the gas in question.

It is necessary, however, to take into consideration the possibility of much reversion of the active gas to the inert taking place owing to the catalytic action of the hot walls of the furnace tube. There is also to be considered the effect of passing the activated gas in its peculiar physical state into the intense magnetic field of the heating coil of the furnace.

A note upon active nitrogen might not be out of place here.

Strutt's method of obtaining it at atmospheric pressure (*loc. cit.*) consists essentially of sparking the gas in a fairly narrow tube, using a jar discharge to give a high current density. He finds that this, rather than voltage, is essential for the production of the gas and that whilst the discharge can produce active nitrogen, it can also destroy it; sparks up to 24 cm. in length appear to be of the maximum efficiency, and beyond that the yield of the active gas falls off rapidly. He has also shown that at low pressures the particular region of the discharge used affects the result to a considerable extent and that under any conditions of pressure a trace of impurity increases the yield.

The above mentioned conditions have been realised in the activating apparatus used by the author. The metallic copper would remove all but traces of oxygen from the nitrogen; the ozonisers used were some 22 cm. in length and the current conditions were also favourable to the formation of the active gas.

In view of the failure to obtain any evidence of nitrogen absorption under the above experimental conditions, it was decided to attack the problem from a slightly different angle.

The apparatus used is shown in Fig. 2. It was desired to produce active nitrogen under the same conditions as those obtaining in the experiments

where arcs were burned in an atmosphere of nitrogen and where the gas was known to be definitely reactive, and accordingly two of the reaction bulbs described in the first experiments were used. The electrodes

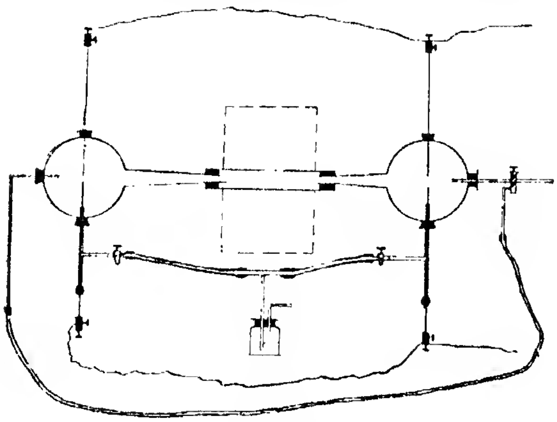

FIG. 2.

were carried vertically and the lower in each case was passed through a T-piece arranged as shown. Gas-tight joints were obtained by means of rubber sleeves and the two-way tap was employed to send the nitrogen from the purifying system through the bulb, where the arc was burning, into the furnace containing the heated iron, from thence to the second bulb and out to atmosphere *via* the taps as required. The arcs were placed in parallel as before and were burned alternately, the duration of the experiment being two hours. Traces of nitrogen only were found in the product.

From these experiments it would appear that the results obtained when the ozonisers were used are substantially correct and that exposure of heated iron to activated nitrogen does not result in any appreciable amount of absorption of the latter element.

These experiments, while interesting, were all carried out under conditions rather different from those obtaining in welding practice, inasmuch as oxygen was excluded, and since it is possible, as pointed out by Paterson and Blair, that the oxygen content of weld metal bears a relation to the amount of nitrogen present, it was decided to investigate the products obtained when iron arc is burned in air.

The apparatus used was as before (Fig. 1), with the exception that the furnace containing metallic copper was dispensed with and that the air was drawn through the apparatus by means of an aspirator; access of water vapour to the reaction bulbs was prevented by means of traps containing concentrated sulphuric acid. The current used was as before and the arcs burned well. Clouds of a brown powder formed on the bulb walls and oxides of nitrogen were distinctly perceptible in the issuing gases. A determination of the nitrogen in the product gave 0·10% and 0·12% on two series of experiments, whilst a determination of iron gave approximately 70% Fe.

This would indicate that the products consist essentially of ferric oxide and a small quantity of the nitrogenous substance. In view of the readiness with which iron becomes oxidised, the presence of this quantity of nitrogen shows that the reaction between iron and nitrogen under the influence of the electric arc must be very powerful, since the additio of 20% of such an extremely reactive element a oxygen only lowers the nitrogen content by som 50%. It is not, in the author's opinion, a valid assumption that a nitride is necessarily the only nitrogenous product in this case, since the oxides of nitrogen which are formed have to be taken in consideration. Experiments were, therefore, carri out with a view to obtain some evidence upon tha point.

It was found in the first place that upon heating quantity of the second preparation in a current hydrogen, as in the previous experiments, sma amounts of ammonia only were formed, the titre the acid in the absorbing vessels being practically t same before and after the experiment. Nitrog equivalent to 0·07% was found in the substance aft heating, from which it follows that 0·05% had bee evolved as uncombined nitrogen.

It was thought that this might be due to t accidental employment of too high a temperature the furnace, leading to decomposition of the ammo which might be formed, since Ramsay and Youn found that this was appreciable above 500°, but control experiment using the mixture of Fe_4N_2 a iron prepared by burning an arc in nitrogen gave same result as before. Hence this hypothesis not appear to be tenable.

Furthermore, upon heating in nitrogen under same conditions as were imposed for the mixtur iron nitride and iron previously obtained, the nitro content did not alter appreciably, 0·13% being fo before and 0·11% after the heating of another sam of the same preparation. Boiling with water before had little or no effect, 0·002% being evol as ammonia upon treatment in this way, and 0·00 being obtained further upon addition of alkali to distillation flask. The residue still contained 0·1 of nitrogen, and a repeat experiment using stron alkali and more prolonged boiling gave no increa yield of ammonia as compared with that stated abo

These facts would indicate that the nitrogen product obtained from the arc in air consists, in probability, of a small amount of nitride, toget with some other substance which apparently owes formation to the presence of the oxygen. It interesting to note that Sabatier and Senderens,[21] w succeeded in preparing nitro-cobalt and nitro-nic by the action of nitrogen peroxide, diluted w nitrogen, on the metals in question, were unable this method to obtain the corresponding i derivative.

It is possible that this second compound mentio above may be nitro-iron or some related substan but there is at present no experimental eviden which permits of any definite statements being mad

[20] Chem. Soc. Trans., 1884, **45**, 88.
[21] Bull. Soc. Chim., 1893, (iv.), **9**, 669.

e recent work of Partington and his collaborators on the question of nitro compounds is interesting far as this point goes.

"hen an arc was burned in the nitrogen as it came t from the cylinder, no steps being taken to ove the 1% of oxygen which it contained, the uct contained 0·10% of nitrogen and in its re- ns behaved essentially as the mixture obtained the arc in air, which would go to show that the ad nitrogenous substance may be formed in the nce of even this small quantity of oxygen.

view of the large amount of ferric oxide present as thought that the nitrogen in this case might dsorbed upon or loosely combined with the e oxide. This was tested by heating a 3-g. ple of ferric oxide to 500° in a current of gen for two hours. Traces only of nitrogen were d in both the heated sample and in the original rial used, thus disposing of the above suggestion. s a matter of interest, the mixture of iron and nitride, the product obtained by burning the n air, and some ferric oxide were all heated to redness in activated nitrogen for two hours to tain if any absorption of nitrogen took place these conditions. No nitrogen was found in esulting products except that made in air, in case the nitrogen content had not altered. addition to this, some Swedish iron was allowed idise superficially by heating to bright redness minutes in a muffle and was then heated to dness for two hours in activated nitrogen to ine the effect, if any, of the layer of Fe_3O_4, presumably would be formed. No evidence rogen absorption was found.

re is, in this connexion, considerable doubt as ether the method used for determining the en can be applied with accuracy in the case of n-nitrogen-oxygen preparation. Fixation of rogen as ammonia would presuppose a supply cent hydrogen, which was not available to any extent in this case owing to the small quantity tallic iron present. Hence the results, so far e second preparation is concerned, must be ded at present as possessing an element of t. Work is being continued upon this point. interesting possibility in the case of actual metals is that any nitro- or nitrogen-oxygen ounds present might quite conceivably give oxylamine as well as ammonia under the action e nascent hydrogen. Assuming this to be the nd bearing in mind the behaviour of free hydr- mine, we have a possible explanation of Paterson Blair's discovery that more nitrogen is obtained the distilling flask contains a zinc-copper le than when this is absent. This matter is being investigated.

general review of these experiments may now de. The main facts which would appear to be blished are as follows :—

. Upon burning an iron arc in nitrogen, appreciable ntities of iron nitride are formed. This would ear to be due to the action of the active nitrogen n the arc vapours, and affords additional evidence support of the theory that such a form of the gas is obtainable. Pre-activation of the entering gas, as well as a slight increase in pressure, does not appear to affect the amount of nitrogen absorbed.

2. Whilst the actual experimental conditions cannot be regarded as being beyond reproach, such evidence as has been obtained would go to show that exposure of heated iron to activated nitrogen does not result in any appreciable combination of the elements in question. The oxidation of the metal has no effect in this connexion.

3. Neither ferric oxide nor magnetic iron oxide absorbs nitrogen upon being heated in the gas, whether it be activated or not

4. Upon burning an iron arc in air, the products appear to contain a second nitrogenous substance, distinct from a nitride, and owing its origin to the influence of the oxygen It is suggested that this substance may be nitro-iron or some related compound formed by the action of the oxides of nitrogen upon the iron vapour or upon the iron oxide present.

5. The presence of 1% of oxygen in the atmosphere in which the arc burns is sufficient to lead to formation of the second and unidentified nitrogenous substance.

These results may now be applied to the problem under consideration—that of the nitrogen in weld metal.

In the first place, the author offers as an alternative hypothesis to Paterson and Blair's view (that the nitrogen in the weld metal is there as a result of the influence of the active nitrogen upon the weld metal itself) the suggestion that this may be due rather to an absorption of the nitride and the second nitrogenous substance from the arc vapours That this does take place is shown by the fact that the electrode tips contain nitrogen, whereas other portions of the electrode which have while heated been in contact with the active gas do not show any appreciable nitrogen content.

Secondly, Paterson and Blair's discovery that, upon heating in hydrogen, part of the nitrogen is evolved as ammonia and part as elementary nitrogen, is explained by the present author's observation that a mixture of a nitride (which yields up its nitrogen as ammonia by the action of hydrogen) and a second substance (which gives up its nitrogen in the uncombined state) is obtained by burning an iron arc in air. This fact also serves to confirm the above-mentioned workers' suggestion that the nitrogen in weld metal may be present partly as a solid solution of iron nitride and partly in some form which is related to the oxygen present.

It would, furthermore, appear probable that the nitride-nitrogen in a weld is that which is evolved as ammonia when the metal is heated in hydrogen. In the case of the figures published by Paterson and Blair, this constitutes about half of the total amount present, the remainder being presumably that which owes its presence to the oxidation effects in the arc. Hence the use of some easily oxidisable substance as a constituent of the flux on the welding rod would be expected to have a considerable effect upon the quality of the weld by reason of its tendency to inhibit formation of the iron-nitrogen-oxygen

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compound owing to preferential oxidation, and thus accordingly to lower the nitrogen content of the metal. This is borne out by the good results obtained in practice with graphite as a component of the rod coating.

The formation of nitride can probably only be minimised, and not entirely prevented, bearing in mind the circumstances of its formation, and a certain amount of nitrogen may be expected always to be present in ordinary welds made where contact with air cannot be avoided. This is obviously to be done by exposing as little iron vapour as possible to the atmosphere in the vicinity of the arc, *i.e.*, by using as short an arc as is practicable. This deduction is again supported by the experience of welding practice.

Some interesting results might be obtained by allowing a stream of some easily oxidisable gas, such as hydrogen, acetylene, etc., to impinge upon the weld from a hollow electrode holder, suitable experimental precautions being taken.

In this way, an arc might be obtained which was surrounded by an atmosphere nearly free from nitrogen or oxygen, with a correspondingly improved metal as a consequence of oxidation or nitrogenation being greatly lowered, if not prevented. This suggestion is, however, purely tentative. It may be argued that the quantity of nitrogen in weld metal would demand a high absorption of the arc vapours in order that the necessary amount of nitrogen should be present to reach the figure of 0·1% or thereabouts. For a weld made under the conditions of current density etc. employed by the present author this objection would certainly be a strong one, but it is his opinion that in industrial practice, where the current density is so much greater, the increased formation of active nitrogen will lead to much higher yields of nitride etc., which will accordingly give the observed nitrogen content. Another factor to be taken into account is the possible catalytic effects of the carbon, manganese, etc. present in the electrodes used in welding practice.

Another objection which may be raised is that Strutt (*loc. cit.*) found that 2% or more of oxygen served completely to inhibit activation of the nitrogen he used. This can be met by a consideration of the oxidation which will simultaneously be taking place. It would appear more likely that on account of the greater affinity of oxygen for iron, practically the whole of this gas may be removed locally from a small space immediately surrounding the arc, and although the whole of the atmosphere here will undoubtedly be in a state of violent motion, the oxygen content may momentarily remain low enough to permit of activation and nitride formation taking place.

The author desires, in conclusion, to express his indebtedness to Dr. J. H. Paterson and Mr. T. W. Moore for the use of their temporary laboratory, where these investigations were carried out, and to Mr. C. L. Haddon for the loan of the coil and ozonisers. He is also grateful to Profs. W. N. Haworth and H. V. A. Briscoe for the interest they have taken in the work.

THE DETERMINATION OF VANADIUM BY REDUCTION WITH HYDROGEN PEROXIDE AND TITRATION WITH POTASSIUM PERMANGANATE.

BY A. W. HOTHERSALL, B.SC. TECH.

Cain and Hostetter[1] have described a method reducing vanadium solutions by means of hydrog peroxide, and have applied it to the determinatic of vanadium in steels.[2] Lord and Demorest[3] suggest the use of this method for determine vanadium in ferro-vanadium.

The mechanism of the reduction and its appl tions in analytical chemistry do not, howe appear to have been thoroughly investigated. view of the importance of the method, the w described in this paper was carried out in order examine its efficiency and discover its limitation

The method consists essentially in adding hydro peroxide to a solution of the sample in strong phuric acid (whereby the vanadium is immedia reduced to the quadrivalent condition) and, a dilution, titration of the liquid with standard p sium permanganate. Reduction of vanadium also take place in dilute sulphuric acid solut but in this case it is necessary to allow the mix to stand in order to enable the excess of hydr peroxide to decompose before titration can be ca out.

The following procedure is recommended in of the results given later in the paper.

The method.

A suitable quantity of the sample is decom with acids, or if necessary by fusion with pota bisulphate (quantity not to exceed 10 g.), and solution filtered if required. 10 c.c. of s sulphuric acid, or 20 c.c. if much soluble m other than vanadium is present, are added, a flask is heated until fumes appear. After cool small quantity of finely powdered potassium manganate is added, and the flask again heate order to destroy organic matter) and allowed to Hydrogen peroxide solution, free from organic m and preferably containing 3% H_2O_2 or more, is a drop by drop until the excess of permanganate been decomposed and the solution has become in colour. The solution is heated until fumes to appear, and then allowed to become quite

(1) If no salts have separated, 1 c.c. of hydr peroxide solution is added drop by drop fro pipette, with constant agitation of the flask. excess of hydrogen peroxide thus introduce catalytically decomposed in a few seconds b vanadyl sulphate solution in strong sulphuric and no further heating is required. It is, how advisable to allow the solution to stand for 1 minutes, after which the test is completed by dilut to 300 c.c., heating to 70°, and titrating with stand potassium permanganate solution.

[1] J. Amer. Chem. Soc., 1912, 34, 274.

[2] U.S. Bureau of Standards, Technol. Paper No. 8 (1912). J. Amer. Soc., 1921, 43, 2552.

[3] "Metallurgical Analysis," pp. 146, 147.

(2) If basic sulphates have separated or soluble lts have crystallised, water sufficient to dissolve e separated matter, but not more than about twice e volume of strong sulphuric acid present,* is lded, and the flask warmed until solution takes ce. After cooling to room temperature, 5 c.c. of drogen peroxide solution followed by a few crystals y 0·1 g.) of potassium bromide are added. The k is then set aside, covered with a watch glass, 24 hours, after which it is heated until fumes appear (to remove bromine and hydrobromic After cooling, a little water is added and the on warmed to dissolve separated salts, diluted) c.c. (or to 700 c.c. if much iron is present), l to 70°, and titrated with standard potassium nganate, a few c.c. of syrupy phosphoric acid added to remove the iron colour if necessary the presence of large amounts of copper, iron, her elements giving coloured sulphate solutions, dvisable to make a blank determination.

is essential that the hydrogen peroxide used l be free from organic preservative, since other- ron and other elements in the solution might duced as well as vanadium. Even in their e, high and variable results are likely to be ed due to attack on the permanganate during n.

eful test for application to commercial peroxide s in evaporating 10 c.c. of the reagent with of strong sulphuric acid and a little ferric e until fumes appear. If, after cooling and , the liquid requires more standard potassium ganate solution to produce a permanent lour than does a similarly prepared solution h no peroxide has been added, the reagent be rejected.

author has found it convenient to prepare en peroxide as required by dropping sodium le into cooled dilute sulphuric acid.

duction in strong sulphuric acid solution.

liquid should be cold before the addition hydrogen peroxide, as the reaction by which um is reduced does not proceed to com- in hot solutions.

s possible by this method to determine large mall amounts of vanadium equally accurately, ate titrations invariably agreeing to within rop.

ays may be allowed to stand for long periods l tests did not exceed 2 weeks) after reduction ut affecting the titration figure provided that is excluded from the flask.

ept in very large amounts, sodium and ammon- lts do not affect the determination. Complete ion of vanadium can be effected in the presence uch as 40 g. of sodium sulphate, but owing to f loss during evaporation and of crystallisation cooling, it is inadvisable to carry out the test h more than 10 g. of these sulphates present.

* The volume of the solution, after the hydrogen peroxide has been d, should be such that the volume of added water plus that of peroxide not exceed three times the volume of strong sulphuric acid present.

The presence of up to 0·27 g. Mo, 0·38 g. As, and/ or 0·24 g. U has no effect upon the determination. Copper does not affect the reduction of vanadium, but large amounts of copper interfere somewhat with the end-point in the permanganate titration, making it necessary to carry out a blank determin- ation. In the presence of 0·25 g. Cu the blank obtained was 0·5 c.c. compared with 0·1 c.c. without copper.

Chromium interferes seriously with the deter- mination since it is reduced by hydrogen peroxide. In one series of tests, 26·4 c.c. of permanganate solution were required when no chromium was present, 26·5 c.c. with 0·035 g. (added as potas- sium dichromate), 26·85 c.c. with 0·07 g., 27·10 c.c. with 0·141 g., and 27·95 c.c. with 0·354 g. Iron has no effect on the determination provided that when the solution is evaporated to fuming with sulphuric acid there is no separation of basic sulphates, which invariably carry down vanadium with them.

Reduction in dilute sulphuric acid solution.

In order to surmount the difficulty due to the presence of iron, it is necessary to carry out the reduction in dilute solution. Auger[4] has shown that this is possible, and he states that in a 10*M* solution of sulphuric acid (about 54% by vol.) the reduction proceeds to completion in a few seconds. At greater dilutions the reduction was found to proceed more slowly. For example, with 33% H_2SO_4 in the test solution 98·8% and 99·3% of the vanadium was reduced in three days (complete reduction being obtained in 18 days) and with 25% H_2SO_4 93·5% and 93·2%.

The speed of reduction is, however, but little affected by the concentration of hydrogen peroxide.

Apparently there is a limiting concentration of sulphuric acid, lying between 20% and 33% H_2SO_4 by volume, below which the reduction will not proceed to completion.

Further experiments on the effect of concentration of sulphuric acid were carried out with the addition of potassium bromide as an accelerating agent, and it was found that complete reduction could be obtained in solutions containing 23% H_2SO_4 by volume, but not in those containing 20% H_2SO_4.

Acceleration of the reduction in dilute sulphuric acid solutions.

The effect of temperature.—If aqueous solutions containing ammonium vanadate, sulphuric acid, and hydrogen peroxide be heated, reduction of the vanadium occurs in a few minutes, but it is not so complete as when the reduction is allowed to proceed at room temperature. The degree of reduction obtained varies with the temperature of the solution (in 25% H_2SO_4, a temperature of 50° has a pro- nounced influence) but the effect is less and less marked as the concentration of sulphuric acid is increased, until with solutions containing no water (*e.g.*, strong sulphuric acid plus barium pervanadate) complete reduction of the vanadium is obtained quite independent of the temperature. This fact cannot, however, be applied to the assay as carried

[4] Compt. rend., 1921, 172, 1355.

out in concentrated sulphuric acid solution since water is necessarily introduced with the hydrogen peroxide.

The addition of a few crystals of potassium bromide greatly accelerates the decomposition of the excess of hydrogen peroxide (Bray and Livingstone[5]) and complete reduction of the vanadium can be obtained after standing for 24 hours. Before titration, however, it is necessary to boil until the bromine and hydrobromic acid formed have been removed. With this modification, the method gives accurate results in the presence of large amounts of iron (tests were made using up to 5 g Fe, added as ferric sulphate).

The application of this modified method to the determination of vanadium in steels was not investigated on account of the interference of chromium, which is almost invariably associated with vanadium in steel.

Platinised asbestos was found to act in a similar manner to potassium bromide, but it is neither so convenient to use nor so cheap as the latter. Other materials such as manganese dioxide and colloidal silica gave negative results. In the absence of iron or other easily reducible elements, metallic copper or finely divided silver, added to the assay after the hydrogen peroxide, resulted in complete reduction of the vanadium in a few seconds.

Mechanism of the reaction.

The reduction of vanadium in sulphuric acid solution by hydrogen peroxide appears to be due to the action of sulphuric acid upon pervanadic acid with the formation of vanadyl sulphate and the liberation of oxygen :—

$$4HVO_4 + 4H_2SO_4 = 2V_2O_2(SO_4)_2 + 6H_2O + 3O_2 \quad .. \quad (i)$$

Any excess of hydrogen peroxide over that required to form pervanadic acid is catalytically decomposed by the reduced vanadyl sulphate, the rate of this decomposition depending upon the concentration of sulphuric acid in the solution.

Pissarjewsky[6] states that pervanadic acid dissociates as follows :—

$$(a)\ VO_2(O_2H) \rightleftarrows VO_2^{\cdot} + O_2H'$$

$$(b)\ VO_2(O_2H) \rightleftarrows VO_2.O_2' + H^{\cdot}$$

$$(c)\ VO_2 + O_2H' \rightleftarrows VO_2.O_2' + H^{\cdot}$$

In the presence of sulphuric acid, reaction (*c*) will proceed from right to left, and when the concentration of sulphuric acid is low and these ions are able to exist without immediate decomposition according to equation (i), it appears that the

[5] J. Amer. Chem. Soc., 1923, **45**, 1251.

[6] Z. physikal. Chem., 1903, **43**, 173.

unstable ion O_2H decomposes with formation of vanadic acid and free oxygen.

$$\underbrace{VO_2 + O_2H}_{\text{Pervanadic acid}} = \underbrace{VO_2 + OH}_{\text{Vanadic acid.}} +$$

The decomposition of the O_2H ion at ordinar[y] temperatures is likely to be slow but would b[e] accelerated by heat. The equilibrium finally obtain[ed] would therefore depend upon acid concentrati[on] and temperature.

This hypothesis accounts for the slow decom[position of pure aqueous solutions of pervana[dic] acid (noticed by Pissarjewsky) and forms a re[ady] explanation of the incomplete reduction obtained [in] hot solutions. It will be recalled that the influe[nce] of temperature was found to be less the higher [the] concentration of sulphuric acid.

Summary and conclusions.

The determination of vanadium by reduction w[ith] hydrogen peroxide can be effected accurately [in] both concentrated and dilute sulphuric acid solutio[ns]. In *concentrated acid solutions* the reduction [is] immediate and complete provided an excess [of] hydrogen peroxide has not been used. In *d[ilute] acid solutions* the reaction proceeds more sl[owly] and it cannot be accelerated by heat wit[hout] oxidising a portion of the vanadium. The [com]pleteness of the reduction depends upon tempera[ture], concentration of sulphuric acid, and upon the le[ngth] of time the solution is allowed to stand. [It is] largely independent of the concentration of hyd[rogen] peroxide. In solutions containing less than [x] H_2SO_4 by volume the reduction will not proce[ed to] completion. The maximum temperature permi[ssible] lies between 25° and 50°. By the additi[on of] potassium bromide complete reduction of the [vana]dium may be obtained in 24 hours.

Of the elements tried, only chromium, whi[ch is] reduced under the conditions employed, has [an] effect upon the estimation. Certain elements, [how]ever, if present in large quantities, may [cause] mechanical interference (*e.g.*, separation of [insoluble] sulphates carrying vanadium), but this may be [over]come by carrying out the reduction in dilute sulp[huric] acid solution.

The method is applicable to a large varie[ty of] materials such as ores, ferro-vanadiums, and vana[dium] compounds of all descriptions. It can be ca[rried] out direct on these products without separatio[n of] any impurity other than insoluble matter. [The] rapidity of the method, together with its accu[racy] and reliability, render it of considerable import[ance] in analytical chemistry.

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HE MECHANICAL PROPERTIES OF LUMINIUM-ZINC ALLOYS CONTAINING CADMIUM.

BY N. F. BUDGEN, M.SC., PH.D.

he object of the present research has been to rtain by the application of simple standard tific tests, the properties, other than constitu- l, of certain aluminium-zinc-cadmium alloys. work, which actually constitutes only a pre- ary survey, is intended to provide sufficient mation regarding these alloys to admit of their parison with other well-known binary and ternary s of aluminium. The only previous investigation luminium-cadmium-zinc alloys recorded is that to Bayliss and Clark,* who in 1912 examined s rich in aluminium and found that compositions ding Al 80—99, Zn 0—20, Cd 0—10%, were ble for rolling, spinning, drawing, and stamping, cientific test data in support of the claims were not published.

e constitutional conditions obtaining over the ternary system have already been investi- by the present author, and indicate that an industrial viewpoint the members which ost likely to be of value lie near the aluminium of the basal triangle representing alloy com- ons, and contain therefore a preponderance is element. In the region of the aluminium the alloys show a solid solution range which ds to a concentration of about 4% Cd and 6% uch alloys exhibit under the microscope a typical onal grain structure. The useful range of ht aluminium-zinc alloys extends almost to Zn, depending upon the purpose for which the is required, but beyond this point the alloys me too hard and brittle to be of industrial .

e range of alloys which have been examined des mixtures from 0 to 24% Zn, 0 to 10% Cd, hence 66 to 100% Al, so that a large number of compositions lie outside the area within which alloys consist entirely of homogeneous solid tion. In such cases grain boundaries, composed nly of a cadmium-zinc alloy, make their appearance micro-sections. The alloys examined cover an on the triangular basal plane, represented by small shaded parallelogram in one corner of the le ternary alloy field, Fig. 1; the lower diagram s on a larger scale the region of the alloys tigated, the position of the circles representing actual alloy compositions.

llowing careful preparation using commercially materials, the alloys were subjected to forging, rolling, and spinning tests, the cast material being tested for hardness and the cast and rolled material for tensile properties.

* Métaux et Alliages, 1914, 7, No. 5, p. 7. E.P. 19,452 of 1912. F.P. 462,361. U.S.P. 1,117,308.

Preparation of alloys.—The metals employed in this work were as follows:—

Aluminium notched bars from the British Aluminium Co.: —Si 0·20%, Fe 0·20%, Al (by diff.) 99·60%. Electrolytic zinc 99·98% pure. Cadmium, in the form of sticks of commerce, kindly presented by the British Metal Corporation: Zn 0·020%, Pb 0·013%, Cd (by diff.) 99·967%.

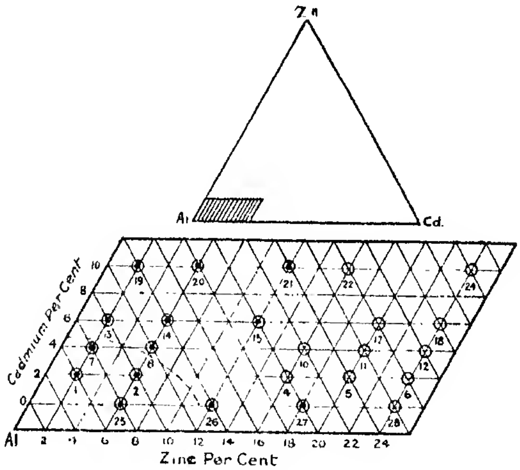

FIG. 1.

The metals in calculated and carefully weighed proportions as shown by Table I, were melted in a 12-lb. Salamander crucible, heated in a coke-fired wind furnace. The aluminium was first melted and the zinc then added whilst heating was continued until the added metal had completely dissolved; the crucible charge was then gently stirred to ensure incorporation of the zinc. The crucible was then taken from the furnace and allowed to cool to within 50° of the solidification temperature of the alloy, when the cadmium in the form of small lumps was added.

In no case on the addition of either zinc or cadmium was there any evidence of volatilisation or undue formation of oxide; a slight quantity of scum formed and was removed. Careful stirring was then applied, the charge somewhat reheated, and after again skimming was poured into a mould giving ingots measuring 4·5 × 0·5 × 10 in. and into another giving round bars 1·25 × 12 in. In every case the metal was poured at the lowest temperature at which it would fill the mould. The surfaces of most of the ingots were clean and smooth, but upon those containing 10% Cd there appeared minute beads of metal which grew uniformly to a height of about 1/16 in., evidently an exudation of some fusible constituent which was forced out on solidification of the portions of higher melting point. The beads gave

to the surfaces of the ingots a rough and speckled appearance. Fractures of the aluminium-rich alloys are more silky in appearance than those zinc- or cadmium-rich, which exhibit a granular or more coarsely crystalline structure.

Forging tests.—Forging tests were made at various temperatures on the round $1\frac{1}{4}$-inch diameter chill-cast bars. The bars covering the whole series of alloys were heated to 400° in a gas muffle near the experimental steam hammer. Each of the bars was in turn taken out and tested with the lightest possible effective blows concentrated over a length of about 3 inches of the 12-inch specimen. At 400° each of the alloys was so friable as immediately to fall to pieces before even 5% reduction in cross-section had been effected. The bars were replaced in the muffle, which was then cooled to various temperatures below 400° down to about 250°. At intervals specimens were taken out and tested under the hammer, and in each case as before fell to pieces as though made of chalk. At 250° and below, some of them forged readily whilst others split and formed considerable edge cracks. The bars were then cooled to room temperature and again tested; they forged no less well but no better than when at 250°, some of the specimens flattening out readily, whilst others immediately cracked into fragments.

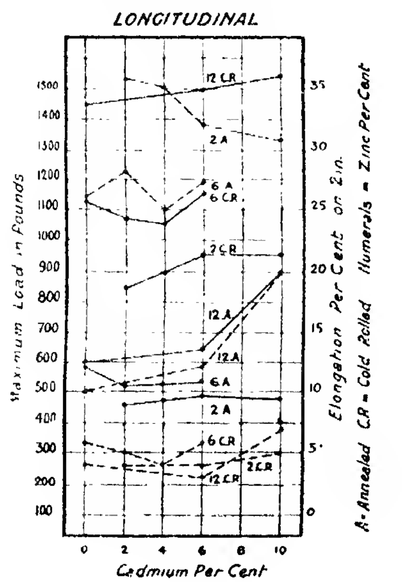

FIG. 2.

*Rolling tests.** For rolling tests the flat slabs measuring $4{\cdot}5 \times 0{\cdot}5 \times 10$ in. were employed. Portions of these were all heated to 400°, cooled to 300°, and passed through the rolls set to give a 10% reduction in thickness. At the first pass most of the specimens broke into small pieces. Lower rolling temperatures were subsequently tried, but with almost equally unsatisfactory results. The remaining portions of the slabs were cooled t[o] room temperature and rolled cold, the results i[n] general being similar to those of the forging tests o[n] the corresponding alloys. Those specimens whic[h] would roll were reduced from 0·5 in. in thickness t[o] 0·1 in. in three passes.

The rolled sheet was clean, free from spill or blister and, except in one or two cases (marked with a[n] asterisk in Table I.), practically free from edg[e] cracks. The results of the hot-forging tests we[re] thus that above 250° all of the specimens cracke[d] badly; those of the cold-forging experiments [are] given in Table I. Under hot and cold rolling [the] alloys behaved much the same as under the hamme[r] and those specimens which would not forge were a[lso] unrollable. In Table I. the specimens which w[ere] forgeable and rollable are marked "Workab[le]" and the others "Unworkable."

TABLE I.

Compositions, forging and rolling tests.

No.	Composition, weight %. Al	Zn	Cd	Observation.
1	96	2	2	Workable
2	92	6	2	"
4	82	16	2	Unworkable
5	78	20	2	"
6	74	24	2	"
7	94	2	4	Workable
8	90	6	4	"
10	80	16	4	Unworkable
11	76	20	4	"
12	72	24	4	"
13	92	2	6	Workable
14	88	6	6	"
15	82	12	6	"
17	74	20	6	Unworkable
18	70	24	6	"
19	88	2	10	Workable
20	84	6	10	"
21	78	12	10	"
22	74	16	10	Unworkable
24	66	24	10	"
25	94	6	0	Workable
26*	88	12	0	"
27*	76	24	0	"
29	82	18	0	Unworkable

Spinning tests.†—Only the alloys which were cap[able] of rolling into sheet form were subjected to spin[ning] tests. The sheet, 0·1 in., was rolled down to a th[ick]ness of 0·05 in., and subjected to spinning tests u[nder] ordinary works conditions. In order first to b[ring] all of the rolled sheets to the same state, they [were] annealed at 400° for half an hour, to eliminate [the] effect of possible different amounts of cold w[ork] induced by cold rolling. The most drastic poss[ible] spinning test was applied, that is, spinning to c[up] form, the cup former having nearly parallel si[des] and being 6 in. deep. As except in the case of pu[re] aluminium, most of the alloys were hard to w[ork] cold with the forming tool, each of the discs [was] heated by gas flame to about 150°, whilst spinn[ing] was in progress, a slight continuous anneal there[by] being given. Many of the sheets withstood spinn[ing] to the whole depth of the cup and showed proper[ties] admirably suited for this purpose; a few, howe[ver] broke down at the early stages and cracked so b[adly] that further progress could not be made.

The table below indicates the behaviour of [the] the rollable alloys examined, when subjected t[o] spinning tests:—

* Performed by courtesy of H. W. Clarke, director of James Booth and Co., Argyle Street, Birmingham.

† For the spinning tests the author is indebted to his friend Ralph Levick, of John Levick's Metal Spinning Works, Birmingham.

TABLE II.

Results of spinning tests.

oy no.		Observations.
1	..	Spun perfectly to deep cup shape
2	..	Spun to cup shape and cracked around rim
7	..	Spun perfectly to deep cup shape
8	..	As No. 2
13	..	Spun perfectly to deep cup shape
14	..	As No. 2
15	..	As No. 2
19	..	Spun to deep cup shape but slightly cracked
20	..	As No. 19
21	..	As No. 19
25	..	Spun perfectly to deep cup shape
26	..	As No. 2
27	..	As No. 2

*Tensile properties. Rolled strip.**

o ascertain the tensile properties of the alloys in the a of sheet, chill cast slabs were rolled, as already ribed, to strips 0·1 in. in thickness, and from

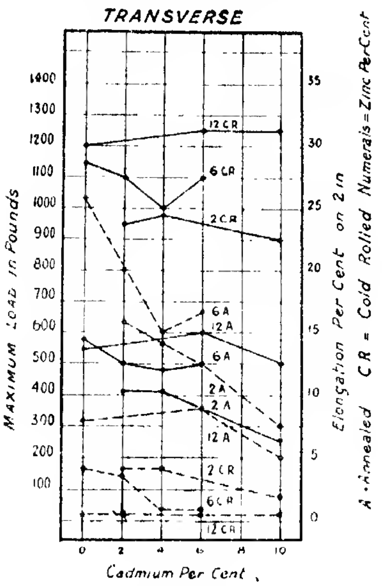

FIG. 3.

tensile test specimens were stamped out by of a hand fly press.† The specimens measured wide at the shanks and $\frac{3}{8}$ in. wide along a 2 in lel length. Both longitudinal and transverse s were cut in quadruplicate, two of each being d in the condition of the sheet as rolled (*i.e.*, -rolled), whilst the two others were annealed at for 1 hour before testing. With the dividers xactly at 2 in., two fine scratches 2 in. apart made on the gauge length of each specimen rawing the dividers along a straight edge. The lers were then set to 2·01 in., and in testing, ield was taken as the load corresponding to an tion of 0·01 in., so that when the divider exactly coincided with the positions of the ne lines on the specimen, the load was recorded. r tension tests, a Dixon and Hummel wire-sting machine was employed.

The results of tensile tests on the alloy sheet are iven in Table III. and graphically represented in Figs. 2 and 3; in these diagrams a full line represents maximum load and a dotted line elongation per cent. on 2 in.; yield load is not plotted.

TABLE III.

Rolled sheet, tensile test data.

No. of alloy.		Cold rolled. Yield load, lb.	Cold rolled. Ultimate load, lb.	Cold rolled. Elong'n % on 2 in.		Annealed. Yield load, lb.	Annealed. Ultimate load, lb.	Annealed. Elong'n % on 2 in.
Longitudinal.								
1	..	700	850	4	..	150	460	36
7	..	750	900	4	..	150	465	35
13	.	850	950	4	..	150	480	32
19	.	800	950	5	.	195	470	31
25	.	1025	1125	6	..	290	590	26
2	..	950	1075	5		180	520	28
8	..	975	1055	4	.	205	530	25
14	..	1150	1150	6	..	170	535	27
26	..	1300	1450	4	..	230	600	10
15	..	1400	1500	3	..	280	640	12
21	..	1300	1550	7	.	350	900	20
27	..	Too brittle to test						
Transverse.								
1	..	800	950	1	..	130	410	16
7	..	800	975	4	.	130	410	11
13	..	Spilly						
19	..	900	900	2	..	120	260	6
25	..	1060	1150	4	..	250	570	26
2	..	950	1100	3·5	..	160	500	20
8	..	900	1000	1	.	200	400	15
14	..	1000	1100	1	..	110	500	17
26	..	1200	1200	0·5	..	250	550	8
15	.	1250	1250	0·5	..	250	600	9
21	..	1250	1250	0·5	.	250	500	5
27	..	Too brittle to test.						

From the data, it is seen that the strongest sheet is that containing 12% Zn, the tensile strength being 17·26 tons per square in., whilst by the addition of 10% of cadmium, the strength is further slightly increased. In this series, however, the elongation is at a minimum. It is seen that there is no marked or systematic variation in the tensile properties of aluminium-rich aluminium-zinc alloys by the addition of cadmium, though the general tendency, in the case of pieces cut longitudinally, seems to be a slight strengthening, whilst the elongation also to some

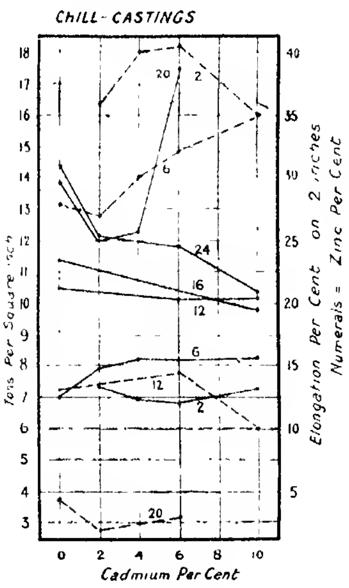

FIG. 4.

* The compositions of the alloys used for testing in the form of sheet re represented by a black dot in the diagram of Fig. 1.
† By courtesy of Dr. H. W. Brownsdon, Messrs. Kynoch, Ltd., Birmingham.

extent increases. Transverse tests appear to show almost the reverse conditions to hold.

Chill-castings.—For the purpose of tensile tests on chill-cast specimens, slabs measuring 4·5×0·5×10 in. were prepared. These were sawn along their greatest length into two pieces, and each of the latter was machined to the form of a test piece measuring 0·4 in. thick, 1·5 in. wide at the shanks, and 1·1 in. wide along the parallel portion. The alloy bars were machined by first rough-shaping on a planing machine and subsequently fine-finishing on a milling machine. The appearance of machined surfaces of specimens containing cadmium compared very favourably with those of pure aluminium or of aluminium-zinc alloys, and a highly pleasing surface was easily obtained.

After careful measurement, the specimens were tested in a Buckton 50-ton horizontal testing machine, and gave the results tabulated below and represented graphically in Fig. 4.

TABLE IV.

Chill-castings, tensile test data.

No. of alloy.	Ultimate load. Tons per sq. in.	Elongation % on 2 in.
1	7·322	36·0
7	6·948	41·0
13	6·812	42·0
19	7·260	35·0
25	7·001	28·2
2	7·910	27·3
8	8·169	30·0
14	8·147	32·2
20	8·211	35·1
26	10·500	13·0
15	10·025	14·0
21	10·164	10·1
4	7·209 (spilly)	2·0*
10	3·722 („)	1·0*
22	9·75	1·0*
5	12·00	2·0
11	12·212	1·0*
17	17·600	5·0
23	14·5	3·0
6	12·018	0·0*
12	6·41[illegible] (spilly)	0·0*
18	11·950	1·0*
24	10·351	0·0*

* Broke outside gauge length.

In the diagram the full lines represent tensile strength in tons per square inch and the broken lines, elongation per cent. on 2 in. The strongest alloy of the series is evidently one containing 6% Cd and 20% Zn; this shows 17·5 tons per square inch but only 3% elongation. As in the case of rolled strip, the addition of up to 10% of cadmium to the aluminium-zinc alloys examined, does not produce any very marked or systematic change in the tensile properties, but it seems that there is a slight weakening and no appreciable increase of elongation except in the case of the series containing 6% Zn.

Hardness.—Brinell hardness tests were made upon the chill-cast alloys with a 10-mm. ball and 1000 kg. load applied for 1 minute. They indicate (Table V.) a slight hardening by the addition of cadmium to each series containing a constant proportion of zinc, except in the case of the series containing 24% Zn, when softening is evidenced.

TABLE V.

Brinell hardness of chill-castings.

Alloy no.	Diam. of impression, mm.	Hardness number.
1	6·35	27·5
7	6·70	24·0
13	6·60	25·0
19	6·20	29·0
2	6·40	27·0
8	6·40	27·0
14	6·20	29·0
20	6·25	28·5
15	5·65	36·5
21	5·40	40·0
4	5·00	48·0
10	5·05	47·0
22	4·70	54·0
5	4·60	57·0
11	4·50	59·0
17	4·55	58·0
6	4·00	76·0
12	3·95	78·0
18	4·15	70·5
24	4·25	67·5

Summary.

The range of alloys examined includes mixtures taining from 0 to 24% Zn, 0 to 10% Cd, and hen to 100% Al. From certain of the alloys conta 10% Cd, small beads of a more fusible constit exude from the surface after chill-casting; th probably a cadmium-rich zinc alloy. Under hammer, all specimens cracked badly above but those containing less than a total of 18% Zn forged well below this temperature. The resu rolling tests are similar to those of forging The general effect of cadmium is to render aluminium-zinc alloys more malleable, thereby ling zinc-rich members which otherwise woul quite unworkable to be readily forged or rolle

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In conclusion, the author wishes to acknowl especial indebtedness to Prof. T. Turner for gra facilities for carrying out the investigation in laboratories and for his continued interest and ad

The investigation was conducted in the Metall Department of the University, Birmingham, financial assistance from the Department of Scie and Industrial Research.

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THE SPECIFIC GRAVITY AND ASH CONTENT OF COAL.

BY T. J. DRAKELEY AND J. R. I. HEPBURN.

investigation has been made to determine her a relation exists between the specific gravity sample of coal and its ash content. In a former nunication, Drakeley and Jones (J., 1923,) have examined the relation between the ic gravity and moisture content of coal.

e specific gravity and the class of coal do not r to be related in a manner which admits of any ematical treatment. All that can be stated is the older types of coal generally possess slightly specific gravities than coals of later geological s.

rder to determine the relationship, large samples (which were actually passing to washing plant) two parts of a Lancashire seam were separated fractions which floated in liquids of known c gravities.

tions of calcium chloride were first adopted as rd liquids, but were subsequently abandoned, he maximum specific gravity for a saturated n is about 1·41 and the more concentrated ns do not readily wet the coal.

ore convenient liquid, proposed by Blyth and (Trans. Inst. Min. Eng., 1918—1919, 57, 264), roform (*d* 1·5), which may be mixed with l to give solutions of any desired lower specific y. Furthermore, the chloroform-alcohol mix- possess the great advantage over salt solutions ing no residue on evaporation.

s been shown (Drakeley and Jones, *loc. cit.*) r practical purposes air-drying is satisfactory. all samples dealt with in this investigation were ted to air-drying in a laboratory in which the e humidity of the atmosphere averaged about

h bulk sample of about 1500 grams of coal was ted into fractions by flotation in solutions of sing specific gravities, the coal remaining in the l for three minutes. During the first minute olution was rapidly stirred, after which two es were allowed for settling. A suitable appara- as already been described (Drakeley, Trans. Min. Eng., 1917–1918, 55, 162), and recently, ilar form has been discussed by Sinnatt and (*ibid.*, 1923—1924, 66, 158)

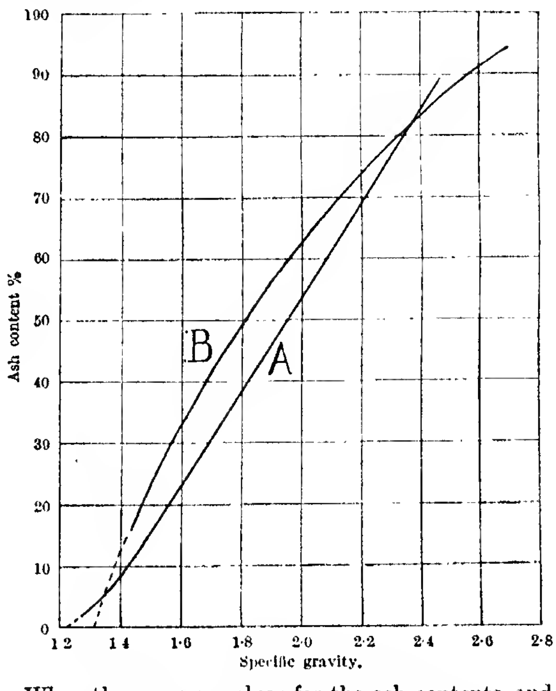
hol and chloroform were removed from each n by drying in an oven at 100°. The fractions then exposed to the air of the laboratory to each the standard conditions, and subsequently the sh content was determined.

Finally, samples of the dirt containing no visible arbonaceous matter were selected from some mined oal (from the same sources), and the respective sh contents and specific gravities were determined. The results of four tests on each bulk sample are given in Table I. :

TABLE I.

Test.	Ash content of fractions. Floating in liquid of *d* 1·30	1·35	1·40	1·45	1·49	Sinking in 1·49	Ash.	*d*.
1	2·30	4·48	7·05	10·32	13·60	52·08		
2	2·33	4·42	6·96	10·25	13·54	51·96		
3	2·36	4·47	7·02	10·30	13·60	52·01		
4	2·34	4·48	7·03	10·32	13·61	52·07	89·32	2·47
5	1·27	3·35	5·75	9·06	12·94	52·18		
6	1·27	3·38	5·77	9·10	12·96	52·21		
7	1·28	3·38	5·84	9·00	12·97	52·21		
8	1·28	3·42	5·85	9·11	12·04	52·22	90·11	2·47
Average ash content.	1·81	3·92	6·41	9·69	13·28	52·13	89·77	
Average sp gr.	1·275	1·325	1·375	1·425	1·470	1·98	2·47	

With the coals in question it was found that a liquid of specific gravity 1·25 only floated an occasional piece of coal, and therefore it may be assumed that the first fraction contained the coal particles of specific gravity ranging between 1·25 and 1·30, and averaging 1·275.



When the average values for the ash contents and specific gravities were plotted, the resulting line was found to be almost straight for the higher, but decidedly curved for the lower values (see curve A of figure). A precisely similar curve may be obtained by averaging and then plotting the results given in another connexion by Blyth and O'Shea (Trans. Inst. Min. Eng., 1918—1919, 57, 269) for coals from two Derbyshire seams

It therefore appeared that in all probability a graph such as curve A would be typical, although the graph represents a relationship which entirely disagrees with that theoretically deduced on the assumption (supported by other evidence) that a crude coal may be regarded as a mixture of clean coal and shale. A further examination therefore seemed desirable.

In a former communication, the authors (J., 1924, 134 T) have made accurate determinations of the apparent and true specific gravities of samples of a Notts hard (steam) coal, and reference may be made to the results given in that paper.

Coal samples of low ash content.

In Table I. (*loc. cit.* page 135 T) are given the true and apparent specific gravities of coal samples free from visible impurities and yielding a small quantity of ash.

In the separation effected by the flotation process, the apparent specific gravity is the controlling factor. As the separation is thus dependent on such arbitrary factors as the rate of penetration of the alcohol-chloroform mixtures, it is more likely that the true specific gravity will be related to the ash. In the event of the existence of a linear relation between true and apparent specific gravity, any relation between the true specific gravity and the ash content would also apply to the apparent specific gravity. That no relationship exists is readily demonstrated by plotting the values for the true and apparent specific gravity given in Table I., when irregularly placed points are obtained.

It has already been shown that the volatile matter and the ash content of the clean coal samples do not admit of mathematical treatment, and that the difficulty is due to the separation of the coal samples into fractions containing varying proportions of the four banded constituents

Similar reasoning accounts for the lack of regularity in the specific gravity and ash values.

Relation between the specific gravity and ash content of general coal samples.

In Table II. of this paper are given the values for the true and apparent specific gravities and the ash contents of general coal samples from the Notts. seam which yielded higher percentages of ash than those obtained in the former section :—

TABLE II.

Ash content.		16·12	27·52	32·83	39·54	46·97	51·00	52·91	69·08	75·81
Sp. gr.	Apparent	1·387	1·481	1·545	1·616	1·701	1·751	1·770	2·035	2·147
	True	1·440	1·543	1·594	1·671	1·782	1·817	1·851	2·124	2·264
	Calculated	1·443	1·540	1·605	1·688	1·775	1·831	1·853	2·125	2·268

If the true and apparent specific gravities are plotted, it will be found that an almost linear relation exists between them. This indicates that the porosity of the samples is almost constant, and that any relation between the ash content and the true specific gravity will also hold for the apparent specific gravity.

In the subsequent paragraphs, the true specific gravity is discussed in connexion with the ash content. The values for the true specific gravity and ash content are plotted in the figure and give curve B. This represents graphically the equation which may be deduced on the assumption, now shown to be true for this case, that the samples may be regarded as mixtures of coal and shale. A similar curve was obtained by Whitaker (Trans. Inst. Min. Eng., 1923, **64**, 191) for mixtures of coal and shale dusts.

The equation takes the form :—

$$1/x = y/a(1/s - 1/c) + 1/c$$

where y is the ash percentage of the sample, a that of pure shale, and c, s and x the real specific gravities of the ash-free coal, shale, and sample respectively.

In the former paper (*loc. cit.*) the value of a has been determined (95·07%) for the coal, and the value of c obtained for the curve B is 1·315. By substitution of these in the equation, x may be calculated. The results are given in Table II., and are in close agreement with the observed values for the true specific gravity.

The abnormal relation deduced in the first section of this paper may now be elucidated. In this connexion, the average specific gravity of a sample was assumed to be midway between the specific gravities of the higher and lower test solutions. This value was plotted against the ash content to give curve A. This assumption is apparently not justifiable even with narrow and certainly not with wide ranges of specific gravity, and a curve similar to B may be obtained by a slight displacement of the points. The curve will not be identical with B, which refers to a Notts coal, but an examination of a Lancashire coal gave a curve coincident with that theoretically deduced.

Iron pyrites.

The coals used in the experiments contained traces of iron pyrites. No simple relation exists for coal samples containing various proportions of this impurity, which has a specific gravity approaching 5 and yet only yields about 67% of ash on incineration in an open furnace.

Summary.

1. There exists no relation between the true and apparent specific gravities and the ash content of samples of clean coal from the same seam, owing to the fact that the sample may be composed of one or a mixture of the four banded constituents of the coal.

2. A relation exists between the true and apparent specific gravities and the ash contents of average samples, and an equation is given for calculating the ash content of the coal from the specific gravity.

3. No simple relation holds for coal samples containing varying proportions of iron pyrites.

4. It is not justifiable, in coal washing tests, to accept the specific gravity of the sample as the mean of the values for the two adjacent solutions used in float-and-sink tests.

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THE DETERMINATION OF PHOSGENE.

BY H. GORDON REEVES, M.SC., A.I.C.

Although phosgene was discovered in 1811 by)avy, as yet no ready process for its quantitative letermination has been described. The present nvestigation was commenced late in 1918 when hosgene was being extensively used for war purposes, ut it was found impossible until recently to complete he work.

Kling and Schmitz (Compt. rend. 1919, **168**, 73, 891) described a method of determining one part phosgene in 10,000 parts of air by bubbling the re through aqueous aniline and determining the direct weight of diphenylurea formed or ating the weight from a nitrogen determination e Kjeldahl process. This method, although it accurate results for small amounts of phosgene, te unsuitable for rapid manipulation.

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EXPERIMENTAL.

Determination of phosgene.—A saturated solution of phosgene in nitrobenzene was contained in a round-bottom flask of 250 c.c. capacity, fitted with a two-hole rubber bung. Through one hole passed a glass tube bent at right angles and terminating in a piece of rubber tubing closed by a screw-clip, and through the other hole passed one end of a double surface condenser. The condenser was connected to three glass U-tubes, each containing 10 c.c. of $13N$ sodium hydroxide solution. In order to prevent bumping and to ensure steady evolution of gas, small pieces of porous earthenware were added to the nitrobenzene solution. The round-bottom flask was heated on the water bath, and heating was continued until phosgene ceased to be evolved from the solution. Rapid evolution commenced at 75°, and one hour's heating sufficed for complete removal of the dissolved phosgene. Dry air was then bubbled through the whole apparatus *via* the tube carrying the screw-clip, in order to drive the last traces of phosgene forward into the absorption tubes. The contents of each U-tube were made up to 500 c.c. and titrated against $N/1$ hydrochloric acid solution. The amount of alkali used in the decomposition of the phosgene was thus arrived at by difference. In a typical analysis 4·734 g. of phosgene were found when 5 g. were used. The discrepancy was traced to the presence of free chlorine as impurity in the phosgene from the cylinders supplied for use.

This free chlorine was determined in two ways:—(1) The contaminated phosgene was passed through dilute potassium iodide solution and the iodine liberated determined by titration with standard sodium thiosulphate solution (Delépine, Bull. Soc. Chim., 1920, **27**, 283). The amount of free chlorine indicated by the method was 3·6–4%. (2) Known weights of liquid phosgene and mercury were shaken together in a bulb immersed in a freezing mixture. The phosgene was allowed to gasify, and from the increase of weight of mercury the amount of free chlorine was calculated.

The chlorine was removed either by passing the phosgene from the cylinder, through tubes containing respectively, powdered antimony, zinc dust, and calcium chloride, or more conveniently and much more rapidly by adding pieces of iron wire to the nitrobenzene before saturation. The iron removes the chlorine and at the same time a small amount of *m*-nitrochlorobenzene is produced. The phosgene thus freed of impurity was re-absorbed in nitrobenzene ready for use.

In the following series of experiments pure phosgene was employed, and its weight was estimated both as chloride and as carbonate (double indicator or B.D.H. universal indicator). Also, as a further precaution, five absorption tubes were used instead of three as previously.

Determination of $COCl_2$ as carbonate

No.	Wt. of $COCl_2$ taken. g.	Total wt of CO_2 found. g	Equivalent wt. of $COCl_2$ g.
1	5·20	5·15	4·814
2	5·60	5·87	5·480
3	4·80	5·097	4·760

Determination of $COCl_2$ as chloride

No.	Wt. of $COCl_2$ taken.	Total wt. of Cl_2 found.	Equivalent wt. of $COCl_2$.
1	5·20	3·53	4·92
2	5·60	4·00	5·58
3	4·80	3·44	4·79

Determination of free hydrogen chloride in phosgene.—By the above method it was found possible to determine hydrogen chloride as impurity in the phosgene. A known weight of pure dry hydrogen chloride gas at room temperature was introduced from a burette into a known weight of pure phosgene, and the mixed gases were passed forward into the decomposition tubes. The amount of free hydrogen chloride was obtained by the difference between the total chloride formed and that due to the decomposition of the phosgene.

Decomposition and determination of phosgene by means of heated zinc.—Phosgene (purified by passing through tubes containing respectively powdered antimony, zinc dust, and calcium chloride) was driven off from nitrobenzene solution and passed over heated asbestos impregnated with pure zinc dust (freed from chloride by repeated extraction with dilute acetic acid, washed with alcohol, and finally dried) contained in a combustion tube, 2 ft. long, supported in a furnace. The phosgene was passed over the heated zinc and heating was continued for three hours. As a precaution three U-tubes containing sodium hydroxide were fitted on to the combustion tube for the purpose of trapping any phosgene which escaped decomposition by the heated zinc. When cool the contents of the combustion tube were washed with pure dilute nitric acid into a large beaker. The asbestos was removed by filtration, carefully washed free from chloride, and the combined filtrate and washings were made up to a litre. 50 c.c. of the solution were mixed with 25 c.c. $N/10$ silver nitrate and titrated against $N/10$ ammonium thiocyanate. In a typical analysis in which the weight of phosgene taken was 2·38 g. the amount found was 2·37 g. Thus no ph... had escaped decomposition in the heated tub...

Determination of free hydrogen chloride.—... above method is most convenient for the determ... tion of free hydrogen chloride admixed with phos... The apparatus finally used is indicated in ...

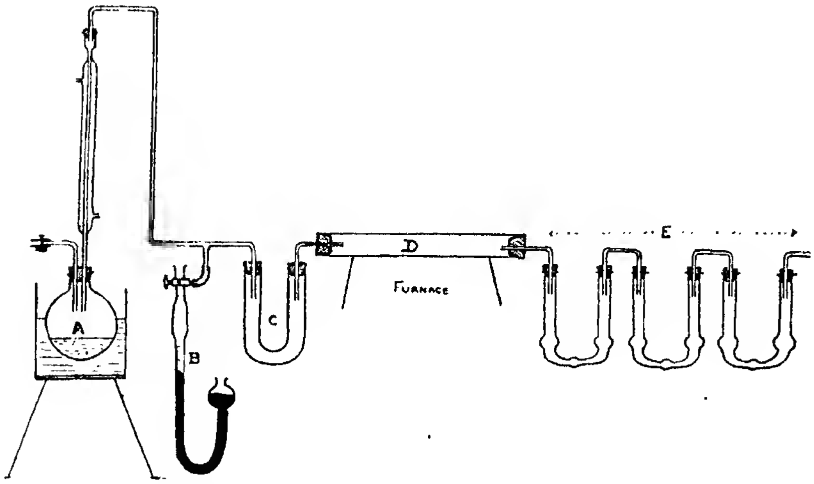

figure. Pure phosgene was driven off from the benzene solution contained in the flask, A, mixed with pure dry hydrogen chloride gas fro... burette, B. The mixed gases then passed through the cold U-tube, C, containing glass coated with pure zinc dust, next through the ...bustion tube, D, and finally into the absor... tubes, E, containing sodium hydroxide.

The amounts of chloride in C and D were separ... determined with silver nitrate and thiocya... No phosgene escaped decomposition in D.

In one analysis the weight of phosgene taken 4·09 g.; found 4·08 g. The amount of free h... gen chloride calculated was 9·64%, and the am... determined 9·58%.

In conclusion, I wish to thank Prof. P. F. Frank... for suggesting the work and for his kind interest... valuable advice throughout the investigation, ... also Mr. S. R. Carter for his help and criticism.

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Strand, W.C. 2.

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The chlorine was removed either by passing the phosgene from the cylinder, through tubes containing respectively, powdered antimony, zinc dust, and calcium chloride, or more conveniently and much more rapidly by adding pieces of iron wire to the nitrobenzene before saturation. The iron removes the chlorine and at the same time a small amount of *m*-nitrochlorobenzene is produced. The phosgene thus freed of impurity was re-absorbed in nitrobenzene ready for use.

In the following series of experiments pure phosgene was employed, and its weight was estimated both as chloride and as carbonate (double indicator or B.D.H. universal indicator). Also, as a further precaution, five absorption tubes were used instead of three as previously.

A pressure equaliser.—In many chemical operations, such for example as the preparation of ethylene, where a gas is either going to be washed through columns of liquid or to be passed into bromine as in the preparation of ethylene bromide, or in similar cases where a back pressure is developed, it is generally found that the preparation of the gas is hindered by the fact that this back pressure prevents the flow of liquid into the generating flask, and that gas often bubbles up in the opposite direction from that desired. The sketch, Fig. 3, shows a very simple and a very efficient method by means of which this drawback can be obviated. The preparation of ethylene may be taken as an example. Into the apparatus there is introduced at A a glass T-piece, and this is connected by means of rubber tubing with a bent glass tube, B, passing through a rubber cork fitted into the neck of the dropping funnel. The pressures in C and D are thus immediately equalised and liquid will flow from D into C no matter what the back pressure may be. This has, of course, the disadvantage that if the back pressure is too great the flask, C, might burst or the stopper blow out of it; but this can very easily be provided for in the already well known way by a T-piece, E, dipping into mercury or some other suitable liquid. This very simple device will certainly be found useful in many cases.

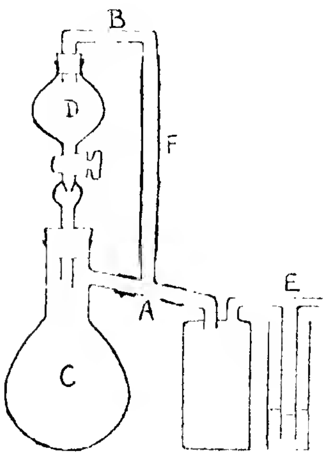


FIG. 3.

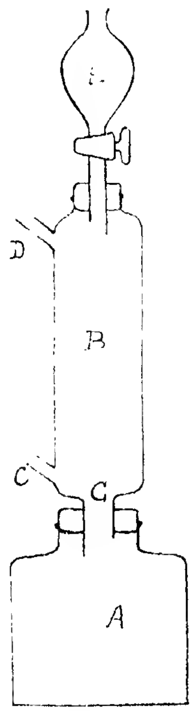


FIG. 4.

A fume absorber for the laboratory.—The piece of apparatus shown in Fig. 4 will be found useful for connecting up the apparatus in which a reaction is being carried out, producing acid fumes or some other easily absorbable substance, such as ammonia. In the preparation, for example, of acetyl chl considerable quantities of hydrogen chlo given off, an inconvenience well known chemists. The same inconvenience is alw enced when an apparatus for generatin

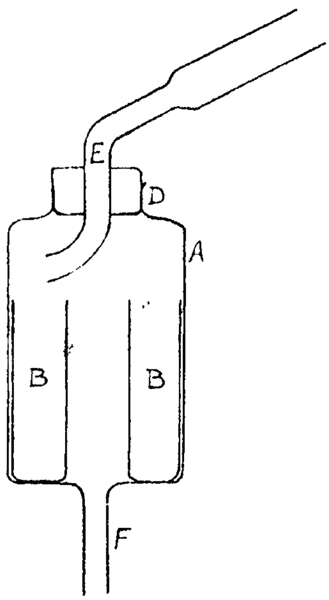


FIG. 5.

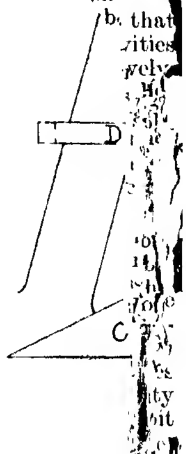


FIG. 6

chloride from concentrated hydrochloric ac sulphuric acid is used intermittently, and be left standing in a fume cupboard. The ap consists of a wide-mouthed squat bottle, which is fitted a wide glass tube, B, the low being constricted and passing through a cork fits into A. There are short side tubes at C B is filled with broken pieces of pumice which are kept from falling into A by some wool at G. The upper part of B is also cons and fitted with a cork through which pa dropping funnel, E, from which water may be to flow down over the pumice stone at such as may be convenient. The exit tube of an app in which, for example, hydrogen chloride is pro as a by-product, is attached by rubber tubing The hydrochloric acid is completely absorbed water trickling over the surface of the pumice There is no back pressure, and owing to the upward slope of C there should be no danger of the water sucking back through C into the re apparatus.

Vacuum distillation receiver.—The sketch in shows an apparatus which will be found usef the distillation of small quantities of liquids reduced pressure. It consists of a tube, A, internal diameter and having a neck, D, $\frac{3}{8}$ in. internal diameter, the other end being with a narrower tube, F, sealed on as shown. Si specimen tubes, B, B, 2 in. by $\frac{7}{16}$ in. (four or fi according to size), are then dropped into A, and ca be fixed in position round the walls of the larg

y pushing a piece of cotton wadding into the between them. The neck of the tube, D, d by means of a rubber cork, through which tube of a distilling flask, or an adaptor, E, as shown in the sketch. Air is pumped gh F, and when the distillation commences B, can be brought successively into position g the whole receiver around E. This may also be made in larger sizes suitable dinary work. An outer vessel 7 cm. in diameter with a neck 3 cm. in diameter, three tubes 10 cm. long by $2\frac{1}{2}$ cm. diameter 6 smaller tubes. Length of cylinder A, 7 cm.

m-wire press.—The sodium-wire press is fitted with a die provided with a small hole which the sodium is squeezed. It hastens reatly the preparation of sodium-wire for emical reactions if a number of holes, five or bored in the die.

t-tube stand.—Fig. 6 shows the end section t-tube stand of useful form. It consists of a wood, AB, to which is affixed another strip, l with holes, through which the wider end t tube may pass, and another strip, C, cut ngle. The test tube, after washing, is placed position shown in the figure, the upper part nto grooves at A. Moisture drains down the the point at which the lip touches C, and away completely. It is thus easy to keep tube both clean and dry. This test tube supplied by Messrs. Gallenkamp, London.

c Chemistry Department,
versity of Glasgow.

TALYSIS AND THE INTERNAL COMBUSTION ENGINE.*

BY EDWARD SOKAL.

l years ago an experimental and subsequently strial investigation was undertaken by the along the lines of applying the principle of s and the use of catalytic agents to the combustion engine. The starting point thought that nearly all the ailments and of the internal combustion engine, apart he purely mechanical constructive features, ue to the same basic phenomenon, namely, lete combustion of motor fuel within the l combustion engine. It occurred to the that it might be possible to promote com- by bringing the mixture of fuel and air combustion chamber into contact with a ent, solid catalytic agent.

the time interval during which useful com- n can take place in a motor is limited by the tion of the power stroke, it seems plausible t an acceleration of the combustion under these circumstances would effect a more complete combustion. Moreover, elementary thermodynamic considerations show that in the Otto or constant-volume cycle, on which the majority of the internal combustion engines and practically all motor engines operate, the heat transfer to the expanding medium is supposed to take place at constant volume or as nearly constant volume as possible, any deviation from this implying a loss in thermal efficiency: in other words, two engines showing the same exhaust gas analysis might have a greatly different thermal efficiency according to whether the process of combustion has taken place before the piston has moved appreciably or has extended and continued during a considerable part of the power stroke. From this basic theoretical starting point the author has been led to experimental work, which afterwards has been continued on an industrial scale, and is now applied successfully to commercial practice in the form of a catalytic coating called "Katalite," which is applied to the cylinder heads, and sometimes also to the pistons and spark plugs of automotive engines.

The combustion of motor fuel within the internal-combustion engine is a chemical reaction which cannot be properly allocated as either homogeneous or heterogeneous. It is started from one or several points according to whether simple or multiple ignition is employed, but the great turbulence prevailing within the combustion chamber gives it to a certain extent the character of a homogeneous reaction, and to this extent only the Guldberg-Waage law of mass action influences the speed of this combustion. This same phenomenon of turbulence explains why the very limited wall surface which can be coated with the catalytic agent can produce marked results. In this way the effect of the catalytic agent becomes analogous to the often, although unsuccessfully, attempted method of stratifying the fuel into leaner and richer layers, the latter ones being adjacent to the point of ignition. There is, however, this important difference, that stratification, which gives truly remarkable results under special laboratory and limited speed conditions, does not work satisfactorily in practice because it is destroyed by turbulence at higher speeds, whilst the effect of a catalytic layer on the surface of the combustion chamber is markedly increased by turbulence, each particle of fuel-air mixture that comes in contact with the coating acting like a stratified rich mixture.

Several years ago, the author, with the collaboration of Prof. E. H. Leslie of the University of Michigan, investigated various catalytic agents as to their fitness for the intended application to internal combustion engines. It was clear from the beginning that certain fundamental requirements had to be fulfilled in order to make this application possible. Besides the obvious commercial requirements of availability and price, the material selected had to exert a very pronounced catalytic effect on combustion and at the same time should not catalyse other undesirable reactions, as for instance, cracking and decomposition of the fuel, furthermore, it had to be refractory, non-abrasive, resistant to poisoning, susceptible of being spread with the use of a suitable

* Read at a meeting of the American Section on March 21, 1924.

binder as a resistant, adhesive, and permanent layer on the walls of the combustion chamber, and, last but not least, it should have a high coefficient of radiation, so that the heating effects of the combustion should not by accumulative increase bring about pre-ignition. The above requirements obviously limited the selection of suitable catalysts to certain classes of substances and to a still smaller number of preferential selections within these classes. Carefully made experiments, in which fuel-air mixtures of various compositions and proportions were permitted to flow at a predetermined speed and under exactly controlled conditions of temperature etc., once through ordinary tubes and then through tubes in which they encountered pieces of pumice stone impregnated with catalytic agents, demonstrated clearly that it was possible to find catalytic agents which would comply with the above-mentioned requirements and still accelerate the rate of combustion of various motor fuels over a thousand times. From this the conclusion was drawn that it ought to be possible to carry out the idea in practice and to obtain the desired improvements, provided, of course, that the fundamental conception was sound.

Amongst the catalysts which comply most closely with the above requirements, the metallic oxides, *e.g.*, vanadium oxide, cobalt oxide, rare earth oxides, and particularly cerium oxide on account of its high coefficient of radiation, have proved highly satisfactory.

Experience has fully confirmed this conclusion. Observations on several hundred cars, extending now over a period of more than two years, and in certain cars over a service range of more than 20,000 miles, have shown that the effect of a catalytic coating applied on a combustion chamber of an automotive engine is marked and permanent; no experiments have been made on other than automotive engines. In some engines, which have a large margin of cooling capacity, it has been found possible to increase the maximum power appreciably, but in all cases it is possible to duplicate the present optimum performance with a very much leaner mixture. An average of a great many tes shows the attainable fuel economy to be over 20% The carbon deposit is greatly diminished, rath soft and sooty, and does not interfere with th catalytic action. Performance tests have prov a decided improvement in flexibility, hill climbi etc. Experiments made under special conditi by the Locomobile Company have also clea confirmed the prediction that the catalytic coat has a decided tendency to counteract deto tion.

The curious phenomenon of detonation or f knock is not to be confounded with pre-igniti and is characterised mainly by abnormally hi pressures occurring during the power stroke lasting an infinitesimally small time only, s they can do no useful work and are only dest impacts. Midgley has found various chemica stances (*e.g.*, lead tetra-ethyl) which added fuel stop detonation, and has tried to explain ation as being due to too rapid combustic the author's opinion this explanation does n good from the standpoint of laws of physical istry. On the other hand, all the phenom detonation seem easily explained if attribu the thermal decomposition of the large fuel mo into a number of smaller molecules with sponding increase of local pressure. It is inter to note that the tendency of fuels to detonate ishes with their thermal stability, as eviden alcohol and benzol. "Katalite" counteracts ation because it accelerates combustion, but ation may also be counteracted by negative ca which might retard the decomposition of fu

So far, the catalytic coating called "Kat has been used in engines as they are now, w any change in the engine. It is considered as p and even probable that with certain chang for instance, increase of the surface of the com chamber, much greater effects could be pr which might have a bearing on the utilisat low-grade fuels, running of engines at co compression pressure, and various other qu of design and operation.

Errata.

THE EVAPORATION RATE OF SOME SOLUTIONS.

BY L. S. BAGSTER.

(This Journal, March 21, 1924, 61 T.—65 T.)

wing to a regrettable printer's error, for which the author was in no way responsible, the blocks of 2 and 3 were transposed, and some of the lettering in these and Fig. 4 was incorrectly reproduced.

he correct illustrations are given below, and should be substituted for those in the March 21 issue :—

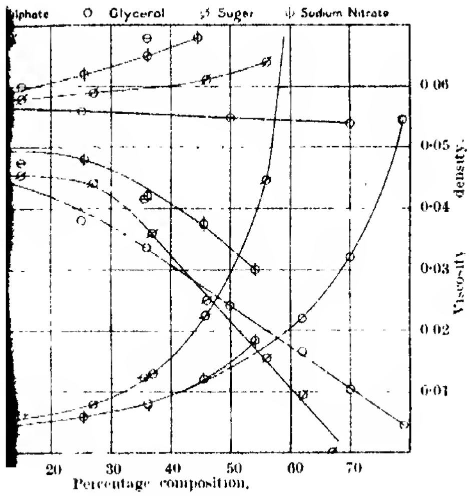


FIG. 2.

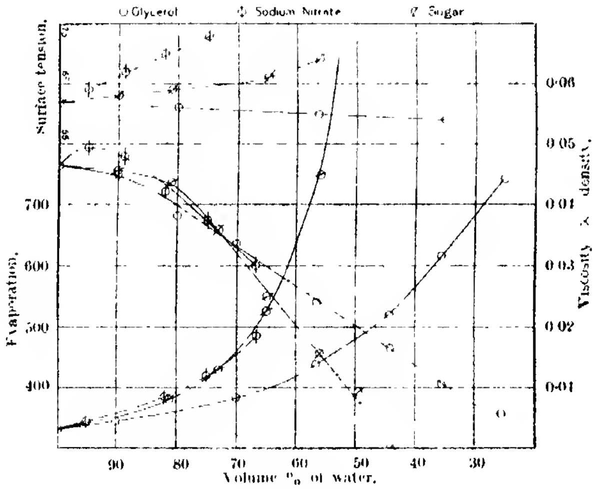


FIG. 3.

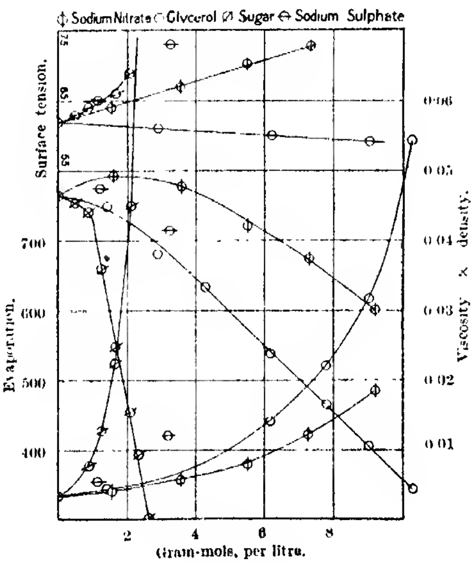


FIG. 4.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

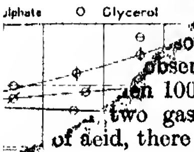
TRANSACTIONS

Vol. XLIII., No. 36.] [September 5, 1924.

...OF WATER IN MIXTURES ...OL, AND WATER.*

...WMAN, B.SC.

...ving to a regrettable p... by the work of Clayton ...and 3 were transposed, ...um carbide to remove ...correct illustrations ...alcohol and ether; he ...r were readily absorbed ... sulphuric acid (98%), ...ot absorbed to any appre-...sorption of acetylene in 98% ...observed by the author, and it ...en 100 c.c. of the gas were slowly ...two gas bubblers each containing ...of acid, there was a loss of about 5 c.c. ...of these facts the following method was ...to determine water in mixtures of ether, ...and water.



...asured volume of the mixture is boiled, and ...ours are led over calcium carbide. The ...e formed is separated from alcohol and ...y passing through concentrated sulphuric in potassium hydroxide solution of this concentration.

The apparatus used is shown in Fig. 1. It was found that carbon dioxide, either from cylinders or generated from hydrochloric acid and marble, contains, in every 250 c.c., 0·7—0·9 c.c. of gas which is not absorbed in potassium hydroxide solution, and therefore the volume of carbon dioxide used for clearing the apparatus of acetylene must be known, in order that a deduction may be made to allow for this insoluble portion. Hence the carbon dioxide is supplied from a graduated gasometer. The prolonged end of the burette, R, extends to the bottom of the boiling tube, E, where it dips under mercury. By this means the escape of ether vapour through the channels cut out by it in the lubricant of the burette tap is prevented. The metal plate under the tube, G, is heated when it is desired to re-volatilise any vapours which have condensed in G whilst passing from the boiling tube. The bubblers, H and I, are cooled in water to prevent excessive rise in temperature of the sulphuric acid due to absorption of the alcohol and

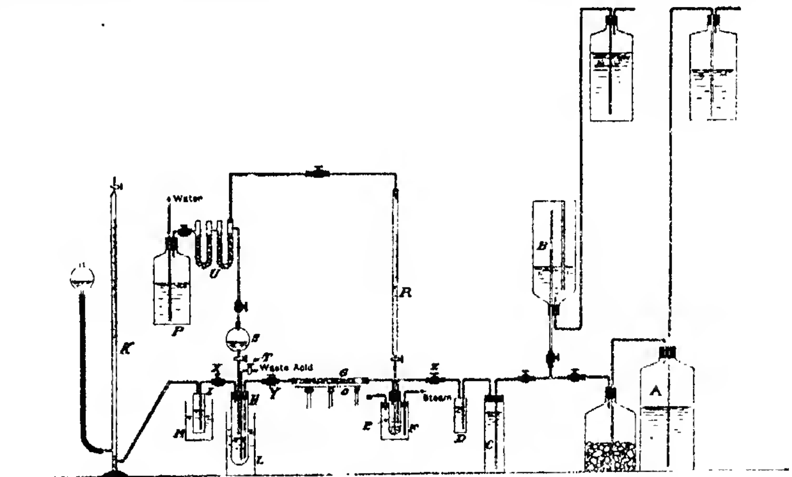


FIG. 1.

...G. 1.—A. Carbon dioxide generator (hydrochloric acid and marble). B. Graduated gasometer; hydrostatic pressure of 4—5 feet of water ...s shown in diagram. C and D. Gas bubblers containing concentrated sulphuric acid. E. Boiling tube, 10×3·5 cm. F. Steam jacket. ...s tube, 35×1·5 cm, filled with small pieces of calcium carbide. H and I. Gas bubblers containing 30-40 c.c. of 98% sulphuric acid. K. ...eter. L and M. Vessels containing cold water. O. Metal plate heated when required by three Bunsen burners. P. Pressure bottle. ...ith the end prolonged to dip under mercury contained in E. The top is connected with the pressure bottle, P. S. Reservoir containing ...ic acid. T. Tap through which waste acid from H is drawn. U. Calcium chloride U-tubes. X, Y and Z. Screw clips.

...l is subsequently collected and measured. ...ommencing a determination a current of ...on dioxide is passed through the apparatus, ...lly the acetylene is driven over by carbon ...into a Schiff nitrometer containing a con-...ntrated aqueous solution of potassium hydroxide (120 g. in 90 c.c. of water) in which the carbon dioxide is absorbed. Acetylene is practically insoluble ether. When the acid in the bubbler, H, is spent it may be replaced without the admission of air to the apparatus by closing the screw clip, X, and opening the tap, T, when the pressure of the carbon dioxide from the gasometer will be sufficient to drive out the acid. The tap, T, is then closed. To introduce fresh acid the screw clip, Y, is closed and the clip, X, opened; the reservoir, S, is filled with acid and the required quantity forced into H by pressure from the bottle, P. This latter also

* Read at a meeting of the Sydney Section on May 14, 1924.

supplies the necessary pressure to force the mixture from the burette into the boiling tube against the pressure of the carbon dioxide within. Except in the cases of D and H, which are entirely of glass, each vessel is provided with a rubber stopper, and all connexions are made with stout pressure tubing securely wired. It was found that a preliminary heating at 100° prevented the occurrence of error due to liberation of any moisture from the rubber stopper of the boiling tube.

Experimental method.

The boiler is heated at 100° by means of the steam jacket, whilst a current of dry carbon dioxide is passed to clear the apparatus of air. Usually from 500 to 750 c.c. of carbon dioxide must be employed for this purpose, the current being continued until, of 250 c.c. passed through the apparatus, only 0·8—1·0 c.c. is not absorbed by the potassium hydroxide solution. The heating is discontinued at the end of the first fifteen minutes. When the air has been displaced the boiler is allowed to cool and the screw clip, Z, closed. The required volume of mixture is then forced into the boiler; the amount to be used depends on the water content; thus, for mixtures containing less than 0·5% of water, 10 c.c. were used; for mixtures containing between 0·5 and 2·0%, 5 c.c.; and for mixtures containing more than 2·0%, 2·5 c.c. The mixture is caused to boil gently by passing a very slow current of steam through the jacket, care being taken to prevent too rapid ebullition. When all the mixture has been evaporated the condensed vapours in G are re-volatilised by warming the plate, O, and the screw clip, Z, is opened slightly to permit the passage of a slow current of carbon dioxide. This current is continued until all the acetylene has been swept over; the tube connecting E and G is warmed meanwhile to re-volatilise vapours condensed therein, the boiler being also heated at 100° by passing a rapid current of steam through the jacket. Usually between 500 and 750 c.c. of carbon dioxide are required to clear the apparatus. From the volume of the gas in the nitrometer is deducted an amount determined by the volume of carbon dioxide used (as explained above); the remainder is taken as the volume of acetylene produced.

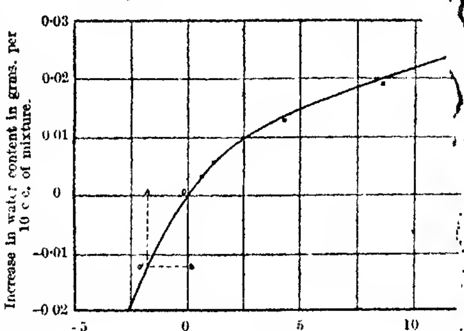
In the first bubbler, H, 33—40 c.c. of sulphuric acid will absorb 20 c.c. of a mixture of ether and alcohol before requiring renewal, whilst the acid in the second bubbler, I, rarely needs changing, because absorption is practically complete in H. The frequency with which the calcium carbide should be renewed depends on the water content of the mixtures under examination, but after ten determinations, when a total of 0·5 g. of water had passed, it was found to be still effective. The calcium carbide used was of the ordinary commercial variety, and results from various samples did not vary appreciably.

Anæsthetic ether, *d* 0·720, was subjected to analysis in the apparatus, and 10 c.c. gave 10 c.c. of acetylene. After drying over metallic sodium for one month and distilling through a twenty-[illegible] fractionating column and condenser, the frac[...]tion distilling between 34·3° and 34·4° was examined[...], and 10 c.c. gave 1·7 c.c. of acetylene. A sample of [...] 10 c.c. of ether which had been dried over meta[...]llic sodium for 6 months gave 1·6 c.c. of acetyl[...]ene. It is therefore assumed that the ether is [...] not dried absolutely by sodium.

To te[...]st the apparatus various mixtures of known compo[...]sition were made and examined. To the ether [...] dried over sodium were added known amounts of aqu[...]eous alcohol of known water content, and readings [...] were taken. From the volume of acetylene obtained [...] a deduction was made for that part of the readin[g ...] due to the water in the original ether, and thus the [...] actual increase of volume of acetylene for known [...] in water content was arrive[d] at. Variation of the [...] concentration of the aqueous alcohol used as diluent [...] did not appreciably affe[ct] the results.

The following is a summary of the results ob[tained] (see also Fig. 2):—

Increase in water content in grams per 10 c.c. of mixture.	Mean.		Increase (over 1·7 c.c. ...) at 20° of acetylene obtained from 10 c.c. of mixture.		Mean.
0·0032		..	0·6 c.c.	..	—
0·0032	0·0032	..	0·6 c.c.	..	0·6 c.
0·0056		..	1·0 c.c.	..	—
0·0063	0·0059	..	1·5 c.c.	..	1·25 c.
0·0131		..	4·5 c.c.	..	—
0·0124	0·0127	..	4·2 c.c.	..	4·35 c.
0·0196			9·2 c.c.	..	—
0·0183	0·0189	..	8·1 c.c.	..	8·6 c.
0·0267			13·5 c.c.	..	—
0·0281	0·0274	..	14·0 c.c.	..	13·75 c.
0·0353			21·0 c.c.	..	—
0·0347	0·0341	..	21·0 c.c.	..	—
0·0323			19·0 c.c.	..	20·3 c.
0·0484			29·2 c.c.	..	—
0·0520	0·0502	..	30·2 c.c.	..	29·7 c.
0·0681			41·7 c.c.	..	—
0·0681	0·0681	..	44·3 c.c.	..	43·0 c.
0·0835			52·6 c.c.	..	—
0·0835	0·0835	..	54·0 c.c.	..	53·3 c.
0·0950			58·9 c.c.	.	—
0·0950	0·0950	..	58·3 c.c.		58·6 c.
0·1219	0·1219	..	74·3 c.c.	..	74·3 c.
0·1426	0·1426	..	88·3 c.c.	..	88·3 c.
0·1532			93·0 c.c.	.	—
0·1532	0·1532	..	96·4 c.c.	.	—
0·1532			96·0 c.c.	..	[illegible]·1 c.
0·2033	0·2033	..	123·5 c.c.	..	[illegible]5 c.
0·2803			168·5 c.c.	..	—
0·2803	0·2803	..	168·7 c.c.	..	[illegible] c.



Increase in volume of acetylene in c.c. obtained from 10 c.c. of [...]

FIG. 2.

The driest ether obtainable gave a readin[g of] 1·7 c.c. (*cf. supra*); since this volume was prob[ably] due to unremoved water it was necessary to a[rrive] at the actual amount of water present. Thi[s was] done by plotting a curve of increase of volum[e over] 1·7 c.c. against increase in water content [...]

and producing back a distance OA corresponding o a volume of 1·7 c.c., the new point O[1] being the new zero. From the result of this extrapolation t seems that there was probably 0·0120 g. of water per 10·0 c.c. in the dry ether (0·14% by weight). The figures representing increase in water content are therefore increased by 0·0120 g. to represent he true water content; similarly, the figures representing the increase in volume are increased by 1·7 c.c. to give the true volume of acetylene.

The new table is then as follows:—

Water content in g. per 10 c.c. of mixture.		Vol. at 20° of acetylene obtained from 10 c.c. of mixture. c.c.	Water content in g. per 10 c.c. of mixture.		Vol. at 20° of acetylene obtained from 10 c.c. of mixture. c.c.
0·0120	..	1·7	0·0801	..	44·7
52	..	2·8	0·0955	..	55·0
79	..	2·95	0·1070	..	60·3
47	..	6·05	0·1339	..	76·0
10	..	10·3	0·1546	..	90·0
[illegible]	..	15·45	0·1652	..	96·8
[illegible]	..	22·0	0·2158	..	125·2
[illegible]	..	31·4	0·2923	..	170·3

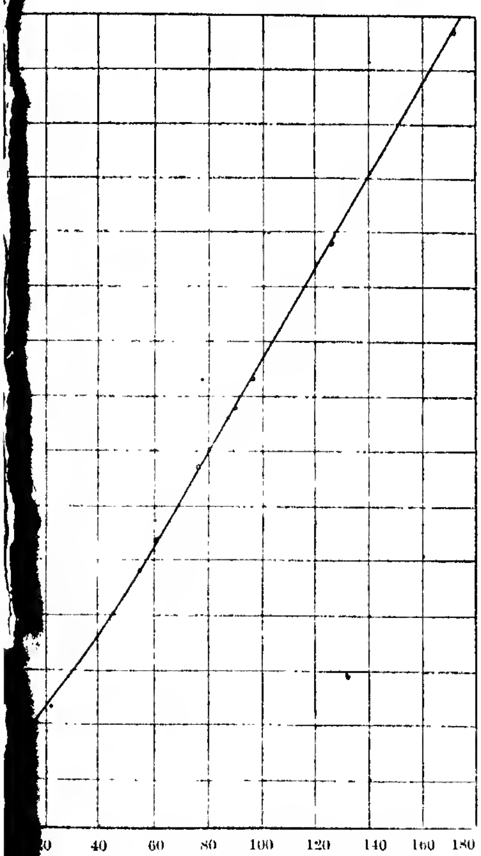


FIG. 3.

curve, Fig. 3, plotted from these results straight line except for the portion near the gin, where it becomes convex to the vertical s. This indicates an expected decrease in sensieness as the water content diminishes, due to the difficulty of bringing all the water vapour into contact with the calcium carbide when it constitutes only a small proportion of the mixed vapours. When the mixture contains more than 1·25% of water, 1·0 c.c. of acetylene at 20° is obtained from 0·00172 g. of water, although theoretically 0·00162 g. of water gives 1 c.c. of acetylene at N.T.P. P. V. Dupré, when using calcium carbide to determine water in ammonium oxalate, cordite, naphthalene, etc. (Analyst, 1906, 31, 213), found that 1 c.c. of acetylene was obtained for every 0·001725 g. of water present, but in that case the acetylene was measured direct and underwent no treatment such as passing through sulphuric acid.

Preliminary enquiries indicate that the method is applicable to the determination of water in aqueous alcohol, and it is intended to make this the subject of further investigations.

The author wishes to express his thanks to Prof. Schofield for suggesting this line of research, to Acting-Professor Harker for advice during the progress of the work, and to Mr. P. G. Carter for drawing the diagram and graphs.

The University,
Sydney.

THE ACTION OF OZONE ON HYDROCARBONS, WITH SPECIAL REFERENCE TO THE PRODUCTION OF FORMALDEHYDE.

BY E. W. BLAIR, D.I.C., B.SC. (LOND.), A.I.C., T. S. WHEELER, PH.D., B.SC. (LOND.), F.R.C.SC.I., F.I.C., and W. LEDBURY, M.SC., A.I.C.

PART III.—THE ACTION OF OZONE ON n-HEXANE.

In papers published by two of the authors (J., 1922, 331 T; 1923, 343 T) investigations have been described dealing with the action of ozone on methane and ethylene, particular attention being paid to the production of formaldehyde. The action of ozone on higher unsaturated hydrocarbons has been investigated and does not, as is well known, differ materially from its action on ethylene; on the other hand, the action of ozone on the higher saturated hydrocarbons does not seem to have been studied, at least quantitatively. In the present investigation the action of ozone on n-hexane, at the boiling point, was investigated.

Apparatus and methods.

Air or oxygen, after passing through a rate-gauge, was freed from dust and carbon dioxide, thoroughly dried by concentrated sulphuric acid and phosphorus pentoxide, and then led through an ozoniser into pure boiling n-hexane, which had previously been three times fractionated to within 0·2° and was contained in a flask heated on a water-bath and fitted with two vertical condensers in series. The gas then passed through three wash-bottles in series, through potassium iodide solution in order to destroy any unused ozone, through a bubbler containing baryta water to show the presence of carbon dioxide,

and then through palladous chloride solution to test for carbon monoxide. All joints in the apparatus were of ground glass.

The quantity of gas passed was determined by noting the average rate of passage and the duration of the experiment from the time the hexane commenced to boil until the experiment was discontinued. The air used was taken directly through a reducing valve from a compressed air supply; oxygen, when employed, was drawn from a cylinder. The percentage of ozone was determined at intervals of one hour, using a three-way tap, which enabled the ozone in a measured quantity of the gas coming from the ozoniser to be determined (see Analyst, 1923, 48, 110.) The determination had to be made at hourly intervals since, if the concentration of the iodine, liberated from the potassium iodide, was allowed to increase, a reaction to produce iodoform took place between it and a small quantity of acetaldehyde, which escaped absorption by the wash-waters.

Experimental results.—During an experiment no fumes were observed in the apparatus as a result of the action of the ozone on *n*-hexane. In the baryta bubbler barium carbonate was gradually deposited, whilst the very slow formation of a precipitate from the palladous chloride solution indicated the presence of traces of carbon monoxide. In all the bubblers a small quantity of hexane was condensed, and the gas issuing from the apparatus had a slight odour of it.

The residue in the reaction flask at the conclusion of the experiment formed two layers, both of which possessed a strong odour of fatty acids. The lower layer, which was much the smaller in bulk, contained no hexane; the upper consisted chiefly of that hydrocarbon. The following detailed account of an experiment will make clear the methods adopted to examine the products and the results obtained.

Description of an experiment

Initial content of refluxing flask—200 c.c. of redistilled *n*-hexane.

O_3 applied, 661·5 c.c.

O_3 not reacting (from liberation of I_2 in KI bubbler), 168·0 c.c. Total volume of residue in flask at conclusion of experiment, 152 c.c.

The residue formed two layers, the lower having a volume of about 10 c.c. This had a total acidity equivalent to 41 c.c. of $N/10$ alkali =(if only monobasic acid is present) 91·8 c.c. of acid as vapour at N.T.P. There were also present formaldehyde (shown by potassium cyanide test), acetaldehyde (shown by the iodoform test), and propaldehyde (shown by the skatole test).

On distillation the liquid darkened and a small quantity of an aldehyde, b.p. 75° (*n*-butaldehyde) passed over. A trace of a white solid (paraformaldehyde?) separated at 90°. At 100° a few drops of water distilled. At 103° isobutaldehyde and at 128° caproic aldehyde were isolated in small quantities. Above 130°, decomposition set in rapidly; distillation ceased at 150°. The residue, small in quantity, was black and viscous and possessed a rancid odour; it was soluble in water yielding a strongly acid solution which did not give an aldehyde reaction with Schiff's reagent. Since *n*-hexane and the lower fatty acids distil without decomposition, other compounds such as dibasic, hydroxy or ketonic acids and lactones were probably present.

The upper layer of the residue had a volume of 142 c.c. On fractionation of an aliquot portion, *n*-hexane corresponding to 129 c.c. on the whole was recovered. It contained small quantities of formaldehyde, higher aldehydes, and acid. A dark brown, viscous liquid remained; this possessed a fruity odour, was slightly acid and insoluble in water. On further heating small fractions corresponding to butyric, valeric, and *n*-hexoic acids were obtained. The greater portion, however, remained as a residue, boiling up to 250°, when decomposition occurred. There would seem to be present, from the boiling point, hexyl hexoate. It is known that this ester is produced when hexyl alcohol is oxidised with acid bichromate solution to hexoic acid (Franchimont and Zincke, Annalen, **163**, 197), and a similar reaction would seem to have occurred here. During the oxidation the acid may have combined, as formed, very rapidly with the alcohol present, but more probably hexoic aldehyde is produced and undergoes simultaneous autoxidation and reduction to the alcohol and the acid, which combine *in statu nascendi* to the ester (*cf.* the Cannizzaro reaction).

A portion of the upper layer of the residue in the refluxing flask was allowed to stand over saturated sodium bisulphite solution for some days, when long, thin, rod-like crystals were deposited. These crystals were distilled with dilute sulphuric acid; the distillate, when treated with iodine and alkali, gave iodoform, showing that the sodium bisulphite compound of acetaldehyde had been obtained.

Before the various distillations described above were carried out, the total residue in the reaction flask was agitated and an aliquot portion of the temporarily homogeneous emulsion produced was withdrawn and examined quantitatively for formaldehyde, higher aldehydes, and total acidity. The wash waters in the bubblers were made up to a standard volume, and similar determinations performed on an aliquot portion.

The following are the complete results:—

Total volume of ozone reacting, 493·5 c.c. at N.T.P.

Total volume of hexane volatilised=approximately 1000 c.c. of vapour at N.T.P.

Total volume of monobasic acid recovered (c.c. vapour at N.T.P.)=95·4.

Total volume of formaldehyde (c.c. vapour at N.T.P.)=38·3.

Total volume of monoaldehydes other than formaldehyde (c.c. vapour at N.T.P.)=227·0.

Total volume of CO_2 (c.c. N.T.P.)=29·5.

The data provided under (2) in the subjoined table summarise the results of the experiment. For the purpose of comparison the results of another experiment (1) have also been tabulated.

Expt.		1.	2.
ume of air employed in litres		439·0	129·0
e of passage of air		1 litre in 3 mins.	1 litre in 3 mins.
ation of expt.		22 hrs.	11 hrs.
O_3 in air current (by vol.)		0·088	0·51
e of contact of ozone and hexane (mins.)		1·8	1·7
ozone consumed		96·4	74·6
obasic acid obtained per c.c. of O_3 applied, as c.c. vapour at N.T.P.	in hexane		
	in residue	0·12	0·13
	in wash waters	0·015	0·015
$_2O$ obtained per c.c. of O_3 applied, as c.c. of vapour at T.P.	in hexane		
	in residue	0·033	0·035
	in wash waters	0·028	0·023
O_2 obtained		Trace	Trace
no-aldehydes obtained per c.c. of O_3 applied in c.c. apour at N.T.P.	in hexane		
	in residue	0·15	0·311
	in wash waters	0·006	0·013

It will be observed that an increase in the per- ntage of ozone in the air stream enhances the yield higher aldehydes. Further, a higher concentration ozone leads to the production of relatively larger ounts of the gaseous oxidation products.

Discussion of results.—In all the experiments st of the monobasic acid formed remained in the ction flask, and the quantity was of the order of ·5 c.c. of monobasic acid vapour per c.c. of ozone plied.

The formaldehyde isolated was divided almost ually between the reaction flask and the washing ain. The quantity obtained increased somewhat th the percentage of ozone in the air or oxygen.

The greater part of the ozone and hexane con- med was recovered as higher monoaldehydes her than as formaldehyde. The major portion these aldehydes remained in the reaction flask. om a study of the quantity of hexane volatilised d of the quantity of ozone consumed, it is clear at much of the hexane passed through the apparatus changed. Comparison of the volumes of ozone nsumed with the quantities of aldehydes and acids tained show that the following reactions probably curred :—

$$_6H_{14}+7O_3=3C_{n-1}H_{2n-1}CHO+3C_{m-1}H_{2m-1}CHO +6O_2+3H_2O \text{ (where } m+n=6\text{), and}$$

$$C_pH_{2p-1}CHO+O_3=C_pH_{2p-1}CO_2H+O_2.$$

these equations represent the only reactions curring, then 7/6 times the volume of the alde- des+13/6 times the volume of the acid obtained, ould equal the volume of ozone consumed. Actually e figure is 502·55 c.c. as against 493·5 c.c. Evi- ntly in some of the oxidising actions the three oms of the ozone molecule were active.

A number of experiments with percentages of ozone rying from 0·09 to 1·72 gave very similar results regards the amount of the products obtained r c.c. of ozone reacting. That this similarity rsists, even with very low concentrations of ozone, ows that the oxygen of the air takes little or no rt in the oxidation.

Summary.

The products obtained by the action of ozone on iling *n*-hexane are as follows :—

) *Aldehydes.*—Formaldehyde, acetaldehyde (in rela- tively large quantities), and the higher aldehydes to hexoic.

) *Acids.*—Probably all up to hexoic (this present in greatest quantities).

(3) *Esters.*—Primarily hexyl hexoate (the presence of these compounds cannot be considered as definitely proved).

(4) Traces of water, carbon monoxide and dioxide.

The aldehydes of higher molecular weight than acetaldehyde are not found in any quantity, owing to the readiness with which they are oxidised to the corresponding acids, and perhaps owing to the for- mation of esters from them.

Acetaldehyde appears to be one of the chief products ; the hexane molecule, once attacked, apparently breaks down with ease.

This work was carried out on behalf of the Depart- ment of Scientific and Industrial Research, to whom we are indebted for permission to publish these results.

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NOTE ON THE ACTION OF BROMINE ON *n*-HEXANE.

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In the authors' experiments on the action of ozone on *n*-hexane (*cf.* page 287 T), a bubbler containing bromine with a small quantity of water was attached to the end of the absorption system, to determine whether any unsaturated hydrocarbons were pro- duced. As the experiment progressed this bromine was gradually decolorised and finally two layers of liquid remained, the lower nearly colourless and the upper straw-coloured. A quantity of yellow crystalline solid was also observed.

The latter was filtered off and shaken with ether. A portion dissolved, and on evaporating the ether yielded white prisms, which, on recrystallisation from pure hexane, had m.p. 87°, b.p. 219°, and appeared to be identical with *p*-dibromobenzene. This was confirmed : (1) by analysis ; (2) by the fact that the addition of pure *p*-dibromobenzene gave no depression of the melting point ; (3) by conversion on nitration into 2.5-dibromonitrobenzene.

The portion insoluble in ether when washed with water, dried, and recrystallised from benzene, in which it was slightly soluble, yielded needles, m.p. 212°. Mixed with *trans*-benzene hexabromide, pre- pared by the action of sunlight on a mixture of bromine and benzene, no lowering of the melting point was observed.

The two layers of liquid were separated and ex- amined. The lower proved to be water. The upper was shaken with 0·5% caustic soda until colourless, and then extracted with ether. The extract was dried and the solvent evaporated. White crystals, which proved to be *p*-dibromobenzene, were obtained. No other products were isolated. In one experiment

about 5 g. of *p*-dibromobenzene and 1 g. of *trans*-benzene hexabromide were produced.

In order to determine if the products were formed by the action of bromine on the *n*-hexane carried through the apparatus, or on some of its oxidation products, blank experiments were performed in which *n*-hexane, three times fractionated (fraction collected boiling within 0·2°), was volatilised into bromine in a current of nitrogen, the same apparatus being used. Identical products were obtained. In these control experiments, and in those with ozone, much of the hexane passed through unattacked; a quantity of the bromine, too, was volatilised.

When benzene was substituted for hexane and a similar procedure adopted, *p*-dibromobenzene and *trans*-benzene hexabromide were again formed and in similar proportions. The rate at which they were produced, however, differed very little from their rate of formation from hexane, so that with the latter the presence of the benzenoid compounds in quantity in the bromine bubbler cannot have been due to any slight trace of the aromatic hydrocarbon in the hexane.

The above results therefore seem to indicate an action, hitherto unobserved, of bromine on *n*-hexane. No ring compounds, as far as we can trace, are reported in the literature as having been obtained by the action of bromine on *n*-hexane; the nearest analogous result is the production of hexabromobenzene, C_6Br_6, from secondary hexyl iodide and excess of bromine by heating under pressure at 220° (Ber., 11, 2247). The conditions necessary for this new reaction appear to be the presence of excess of bromine and of the hexane as a very dilute vapour. The direct action of liquid bromine on liquid *n*-hexane yields a liquid dibromohexane, b.p. 211° (Jahresber., 1862, 411). This result we have confirmed.

The mechanism of the reaction is not clear. Since benzene volatilised into bromine by means of nitrogen yields results identical with those given by hexane, it is possible that cyclohexane and then benzene are formed by oxidation of *n*-hexane by the bromine, and that the benzene is then brominated, by the great excess of bromine, to the hexabromide and the dibromo compound.

We hope further to investigate this phenomenon by allowing the vapours of benzene and *n*-hexane to mix; also, by cooling the gas coming from the bromine bubbler, to attempt to condense benzene or cyclohexane. Replacement of bromine by other oxidising agents, such as nitric acid, is contemplated.

We desire to express our thanks to the Department of Scientific and Industrial Research, for permission to publish this note.

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TRANSACTIONS

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HE CAUSE OF THE LOW YIELD OF ALCOHOL ON FERMENTATION OF MOLASSES.

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This investigation was undertaken at the suggestion Mr G. H. Dickson, Managing Director of the Indian stillery Co., Cawnpore, who showed that the yield alcohol from the fermentation of molasses was ways considerably less than that expected from analysis of the molasses. He pointed out that low yield was probably not due to bad conditions fermentation, bacterial infection, etc., because in same distillery the yield of alcohol from *mohua* wers was much nearer to that expected from alysis. He also stated that the spent wash from lasses was able to reduce a considerable amount of hling's solution.

The object of this investigation was to ascertain cause of this low yield of alcohol and if possible find a means of improving the yield.

This low yield of alcohol from molasses is well own (see Allen's "Commercial Organic Analysis," ed., vol. 1, p. 357). The reducing power of nt wash is also known. In the "Chemists' Year ok," 1920, vol. 2, p. 866, for the determination invert sugar there is given a correction for non-ar substances which reduce Fehling's solution, principle being to ferment away sugars with wer's yeast and determine the reducing power after mentation. Harker (J. 1906, 831) came to conclusion that the non-fermentable reducing stances, returned as reducing sugar in the analysis molasses, and left in the spent wash, were not ficient to account for the low yield of alcohol, did these substances inhibit the complete fer-ntation of the sugars. In his opinion some stance returned as sucrose both by optical and uction methods was destroyed during fermentation hout giving any alcohol, even under conditions ing a very good yield of alcohol from sucrose.

Fermentation experiments.

All our experiments were made on a sample of lasses left in the manufacture of sugar from lian *ghur*. It gave the following figures on alysis: Reducing sugars 17·8%; sucrose (by rget's process) 37·4%; other organic matter n sugars) 14·6%; ash 6·5%; water 23·7%.

For analysis, the molasses solution was purified treatment with normal lead acetate, the excess lead was removed by disodium phosphate or hrogen sulphide, and the cupric reduction method lumetric and gravimetric) and polarimetric method e employed for determining sugar, the inversion ng effected by invertase in preference to acids. reducing sugars were determined by the cupric uction method and the sucrose by the polari-tric method, using Clerget's formula for calculation. The total sugar as reducing sugar was obtained by adding the amount of reducing sugars and the equivalent of the sucrose. The total sugar as reducing sugar was also determined direct by the cupric reduction method, the inversion being effected by invertase. The two methods gave 57·2 and 56·8% respectively, and the mean, 57·0%, was taken as the percentage of reducing sugar in the molasses. As pointed out by Harker (*loc. cit.*), the amount of reducing sugar returned is higher—viz., 59·3%—if the inversion is effected by acid.

A. Large scale fermentation. The weight of molasses used was 2545 kg., the volume of wash 1732 litres. Initial sp gr. 1·0491, final sp. gr. 1·0132. 500 c c of wash were distilled, and the distillate was made up to 500 c c. The alcoholic distillate had d 0·9935. 2545 kg of molasses contain sucrose and reducing sugars equal to a total of 1450 kg. of reducing sugars which, according to Pasteur, should yield 718 kg. of alcohol. The actual yield was 620 kg, or 86·3% of Pasteur's maximum practical yield. (Figures supplied by the Indian Distillery Co.)

B. Semi-large scale fermentation —Molasses used 17·24 kg. Initial sp. gr of wash 1·054, final 1·018. Volume of alcohol obtained, 4·2 litres of d 0·825 and 2·5 litres of d 0·945. 17·24 kg of molasses contain the equivalent of 9·82 kg. of reducing sugars which, according to Pasteur, should yield 4·86 kg of alcohol. The actual yield was 3·97 kg. of alcohol or 81·6%

C. Laboratory fermentation.—All precautions were taken to sterilise the molasses by boiling and dissolving in boiled distilled water. The wort was pitched with active yeast obtained from the Indian Distillery Co., and fermentation was carried out at 33°–35° in previously sterilised bottles, the mouths being closed by cotton-wool.

Molasses used, 140 g., volume of wash, 760 c c.; 0·5 g. of ammonium sulphate and 0·2 c c. of concentrated sulphuric acid were added.

Initial sp. gr. 1·048 to 1·052; volume of active yeast solution added, 150 c c.; total volume of fermented wash, 910 c.c.; final sp. gr. 1·016 to 1·020; volume of active wash reserved for next batch 150 c c.; volume of wash distilled, 760 c.c.

A series of eight experiments was carried out. The yield of alcohol obtained in each experiment is recorded in column 2, the yield expressed as percentage of Pasteur's maximum practical yield in column 3. The reducing power of the spent wash was determined in each experiment and the equivalent of reducing sugar is recorded in column 4. In column 5 is given the corrected value for sugar in the molasses, obtained by subtracting the amount of reducing substance in the spent wash from the original figure for reducing sugars in the molasses, and in column 6 is given the yield of alcohol reckoned from the corrected value for sugar in the molasses, and expressed as percentage of Pasteur's maximum practical yield.

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No. of expt.	Yield of alcohol g.	Alcohol as % of max. yield	Reducing power of spent wash.	Sugar in molasses (Corr.)	Yield of alcohol from corrected value.
1	32.4	82.0	12.1	67.4	99.7
2	33.1	83.8	10.8	69.0	99.0
3	31.7	80.2	11.6	68.2	97.9
4	32.5	82.3	12.0	67.8	98.9
5.	32.9	83.3	10.5	69.3	98.0
6.	33.6	85.1	10.2	69.6	99.6
7.	31.0	78.5	12.8	67.0	95.1
8.	33.0	83.5	10.6	69.2	98.4

These figures show that the reducing substance left in the spent wash entirely accounts for the low yield of alcohol from the molasses.

This result is in direct contradiction of that obtained by Harker (*loc. cit.*) He does not mention the source of the molasses examined, but it contained more ash and less reducing sugars than our sample, and, especially, it gave much less reducing substance in the spent wash viz., 2.46% on the weight of molasses, whilst our sample gave 8.1%.

Nature of the reducing substances left in the spent wash.

Pentoses. It appeared possible that the reducing substances left in the spent wash might be sugars such as pentoses unfermented by ordinary yeast. The original molasses gave the furfural test for pentose and the spent wash gave a small quantity of osazone which, on purification melted at 156°–158° (*cf.* arabinosazone, m.p. 158°, xylosazone, m.p. 158°).

Pentoses were determined in the original molasses by the method of Günther, de Chalmot, and Tollens (Ber., 1891, **24**, 3575) and found to be present to the extent of 1.2%.

Glutose. This unfermentable sugar has been found in sugar-cane molasses in amounts varying from 1 to 5%, as a result of the action of the lime used in clarification upon the invert sugar of the juice. Not being fermentable it is found as a constituent of the vinasse from molasses distilleries (Pellet, Bull. Assoc. Chim. Sucr., **16**, 1181; **19**, 834; Browne, "Handbook of Sugar Analysis," p. 629). It was thought at first that the reducing substances present in the molasses and spent wash under investigation might be chiefly glutose, especially as the spent wash is optically inactive and aqueous solutions of glutose are said to show no perceptible optical activity. But according to the literature glutose forms an osazone, and this was confirmed by preparing a sample of glutose, which gave a good yield of osazone, crystallising in yellow, lustrous, silky needles, m.p. 181°–182°. But, as the spent wash gives only a very small yield of osazone, of which the melting point corresponds to that of a pentosazone, it cannot contain any appreciable quantity of glutose.

Organic acids. The reducing properties of the spent wash cannot be due to any ordinary organic acids with reducing properties, as these are all precipitated by normal lead acetate, whereas this reagent does not remove the reducing substances from the spent wash.

Gums. A good deal of the dissolved matter is precipitated from the spent wash by strong alcohol, and, conversely, a good deal of solid is left on exhaustively extracting with alcohol the residue obtained by evaporating the spent wash to dryness. The reducing power resides chiefly in the fraction insoluble in alcohol—*e.g.*, 100 g. solid matter gave 57.5 g. of residue insoluble in alcohol and 42.5 g extracted by alcohol; reducing substances in the insoluble residue (reckoned as reducing sugar) 15.6 g.; in the substance extracted by alcohol 4.4 g. The substance insoluble in alcohol was oxidised by nitric acid (*d* 1.2) and gave a good yield of mucic acid—viz., 100 g. gave 12.5 g. of crude mucic acid which, on recrystallisation gave 3 g. of pure mucic acid melting at 215°–216° and a second crop of 2.6 g. which almost entirely melted below 220°. This large yield of mucic acid proves that the reducing properties of the spent wash are chiefly due to a gum of the galactan type. In order to obtain further proof of this the spent wash was hydrolysed with 5% sulphuric acid for 18—24 hours. Some increase in reducing power was at first observed, but after prolonged boiling the reducing power actually decreased. Even after this protracted hydrolysis the bulk of the gum remained unchanged, as was seen by its insolubility in alcohol. A portion of the hydrolysed spent wash, 2.5 g of reducing substance, yielded 0.5 g of crude osazone which was fractionally crystallised from acetone. Only one pure osazone could be isolated from it; this melted at 192°—193° and was, therefore *galactosazone*. The initial increase in reducing power followed by eventual decrease can be explained on the assumption that the gum is partly of the galactan and partly of the xylan type and on hydrolysis it gives galactose and pentose, which latter is decomposed by protracted boiling with acid, giving furfuraldehyde.

The occurrence of such a gum in cane-juice, *ghur*, or molasses has not been previously described. Heriot ("Manufacture of Sugar from the Cane and Beet," pp. 128, 134) mentions the occurrence of xylan in sugar-cane and juice. But, as xylan is precipitated by lead acetate and, moreover, is quickly hydrolysed on heating with dilute hydrochloric or sulphuric acid (Browne, *loc. cit.*, p. 553), it cannot be the reducing substance which we have found in the spent wash, which is not precipitated by lead acetate and is very resistant to hydrolysis. Moreover, xylan would not yield mucic acid on oxidation.

Other gums which are mentioned as occurring in cane-juice are dextran and levan produced by the action of bacteria. But these substances yield dextrose and lævulose on hydrolysis and would not give mucic acid on hydrolysis.

Conclusion.

(1) This investigation has shown that in molasses prepared from Indian *ghur*, the low yield of alcohol on fermentation is almost entirely due to a gum, which on account of its reducing properties is returned as reducing sugar in the analysis of molasses. This gum is very resistant to acid hydrolysis and yields no dextrose or lævulose on protracted acid hydrolysis. It gives a good yield of mucic acid and is, therefore partly of the galactan type. It may be mixed gum of the galacto-xylan type.

It is intended to ascertain whether this gum could be used as a substitute for other gums which are employed as mucilage or in textile printing etc.

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THE AMINO-NITROGEN OF WOOL IN RELATION TO CHLORINATION.

BY S. R. TROTMAN AND C. R. WYCHE.

The reactions which take place during the chlorina-on of wool are obscure and difficult to investigate, it it is supposed generally that the first action is to roduce chloramines, of the type R·NHCl or CO·NHCl, whilst further treatment results in e breaking down of the keratin molecule into simpler lorinated compounds and sulphuric acid. Meunier nd Latreille (Chim. et Ind., 1923, **10**, 636 642) ggest that stable chloramines are formed and that e hydrochloric acid thereby produced is fixed by on-chlorinated amino compounds, forming sub-ances of the type R·CO·NHR,HCl. It must be bserved that, if the keratin molecule is built up in e manner of a polypeptide, the number of free NH_2 roups capable of reacting with chlorine must be omparatively small. No direct evidence appears to ave been published concerning the amount of mino-nitrogen present in wool, although various bservers have determined the percentage of nitrogen ordinary and deaminated wool. During the course f some investigations upon the "unshrinkable" nish, it became desirable to try to determine both he amount and nature of the amino groups present wool, by direct measurement of the nitrogen volved. The following method was adopted.

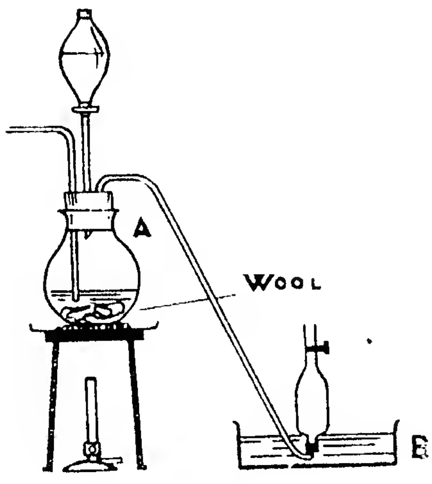

Fig 1.

A weighed piece of dry, purified webbing was placed n flask, A (Fig. 1), together with some water. The ontents of the flask were boiled to expel occluded air nd the flask was then connected, as shown, with a rbon dioxide generating apparatus, a tap funnel, nd a delivery tube dipping beneath the surface of odium or potassium hydroxide solution in B.

The tap funnel having been closed, the air was completely displaced by carbon dioxide. A solution of sodium nitrite in hydrochloric acid was then introduced by means of the tap funnel.

If any amino groups attached to aliphatic residues are present in wool, there should be an evolution of nitrogen at the ordinary temperatures. To expel this, a slow stream of carbon dioxide was passed through the apparatus for about three hours. The gas collected in the receiver was allowed to stand in contact with potassium hydroxide for some time, to free it from carbon dioxide. It was then transferred to a pipette, measured, and analysed, nitric oxide and oxygen being removed successively by means of ferrous sulphate and pyrogallol. The diazotisation of wool is a slow process, at the ordinary temperature, requiring at least 24 hours. After collecting any nitrogen formed by decomposition of aliphatic amino groups, the fabric was allowed to soak in the nitrous acid solution for from one to two days. It was then removed, washed with water, replaced in the flask, and the air again expelled by carbon dioxide. Cuprous chloride solution was then run in, through the tap funnel, and the contents of the flask were boiled gently to expel the nitrogen. The last traces were again swept out by means of carbon dioxide. The gas collected was analysed as before. The results of these experiments proved, quite conclusively, that wool contains amino groups attached to both aliphatic and aromatic residues. Several different kinds of wool were tested, and in every case there was an immediate liberation of nitrogen, followed by a further evolution when the diazotised product was boiled with w. ter or cuprous chloride solution. The percentages obtained, however, were not constant.

Some figures are given in the following table:—

Expt. no.	% N liberated in the cold.	% N liberated on boiling.	Total % N.
1	0·257	0·304	0·561
2	0·378	0·170	0·548
3	0·257	0·130	0·387
4	0·190	0·236	0·426

It was found, subsequently, that the azo compound of wool is decomposed slowly during the process of diazotisation and that the percentage of nitrogen obtained, on boiling, depended upon the interval between the first and second parts of the experiment. An experiment in which arrangements were made to prevent loss due to this cause gave for the total amino-nitrogen 0·785%. But the manipulation was very difficult, since a large volume of nitric oxide was also produced. Further tests are being made. In the last case the total nitrogen present in the original and deaminated wool was determined. The loss was 0·356%, *i.e.*, less than the total amino-nitrogen present. This difference agrees with that obtained by E. R. Trotman (J. Soc. Dyers and Col., 1924, 40, 77), but is much less than that given by Benz and Farrell (J., 1897, 406), namely from 0·1 to 1·2%. Kann's statement (J., 1914, 251) that no amino groups are present may be referred to, whilst Gebhard

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(J., 1910, 640) says that no nitrogen is given off when diazotised wool is boiled. The fact that the total amino-nitrogen is greater than the difference between the percentage of nitrogen present in ordinary and deaminated wool must indicate that nitrosamines, of the type R·N(NO)R′, have been formed from imino groups. This is important, because the Liebermann test for imino groups is not applicable to keratin, after diazotisation and deamination, owing to secondary reactions disguising the colour. If wool contains as much as 1% of amino-nitrogen this would be quite insufficient to account for the chlorine which is absorbed during chlorination, as will be seen later. Hence it appears unlikely that the amino groups play a very important part in the reactions concerned. This is indicated also by the following experiments.

(1) Several specimens of knitted fabric were diazotised and deaminated by prolonged heating at a low temperature. It was found that deamination did not produce structural damage such as is associated with badly chlorinated samples (*cf.* Trotman, J., 1922, 219 T). The shrinkages of the original and deaminated fabrics were exactly the same; the tensile strength and elasticity were also unaltered. Thus in the case of a yarn:—

	Elasticity.	Tensile strength
Original yarn	19·2 ..	7·10
Deaminated yarn .. .	20·6 ..	7·31

When deaminated woollen fabrics are chlorinated they become unshrinkable. The fabric is neither more nor less sensitive to the treatment, the structural damage produced being practically the same in both cases.

(2) The total chlorine absorbed by ordinary and deaminated wool is practically the same, namely, from 24 to 35%, and in both cases the rate of absorption is almost identical. When wool or deaminated wool is treated with chlorine, there is, at first, a very rapid disappearance of chlorine, followed by a slow and gradual absorption. Thus, the curve consists of two distinct portions (Fig. 2).

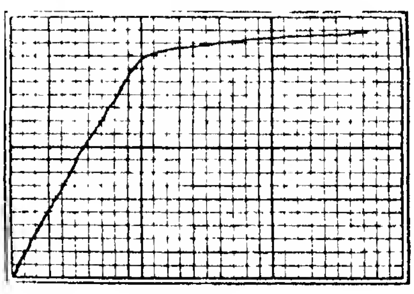

Fig. 2.

This appears to indicate that both adsorption and chemical action take place, at first simultaneously, and after adsorption has ceased, chemical action only. These points will be dealt with fully in a later paper, but the following experiments were made with the object of separating the total chlorine adsorbed and that which enters into chemical combination.

A purified knitted fabric was soaked in excess of chlorine water till absorption ceased. It was then washed several times with an acidified solution of hydrogen peroxide to remove adsorbed chlorine. It is known that the combined chlorine of chloramines is not liberated by hydrogen peroxide. After thorough washing, the residual chlorine was determined by boiling a weighed piece of the fabric with fuming nitric acid in the presence of silver nitrate. The experiment was then repeated with the same fabric after diazotisation and deamination. The results were:—

	% of combined chlorine on dry fabric No. 1.	No. 2.
Original fabric	6·6 ..	5·3
Deaminated fabric ..	6·4 .	5·7

After treatment with hydrogen peroxide, the fabric still liberated iodine from potassium iodide in the presence of an acid. This power was only destroyed very gradually by prolonged boiling with water. When wool is washed, after chlorination, with cold water, adsorbed chlorine is retained even after 24 hours' continuous washing. It is expelled by boiling with water. In one experiment, after washing in a stream of running cold water for 24 hours, the fabric was boiled with water four times for half an hour. It still liberated iodine from potassium iodide. The residual chlorine was in two different experiments (1) 0·6% and (2) 0·7%. It is evident that these chlorine compounds must be comparatively stable (*cf.* Meunier and Latreille, *loc. cit.*).

It has been shown already (Trotman, *loc. cit.*) that during the chlorination of wool, both nitrogen and sulphur are dissolved, the latter as sulphuric acid. The following confirmatory experiments have been made.

Pure cashmere wool was soaked for 24 hours in chlorine water. The total quantity of chlorine absorbed was 22·1%. After filtration the filtrate contained dissolved sulphur 0·49% and dissolved nitrogen 1·11% on the weight of wool. The filtrate was boiled, for some time, to expel chlorine and then evaporated to dryness at a low temperature. The dry residue still reacted with potassium iodide. Its aqueous solution gave the biuret reaction and precipitated tannic acid. It was partly soluble in alcohol. When the alcoholic extract was evaporated to dryness the residue still liberated iodine from potassium iodide, as also did the insoluble portion.

Summary.

(1) Wool contains both aliphatic and aromatic amino groups.
(2) The total amino-nitrogen is probably about 0·7%.
(3) The total amino-nitrogen is greater than that lost by deamination. Hence probably imino groups are present.
(4) The Liebermann reaction gives inconclusive results with wool.
(5) Ordinary and deaminated wool have the same shrinkage, elasticity and tensile strength, and absorb practically the same amount of chlorine.
(6) During chlorination of wool, chlorine is both adsorbed and enters into chemical combination.

(7) The prolonged action of chlorine gives rise to sulphuric acid and soluble nitrogen compounds. The latter contain firmly combined chlorine and are only decomposed by prolonged boiling. The chlorinated wool contains approximately 6% of chlorine which cannot be removed by means of hydrogen peroxide and which is only expelled by boiling.

PREPARATION OF ETHYL ACETATE AND ETHYL ACETOACETATE.

BY KENNETH CHARLES ROBERTS, M.SC.

Preparation and purification of ethyl acetate.

As a preliminary to the study of the preparation of ethyl acetoacetate, various methods of preparing and purifying ethyl acetate have been subjected to critical investigation.

Wade (Chem. Soc. Trans., 1905, **87**, 1656–1668) describes two continuous processes for the preparation of ethyl acetate. The "fast" process is claimed to give a product containing approximately 77% of ester, whilst the "slow" process, using equimolecular quantities of alcohol and acetic acid and only a very small quantity of sulphuric acid, is claimed to give a product containing 85% of ester. These yields appear surprisingly high when compared with those obtained in the ordinary way from mixtures of ethyl alcohol and acetic acid.

The residue in the "slow" process was observed to accumulate appreciably (*loc. cit.*, p. 1659); it is impossible to see how this can be so—the residue being mainly water—and yet the process still be truly continuous, *i.e.*, maintain its initial efficiency without a falling off in the percentage of ester in the distillate. The small quantity of sulphuric acid used must act largely as a catalyst, and there is, therefore, no apparent reason why the ordinary equilibrium for an equimolecular mixture of alcohol and acetic acid should be displaced to give a product containing 85% of ester as claimed by Wade.

As regards the "fast" continuous process, it may be assumed without appreciable error, that the residue after distillation is negligible. If then, the law of mass action is applied to a mixture containing originally $1\frac{1}{2}$ mols. of alcohol and 1 mol. of acetic acid, it may be shown that the distillate must contain about 18% of alcohol. This is not in agreement with Wade's figure of 12%, but agrees with the 19% observed in this investigation.

Wade's method of analysis is difficult to interpret, is intricate, and is also limited in its application owing to the proximity of the boiling points of the ternary and ester–water mixtures (70·3° and 70·45°, respectively, *loc. cit.*, p. 1666).

The practical investigation of the Wade processes is described below, and the yields of ester based on a different method of analysis are in both cases lower than those given by Wade, as was anticipated.

The following is a summary of the analytical method used in this investigation: A few grams of the crude ester are weighed out, and the free acid is titrated with standard alkali. The ester is then saponified with excess of 2*N* caustic soda, and the quantity of ester determined by titration with standard acid. The liquid is then distilled until all the alcohol has passed over, the quantity of alcohol being obtained by a density measurement. From the total alcohol thus obtained, that formed by saponification is deducted, and hence the original alcohol obtained. Water is obtained by difference.

The above method is not applicable in presence of a fifth constituent—*e.g.*, ether. Also, to ensure accuracy, density determinations must be made within 0·1° of the temperature for which the tables used are given. Duplicate analyses of a single distillate gave perfectly concordant results:—

Comparison of processes.

Summary of results.—

	100 c.c. glac. acetic with—	Wt. distillate.	% Composition		Wade's result.	B.p. range after treatment w. K_2CO_3		% Ester calc. on acetic acid.
A.	150 c.c. abs. alc. 5 c.c. conc. H_2SO_4. (Wade's "fast" continuous.)	204 g.	Acetic	2·5	—	70·1–	72°	92% (Excess alcohol).
			Ester	69·5	76·5			
			Alcohol	19·2	12·5			
			Water	8·8	11·0			
B.	100 c.c. abs. alc. 5 c.c. conc. H_2SO_4. (Wade's "slow" continuous.)	158 g.	Acetic	5·9				
			Ester	75·6	85·4	40% at 70°–	72°	77%
			Alcohol	7·7	8·6	30% at 72–	76°	
			Water	10·8	6·0			
C.	100 c.c. abs. alc. 20 c.c. conc. H_2SO_4. (Discontinuous process.)	150 g.	Acetic	4·3		Over 50% at 76°–	77°	83%
			Ester	86·8	—			
			Alcohol	4·7				
			Water	4·2				

Product C is thus the only one which lends itself readily to purification by fractionation.

When a further 200 c.c. of this mixture of acetic acid and alcohol was run into the residue in process B, the yield of ester fell to 73% by weight of distillate, thus showing that the process is not truly continuous, as had been anticipated from theoretical considerations.

In process C, the procedure is as follows: The mixture is heated under a reflux condenser on a water-bath for 10 minutes until equilibrium is attained, and the liquid then distilled from an oil-bath at 130°. The figure of 20 c.c. concentrated sulphuric acid is arrived at from thermo-chemical considerations.

It will be seen from the table that process A is wasteful of absolute alcohol, and the high alcohol content of the product makes purification very difficult. This process is, therefore, eliminated as a profitable source of ethyl acetate. Process B is much more efficient, but less so than process C, which lends itself very readily to the method of purification elaborated below. A detailed comparison of processes B and C in this connexion is given later.

Method of purification.

Wade mentions (*loc. cit.*, p. 1668) that alcohol impurity may be removed by repeated shaking with and distillation from water, but no data are given. This principle was adopted, and the following results were obtained:—

	Original composition	Water ratio 2:1 One distillation	Water ratio 2:1 Two distillations.	Water ratio 4:1 One distillation.
Ester	69·5%	86·8%	90·2%	89·1%
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(J., 1910, 640) says that no nitrogen is given off when diazotised wool is boiled. The fact that the total amino-nitrogen is greater than the difference between the percentage of nitrogen present in ordinary and deaminated wool must indicate that nitrosamines, of the type R·N(NO)R', have been formed from imino groups. This is important, because the Liebermann test for imino groups is not applicable to keratin, after diazotisation and deamination, owing to secondary reactions disguising the colour. If wool contains as much as 1% of amino-nitrogen this would be quite insufficient to account for the chlorine which is absorbed during chlorination, as will be seen later. Hence it appears unlikely that the amino groups play a very important part in the reactions concerned. This is indicated also by the following experiments.

(1) Several specimens of knitted fabric were diazotised and deaminated by prolonged heating at a low temperature. It was found that deamination did not produce structural damage such as is associated with badly chlorinated samples (*cf.* Trotman, J., 1922, 219 T). The shrinkages of the original and deaminated fabrics were exactly the same; the tensile strength and elasticity were also unaltered. Thus in the case of a yarn:

	Elasticity.	Tensile strength.
Original yarn	19·2	7·10
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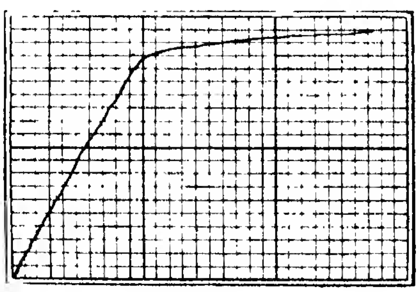

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Summary of results:—

	100 c.c. glac. acetic with—	Wt. distillate	% Composition		Wade's result	B.p. range after treatment with K_2CO_3		% Ester calc. on acetic acid.
A.	150 c.c. abs. alc. 5 c.c. conc. H_2SO_4. (Wade "fast" continuous.)	201 g.	Acetic	2·5		70·4°–72°		92% (Excess alcohol)
			Ester	69·5	76·5			
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B.	100 c.c. abs. alc. 5 c.c. conc. H_2SO_4 (Wade "slow" continuous.)	158 g.	Acetic	5·9		60% at 70°–72°		77%
			Ester	75·6	85·4	30% at 72°–76°		
			Alcohol	7·7	8·6			
			Water	10·8	6·0			
C.	100 c.c. abs. alc. 20 c.c. conc. H_2SO_4 (Discontinuous process.)	150 g.	Acetic	4·3	—	Over 70% at 76°–77°		83%
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Product C is thus the only one which lends itself readily to purification by fractionation.

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In process C, the procedure is as follows: The mixture is heated under a reflux condenser on a water-bath for 10 minutes until equilibrium is attained, and the liquid then distilled from an oil-bath at 130°. The figure of 20 c.c. concentrated sulphuric acid is arrived at from thermo-chemical considerations.

It will be seen from the table that process A is wasteful of absolute alcohol, and the high alcohol content of the product makes purification very difficult. This process is, therefore, eliminated as a profitable source of ethyl acetate. Process B is much more efficient, but less so than process C, which lends itself very readily to the method of purification elaborated below. A detailed comparison of processes B and C in this connexion is given later.

Method of purification.

Wade mentions (*loc. cit.*, p. 1668) that alcohol impurity may be removed by repeated shaking with and distillation from water, but no data are given. This principle was adopted, and the following results were obtained:—

	Original composition	Water ratio 2:1 One distillation.	Water ratio 2:1 Two distillations	Water ratio 4:1 One distillation.
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Water	8·8%	6·4%	7·8%	6·2%

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The loss of ester is thus very slight, and about 75% of the alcohol originally present is left behind in the flask at each distillation. Wade states (p. 1668) that only 30% of the alcohol is left behind after each distillation from water, but does not state the amount of water used.

The 2% of alcohol left after this treatment may, if desired, be readily removed by fractionation without serious loss of ester. It is also insufficient to interfere with drying processes to any extent. (Potassium carbonate and other agents are not completely effective in presence of much alcohol.)

The separation by distillation from water depends on the volatility of the alcohol in the alcohol water mixture (b.p. 78·15°) at the temperature of distillation of the ester-water mixture (70·45°). Hence, if the ester layer be first separated, and the aqueous layer containing practically all the alcohol be then distilled to recover its dissolved ester, an even better separation than the above should be obtained. This procedure, when tried, gave such favourable results, that it was adopted subsequently.

Application of method of purification to the Wade "slow" discontinuous and the continuous processes.

Summary of results: –

200 c.c. each alcohol and acetic acid with	Wt. of distillate	Ester in distillate	Yield on alcohol	Water ratio	Purification. Wt. ester boiling within 0·5°.*	% on original alcohol.
(1) 10 c.c. H_2SO_4 ('Slow' continuous)	313 g.	77·6%	79·1%	3 : 1	158 g.	62%
(2) 10 c.c. H_2SO_4 (Discontinuous)	328 g.	83·5%	89·5%	2 : 1	170 g.	57%

* After drying over potassium carbonate and fractionating three times.

All low-boiling residues, the bulk of which had an ester content of over 90%, were kept and worked up in the same way, so that loss of ester was reduced to a minimum.

The discontinuous process, therefore, gives a higher yield of ethyl acetate after treatment with water in the ratio of two to one, than does the slow continuous when water is used in the ratio of three to one. It is also more expeditious.

Summary.

Ethyl acetate is best prepared as follows: An equimolecular mixture of absolute alcohol and glacial acetic acid is heated under a reflux condenser with one-tenth its volume of concentrated sulphuric acid on the water-bath for 10 minutes, and then distilled from the oil-bath at 130°. The crude distillate is purified by shaking with twice its volume of water, separating the ester layer, and distilling the aqueous layer up to 72° for dissolved ester. The two portions of ester thus obtained are mixed, dehydrated over potassium carbonate, and fractionated. Ester of 98% purity, free from water, is then obtained in excellent yield by collecting the portion boiling at 76·15°–77·15° (1 mm. of mercury corresponds to a change in boiling point of 0·06°).

Final purification of the high-boiling ester was effected by heating it with phosphorus pentoxide (Inglis and Knight, Chem. Soc. Proc., 1907, 198) and then fractionating. The whole product distilled within 0·1°, and the bulk, as nearly as could be judged, at a constant temperature. This highly purified material was used in the subsequent work.

Preparation of acetoacetic ester.

The mechanism of the reaction in the synthesis of acetoacetic ester has never been fully explained, and it was thought that by carrying out a series of quantitative measurements of the yields obtained under a standard set of conditions, the condensing agent only being varied, further light might be thrown on the mechanism of the reaction; also that the ordinary laboratory preparation might be improved.

The ethyl acetate used throughout the following series of condensations was the constant boiling material prepared as described above. Caustic soda was excluded, as far as possible, in adding sodium by weighing out the required amount of clean metal in anhydrous ether, and rejecting the first and last portions of wire which emerged from the press, since they were generally somewhat tarnished. In each case 100 g. of ethyl acetate were condensed with 10 g. of sodium or the equivalent amount of other condensing agent.

Condensations were carried out as follows: –

(1) Ethyl acetate with metallic sodium.

(2) Ethyl acetate and sodium with varying percentages of alcohol.

(3) Ethyl acetate and sodium ethoxide.

(4) Ethyl acetate and sodamide.

Summary of results: –

Condensing agent	Time for reaction, hours	Yield of acetoacetate, g.	B.p. ranges of ethyl acetate-alcohol mixture.
Sodium . .	6 ..	Not obtainable	–
„ (wire) }*	2 ..	.. 18 ..	–
„ (powder) }†	1 .	.. 18 ..	–
„ ½% alcohol	1¾ .	.. 18 .	75·5°–76·5°
„ 1% „	1¼ .	. 19 ..	75°–76·5°
„ 2% „	1¼	. 23 .	74·5°–76·5°
„ 5% „	1½ ..	.. 24 ..	73·5°–76·5°
„ 10% „	1 .	12 ..	72°–76·5°
„ 5% „ and 1% water	¾ ..	trace	–
„ chloride	2 .	„ ..	–
Sodamide .	not observed	4 ..	–
Ethyl acetate A	1 .	.. 15 ..	not observed
„ „ B .	1½ ..	.. 22	74°–76·5°

* To exclude all trace of caustic soda, a piece of sodium was heated with ethyl acetate until all tarnish was removed. The liquid was then decanted, the sodium washed rapidly three times with ethyl acetate, and, finally, a further quantity of the latter added and the mixture heated under a reflux.

† It might be anticipated that prolonged heating would decrease the yield of acetoacetic ester owing to formation of by-products, but, within limits, this is seen not to be the case.

Ethyl acetate A is the crude material from the discontinuous preparation simply dehydrated with potassium carbonate and condensed with sodium. Taking the other results into consideration, it is evident that there is either a trace of water or too much alcohol present, and so the maximum yield is not obtained.

Ethyl acetate B is the crude material from the discontinuous preparation purified by one distillation from water as described above, and then dehydrated over potassium carbonate.

The above results show that the maximum yield f acetoacetic ester is obtained by condensing a ynthetic mixture of pure ethyl acetate and 5% f absolute alcohol with untarnished sodium wire. 'urthermore, when using the purest materials availble, the reaction between ethyl acetate and sodium s initially extremely slow, even at the boiling emperature, but later proceeds with increasing apidity. This is to be expected if even a minute race of alcohol or water is initially present, since his trace will react to produce more alcohol, either lirectly, in the case of a trace of alcohol, or by ormation of caustic soda and subsequent saponifying ction in presence of a trace of water. In addition, he yield using ethyl acetate and sodium only, is ower than when alcohol is present. It would, herefore, appear that sodium alone is ineffective is a condensing agent, though the actual mode of eaction of sodium ethoxide or sodamide is not as et definitely known (*cf.* Scheibler and Ziegner, Ber., 1922, **55**, B, 789).

The above observation is in direct opposition to hat of Tingle and Torsline (J. Amer. Chem. Soc. 908, **30**, 1875), but the validity of their conclusions s rendered doubtful on the following grounds: The yields obtained with different grades of ester ire not given, whilst accuracy with regard to the boiling point of the ethyl acetate used does not appear o have been rigidly observed. Moreover, a neutral eaction of the ethyl acetate to litmus is no test of he freedom of the ester from alcohol and water, he most likely impurities and the most important. Also, treatment with calcium chloride after phoshorus pentoxide appears ineffective, since calcium hloride is appreciably soluble in ethyl acetate and lecomposes it at the boiling point (Le Cann, Compt. rend., 1885, **100**, 40). Granted, however, that the ethyl acetate employed was pure, it is also allmportant that the sodium introduced should be ree from caustic soda. No mention is made of precautionary measures in this regard, but the claim s, nevertheless, made that sodium dissolves as eadily in pure ethyl acetate as when alcohol is present. In view of the results given above, this would not appear to be the case.

The progressive falling off in the yield between a condensing agent containing 5% of alcohol, and one consisting solely of sodium ethoxide would appear to be due to the accumulation of alcohol in the reaction mixture. An increasing quantity of alcohol in the reaction mixture would cause a displacement of the equilibria cited by Dieckmann (Ber., 1900, **33**, 2670) unfavourable to the formation of ethyl acetoacetate.

The present series of experiments has also established the best set of conditions under which to carry out the reaction as a laboratory preparation. This follows since ethyl acetate B (above) gives a yield comparable with the best obtainable from pure materials. The value of this observation is increased by the fact that ethyl acetate B is so readily prepared. Finally, the reason for low yields in the ordinary laboratory preparation is not, as is often stated in textbooks, the presence of appreciable quantities of alcohol, but rather the presence of small quantities of water or caustic soda.

In conclusion, the author wishes to express his indebtedness to Professor Inglis for his guidance during the course of this work.

University of Otago,
Dunedin, New Zealand.

THE RATE OF DISAPPEARANCE OF SULPHITES IN RAW MEAT.*

BY F. H. CAMPBELL, D.SC.

The Health Acts governing, *inter alia*, the manufacture and sale of foods in Australia, provide that all samples taken for analysis shall be divided into three parts by the official, who makes the purchase, and that of these one shall be retained by him for analysis by an umpire in case of any dispute. The Acts contain no direction as to the treatment of this sample and, in the case of materials such as meat, changes may occur which render its analysis useless. The addition of sulphites to raw minced or sausage meat is permitted but the amount must not exceed a quantity corresponding to 3·5 grains of sulphur dioxide per lb. Except in summer the temptation to use excess of preservative is small, so that almost all the samples are taken during warm weather. Before the sample can reach the umpire analyst a period of not less than a month must elapse, and experience has shown that meat kept in a sealed vessel at ordinary summer temperatures loses sulphite at a rapid rate. For example, the author found in a sample six weeks old only one-fortieth of the amount of sulphur dioxide reported to be present by the analyst who examined the fresh sample. In a recent case in Victoria the municipal analyst found the fresh sample to contain an amount of preservative in excess of that permitted, the author found 1·2 grains of sulphur dioxide per lb. in the month-old sample, and the umpire, whose sample was some six weeks old, found a slightly smaller amount. He added to his report a comment to the effect that the condition of the sample was such that it was impossible to judge of the amount originally present. The result was that the defendant was convicted and fined.

The outcome of this case was that the author was commissioned by the Master Butchers' Association of Victoria to investigate the rate at which sulphites disappear when admixed with raw meat and kept under different conditions in closed bottles.

The scope and details of the investigation are given below.

The meat used was freshly-minced lean beef to which a certain proportion of flour had been added; it yielded sulphur equivalent to 0·13 grain of sulphur dioxide per lb. of meat. Sodium sulphite, which

* Read at a meeting of the Sydney Section, May 14 1924.

yielded 11·9% of sulphur dioxide, was finely powdered and thoroughly incorporated with the meat by hand.

Approximately equal weights of treated meat were placed in clear, wide-mouthed bottles, and the glass stoppers, after insertion, were dipped into molten paraffin wax. Three sets of samples were exposed to diffused daylight and the ordinary fluctuations of temperature. The records kindly supplied by the Meteorological Department show that the mean temperature during the period under review was about 50° F. The fourth set of samples was kept in a refrigerating chamber.

At the end of each period a bottle of each set was opened and 50 grams of its contents were removed and analysed at once. The ordinary method was used, namely, liberation of sulphur dioxide in an atmosphere of carbon dioxide by means of 20% phosphoric acid, absorption of the gas in $N/10$ iodine, with a final weighing as barium sulphate.

The following results were obtained.

TABLE I.

Age of sample	SO_2 present (in grains per lb.) Mixture at room temperature 1 Grains	Loss %	2 Grains	Loss %	Mixture in refrigerator Grains	Loss %
Original (calc.)	2·72		5·65		2·72	
As bottled	2·42		5·52		2·42	
7 days	2·11	12·8	5·40	2·2	2·19	9·5
14 „	2·17	10·4				
28 „	2·13	12·0				
42 „			5·24	5·1	2·19	9·5

In the first sample at room temperature, some liquid had separated after 28 days; in the second sample moulds and gas developed after seven days, whilst after 42 days a muddy black liquid separated. In the mixture kept in the refrigerator, a slight amount of water had separated after 42 days, but there was no mould growth.

The development of mould in the mixture containing the greatest amount of preservative and the evidences of incipient putrefaction are attributed to the fact that the meat used in this set was exposed to the atmosphere for some hours before the mixture was made and bottled. A fourth set gave somewhat irregular results, owing to imperfect mixing, but they were confirmatory, in a general way, of the rest.

The results show that the rate of disappearance is greatest during the first seven days, but that, if the sample is kept in hermetically sealed vessels at a temperature not exceeding 50° F., there is but slight risk of disagreement between the results of reliable analysts even if the sample is as much as six weeks old. They show, further, that "freshness" as judged by the appearance and odour of the sample is no criterion of its suitability for analysis for preservative provided the temperature has not materially exceeded 50° F.

Effect of cooking. The amount of sulphur dioxide was determined in two samples before and after cooking, a weighed quantity of meat being fried with a weighed quantity of fat.

TABLE II.

Sample	SO_2 in raw meat Grs. per lb.	SO_2 in cooked meat Grs. per lb.	Loss. %	Time of cooking. Min.
Minced meat	3·60	0·08	97·8	20
Sausage	3·40	1·74	48·8	30

Mechanism of the change of sulphite in presence of meat.—No systematic attempt was made to elucidate the chemistry of the disappearance of sulphite, but it can be shown that if, as is most probable, sulphate is formed as the result of aerial oxidation, the penetration of raw meat by air is an exceedingly slow process under the conditions obtaining in these experiments. Autoxidation does not appear to occur (Sheinfield, Vilbrandt, and Withrow; Chem. and Met. Eng., 1921, **25**, 953). It was proved by actual measurement that the bottles contained two to five times as much oxygen as is necessary for the conversion of the whole of the sulphite present into sulphate.

Conclusions.

(1) Raw meat containing sulphite remains in a condition suitable for analysis for six weeks and probably longer, provided the temperature is kept sufficiently low.

(2) The suitability of a sample of meat for analysis cannot be judged by the odour and appearance, if it has been kept in cold storage.

(3) A Health Act which does not contain specific directions as to the storage of perishable samples is inequitable and should be amended.

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RYLAMINE SALTS OF THE NAPHTHA-NESULPHONIC ACIDS. II.—THE SALTS α- AND β-NAPHTHALENESULPHONIC ACIDS.

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In a previous paper (J., 1924, 165 T) we described arylamine salts of the 2.6- and 2.7-naphthalene-ulphonic acids and cited the literature on this ject. This communication embodies the results our work on similar salts of α- and β-naphthalene-phonic acids.

Fierz-David (J., 1923, 421 T) confirms that it is possible to prepare either the α or the β acid in a re state by sulphonation alone. He states that der the optimum conditions for the α acid, the oduct is a mixture of 96% of α and 4% of β acid, d under the optimum conditions for the formation the β acid, the product consists of 85% of β and % of α acid.

Mixtures of these acids may be separated by means their arylamine salts, the aniline, p-toluidine, and xylidine salts being particularly useful in this spect, and moreover, since the majority of these lts have well-defined melting points, the testing of e purity of the product is simple.

On the other hand, the sulphonic acids are conveni-t for precipitating and identifying small quantities unknown amines, as the various salts melt over a ide range of temperatures.

The α- and β-naphthalenesulphonic acids readily rm a series of well-defined salts with arylamines. he salts of the α acid are usually more soluble than e analogous salts of the β acid—usually about three mes as soluble at the ordinary temperature. This, owever, is not always the case; for example, the chloroaniline dichloroaniline, m-nitroaniline, p-tro-o-toluidine, and p-phenetidine salts of the α id have approximately the same solubility or are ss soluble than the corresponding salts of the β acid the ordinary temperature.

The salts were prepared by similar methods to those escribed in our previous paper, and in addition the ad salt of the α acid and the barium salt of the β acid ere also utilised, as it was found that in some cases here the hydrochloride of the amine was added to e sodium salt of the acid, the sodium salt of the acid variably separated out. In all cases molecular uantities of the base and acid, plus a slight excess of e base, were used. In the case of diamines, the lts usually consist of one molecule of the base and molecules of the acid. Basic salts are difficult to btain, the only one that was isolated being basic toluidine-β-naphthalenesulphonate.

In the case of substituted amines, the salts with he α acid have their melting points in the order p, , o, ortho being the highest. With the β acid, however, the order is m, o, p. The solubilities in water do not lend themselves well to such a generalisation, but in the cases of the toluidines, both the α acid and the β acid salts are in the order m, o, p.

The best solvent for all the salts was found to be water slightly acidified with hydrochloric acid. Ethyl alcohol can also, in certain cases, be used for purification.

Dissociation occurs in boiling aqueous solution, especially when the amine is volatile in steam, but this can be prevented by the addition of a little hydrochloric acid.

The titration and determination of solubility of the salts were carried out as described for the 2.6- and 2.7-naphthalenedisulphonic acids (*loc. cit.*). All the solubilities are recorded as parts by weight of salt in 100 parts by weight of solution, and all melting points are corrected. Where no melting point is recorded, the salt did not melt below 330°.

The α- and β-naphthalenesulphonic acids used in the investigation were given a preliminary purification, the α by recrystallisation from alcohol, and the β by recrystallisation from water. The following salts were prepared and studied :—

Aniline α-naphthalenesulphonate.—10 g. of sodium α-naphthalenesulphonate were dissolved in 40 c.c. of hot water and 8 c.c. of concentrated hydrochloric acid, and 6 c.c. of aniline were added. On cooling, crystals were quickly formed. When twice recrystallised from water, white leaflets were obtained, m.p. 183°, which were very readily soluble in hot alcohol. *Solubility, 1·58/100 at 15°; 0·4142 g. required 13·75 c.c. of $N/10$ NaOH = 99·9% theory.

Aniline β-naphthalenesulphonate, prepared as in the case of the α salt, was obtained as fine white needles, m.p. 269°. It can be easily recrystallised from alcohol, in which it is only sparingly soluble in the cold. Solubility 0·52/100 at 15°; 0·6432 g. required 21·3 c.c. of $N/10$ NaOH = 99·7% theory.

o-Toluidine α-naphthalenesulphonate.—White crystals readily recrystallised from water, m.p. 237°. Very soluble in boiling alcohol. Solubility 0·99/100 at 15°; 0·5490 g. required 17·4 c.c. of $N/10$ NaOH = 99·8% theory.

o-Toluidine β-naphthalenesulphonate.—Readily recrystallised from water or alcohol in the form of white, feathery needles, m.p. 213°. Solubility 0·47/100 at 16°; 0·5804 g. required 18·2 c.c. of $N/10$ NaOH = 98·8% theory.

m-Toluidine α-naphthalenesulphonate.—10 g. of sodium α-naphthalenesulphonate and 5 g. of m-toluidine were dissolved in 45 c.c. of hot water and 5 c.c. of hydrochloric acid. On cooling, a lower oily layer separated, but both layers crystallised on further standing. On recrystallisation white, silky needles were obtained, m.p. 195°—196°, which are readily soluble in hot water and alcohol. Solu-

* Solubility—100 parts by weight of solution contain 1·58 parts by weight of salt at 15°.

bility 0·68/100 at 12°; 0·4196 g. required 13·3 c.c. of N/10 NaOH = 99·8% theory.

m-Toluidine β-naphthalenesulphonate.—Readily recrystallised from hot water. Colourless plates, m.p. 205°. Solubility 0·39/100 at 15°; 0·716 g. required 22·2 c.c. of N/10 NaOH = 99·7% theory.

p-Toluidine α-naphthalenesulphonate.—25 g. of sodium α-naphthalenesulphonate were dissolved in 100 c.c. of water, and 16·7 g. of p-toluidine dissolved in 15 c.c. of hydrochloric acid and 50 c.c. of water were added. On cooling an emulsion was first formed, which soon separated into a greenish upper layer and a brownish lower oily layer. When nearly cold the lower layer solidified to a whitish stringy mass. It can be recrystallised from water or from ethyl alcohol, in which it is very soluble even in the cold; m.p. 181°. Solubility 1·38/100 at 15°; 0·4418 g. required 13·95 c.c. of N/10 NaOH = 99·5% theory.

p-Toluidine β-naphthalenesulphonate.—This salt was used for preparing pure β-naphthalenesulphonic acid. 47 g. of sodium β-naphthalenesulphonate were dissolved in 500 c.c. of hot water, the solution was filtered, and 20 c.c. of hydrochloric acid and 22 g. of p-toluidine were added. The crystals which separated on cooling, were washed with 100 c.c. of cold water, and had m.p. 211°–212°. On recrystallisation very pale yellow, fine needles, m.p. 221°, were obtained. Solubility 0·47/100 at 16°; 1·1236 g. required 35·3 c.c. of N/10 NaOH = 99·1% theory.

m-Xylidine α-naphthalenesulphonate.—10 g. of sodium α-naphthalenesulphonate, 7·2 g. of m-xylidine acetate, and 2 c.c. of hydrochloric acid were dissolved in 40 c.c. of hydrochloric acid. Two layers were formed, but on standing both crystallised. On recrystallisation white, glistening needles were obtained, m.p. 167°. This salt is best recrystallised from alcohol, in which it is very soluble. It does not recrystallise well from water and partly becomes an oil in boiling water. Solubility 1·20/100 at 15°; 0·4722 g. required 14·25 c.c. of N/10 NaOH = 99·3% theory.

m-Xylidine β-naphthalenesulphonate.—Sufficient hydrochloric acid was added to 10 g. of sodium β-naphthalenesulphonate and 7·2 g. of m-xylidine acetate in 40 c.c. of hot water to form a homogeneous solution. On cooling, two layers were formed, but the lower brown oily layer crystallised on standing. Recrystallised well from alcohol, in which it is sparingly soluble cold, m.p. 211°. Solubility, 0·27/100 at 10°; 0·5104 g. required 15·4 c.c. of N/10 NaOH = 99·2% theory.

α-Naphthylamine α-naphthalenesulphonate.—This salt was prepared by Ambler (J. Ind. Eng. Chem., 1920, **12**, 1081), who finds that it melts at 232° with decomposition. Our specimen was fairly soluble in boiling water, from which it was obtained in fine white leaflets, which melt at 229° to a light brown liquid and decompose about 275°. Solubility 0·23/100 at 12°; Wales (*ibid.*, 1922, **14**, 317) gives 0·31/100 at 25°. 0·4966 g. required 14·0 c.c. N/10 NaOH = 99·0% theory.

α-Naphthylamine β-naphthalenesulphonate.—10 g. of sodium β-naphthalenesulphonate in 100 c.c. of water were added to 6 g. of β-naphthylamine and 6 c.c. of hydrochloric acid in 150 c.c. water. A thick white precipitate was obtained whilst still hot. Recrystallised twice from boiling water, in which it is sparingly soluble, it yielded white, feathery crystals, m.p. 240° without decomposition. Ambler (*loc. cit.*) gives 240°—247° (decomp.). Solubility 0·11/100 at 12° (Wales gives 0·20/100 at 25°) 0·5392 g. required 15·4 c.c. of N/10 NaOH = 100·0% theory.

β-Naphthylamine α-naphthalenesulphonate.—10 g. of sodium α-naphthalenesulphonate were dissolved in 500 c.c. of hot water, and 6 g. of β-naphthylamine and 6 c.c. of hydrochloric acid in 500 c.c. of hot water were added. Crystals of m.p. 196°—199° separated in the hot solution. White plates, m.p. 193°—199°, were obtained when the mother liquor cooled. On recrystallisation, beautiful white plates were obtained, m.p. 200°–201°, very sharply and without decomposition (Ambler states that it blackens at 202° and melts at 211°). Solubility, 0·11/100 at 15° Wales gives 0·17/100 at 25°); 0·5232 g. required 14·85 c.c. of N/10 NaOH = 99·6% theory.

β-Naphthylamine β-naphthalenesulphonate.—6 g. of sodium β-naphthalenesulphonate in 500 c.c. of water were added to 4·5 g. of β-naphthylamine and 4 c.c. of hydrochloric acid in 700 c.c. water. A precipitate was obtained immediately. It was recrystallised from a large quantity of hot water, in which it is very sparingly soluble; m.p. 275°—276° Ambler gives m.p. 276°—279° (decomp.). Solubility 0·04/100 at 15° (Wales, 0·056/100 at 25°). 0·4842 g. required 13·8 c.c. of N/10 NaOH = 100·0% theory.

Benzidine α-naphthalenesulphonate.—An attempt was made to prepare both the basic and normal salts, but only the normal salt was obtained. This is readily prepared by adding benzidine hydrochloride to a hot solution of the acid, when an immediate precipitate is obtained, which is sparingly soluble even hot. Solubility 0·15/100 at 15°; 0·5318 g. required 17·65% c.c. N/10 NaOH = 99·6% theory m.p. above 330°.

Benzidine β-naphthalenesulphonate.—4 g. of benzidine and 5 c.c. of hydrochloric acid in 500 c.c. of water were added to 5 g. of β acid in 500 c.c. of water. An immediate grey precipitate was obtained which is difficult to recrystallise from water owing to its insolubility. It is also practically insoluble in alcohol. Solubility 0·03/100 at 15°; 0·5104 g. required 16·95 c.c. of N/10 NaOH = 99·6% (mol. wt. 600).

Tolidine α-naphthalenesulphonate.—Sufficient tolidine hydrochloride theoretically was added to a solution of α acid to form the basic salt. On cooling slightly two layers were formed, but the lower brown layer was comparatively small, and both crystallised on standing. On recrystallisation, white crystals were obtained which proved to be the normal salt in both cases, m.p. 294° (decomp.). Solubility 0·25/100 at 15°; 0·4544 g. required 14·3 c.c. of N/10 NaOH = 98·9% theory.

Tolidine β-naphthalenesulphonate.—In this case both the normal and the basic salts were obtained. *Normal salt*.—2·1 g. of tolidine and 3 c.c. of hydro

...oric acid in 100 c.c. of water were added to 6 g. free β acid in 50 c.c. of water. An immediate ...cipitate was obtained, which was recrystallised ...m a large volume of hot water. Solubility ...3/100 at 15°; 0·6742 g. required 21·4 c.c. NaOH ...% theory (mol. wt. 628). *Basic salt.*—3 g. of ...dine were added to 5 g. of free β acid in 200 c.c. water, when an immediate precipitate was ...ained. Beautiful silvery plates were obtained on ...rystallisation from water. Solubility 0·07/100 12°; 0·5120 g required 12·13 c.c. of $N/10$ NaOH ...9·6% theory (mol. wt. 420).

...Dianisidine α-naphthalenesulphonate.—Grey crys...s, m.p. 272° (decomp.). Solubility 0·28/100 at 15°: ...018 g. required 17·95 c.c. of $N/10$ NaOH ...4%. Attempts to make the basic salt only ...lded the normal salt.

...Dianisidine β-naphthalenesulphonate.—2·5 g. of ...nisidine, 5 g. of free β acid, and 200 c.c. of water ...l a little hydrochloric acid yielded glistening ...stals whilst still hot. On recrystallising, long ...ong plates were obtained, m.p. 290° (decomp.). ...ubility 0·10/100 at 15°; 0·3486 g. required ...4 c.c. of $N/10$ NaOH=98·4% theory.

...Chloroaniline α-naphthalenesulphonate.—Recrys...lises very readily from water, m.p. 237°. Solu...ity 0·49/100 at 15°: 0·3704 g. required 11·0 c.c. $N/10$ NaOH=99·9% theory.

...Chloroaniline β-naphthalenesulphonate.—Small ...ite needles, m.p. 214°. Solubility 0·35/100 at ..., 0·5002 g. required 14·9 c.c. of $N/10$ NaOH= ...0% theory.

m-Chloroaniline α-naphthalenesulphonate.—White ...tes, m.p. 176°, crystallises well from water or ...ohol. Solubility 0·29/100 at 15°; 0·6202 g. ...uired 18·55 c.c. of $N/10$ NaOH=100·3% theory.

m-Chloroaniline β-naphthalenesulphonate.—White ...stening plates, m.p. 244°, were obtained which ... sparingly soluble in hot water and alcohol. ...lubility 0·14/100 at 15°; 0·4690 g. required ...95 c.c. of $N/10$ NaOH=99·8% theory.

...p-Chloroaniline α-naphthalenesulphonate.—Colour... plates, m.p. 231°. Solubility 0·18/100 at ..., 0·6168 g. required 18·45 c.c. of $N/10$ NaOH ...4% theory.

p-Chloroaniline β-naphthalenesulphonate.—White ...flets, m.p. 252°–253°. Recrystallises readily ...m water. Solubility 0·23/100 at 15°: 0·5064 ...uired 15·05 c.c. of $N/10$ NaOH 99·7% theory.

m-Bromoaniline α-naphthalenesulphonate.—5 g. of ...cid and 3 c.c. of *m*-bromoaniline were dissolved ...3 c.c. of hydrochloric acid and 20 c.c. of hot ...ter. On cooling an emulsion was formed which ...ickly solidified. Recrystallises very readily from ...ter, m.p. 168°. Solubility 0·36/100 at 15°; 0·2914 g. ...uired 7·65 c.c. of $N/10$ NaOH=99·9% theory.

m-Bromoaniline β-naphthalenesulphonate.—White ...tes easily recrystallised from water, m.p. 237°. ...lubility 0·10/100 at 15°; 0·4878 g. required 12·8 c.c. $N/10$ NaOH=99·7% theory.

p-Bromoaniline α-naphthalenesulphonate.—Crystal...es readily from water. Colourless leaflets, m.p. ...4°. Solubility 0·35/100 at 15°; 0·5608 g. required ...8 c.c. of $N/10$ NaOH=100·3% theory.

p-Bromoaniline β-naphthalenesulphonate.—Large colourless plates, m.p. 244°. Solubility 0·10/100 at 15°; 0·4634 g. required 12·2 c.c. of $N/10$ NaOH 100·0% theory.

Phenylhydrazine α-naphthalenesulphonate.—6 g. of phenylhydrazine hydrochloride in 100 c.c. of water were mixed with 10 g. of sodium α-naphthalene sulphonate in 80 c.c. of water. On cooling large clusters of white needles, m.p. 178°, separated. Solubility 0·57/100 at 12°; 0·2966 g. required 9·05 c.c. of $N/10$ NaOH=98·4% theory.

Phenylhydrazine β-naphthalenesulphonate.—An immediate precipitate was formed on mixing the hot solutions of the acid and hydrochloride of base. White needles on recrystallisation from hot water, m.p. 217°. Solubility 0·24/100 at 10°; 0·2290 g. required 7·2 c.c. of $N/10$ NaOH=99·4% theory.

1.2.4-Dichloroaniline α-naphthalenesulphonate.—Separates as an oil which crystallises on standing. White crystals, m.p. 234°. Solubility 0·12/100 at 15°; 0·4130 g. required 11·15 c.c. of $N/10$ NaOH=99·8% theory.

1.2.4.-Dichloroaniline β-naphthalenesulphonate.—Colourless fine plates, m.p. 178°. Solubility 0·14/100 at 15°; 0·5212 g. required 14·05 c.c. of $N/10$ NaOH 99·7% theory.

o-Anisidine α-naphthalenesulphonate.—6·2 g. of lead α-naphthalenesulphonate were suspended in 40 c.c. of water and 2·5 g. of *o*-anisidine were added. Whilst hot, 20 c.c. of $N/1$ sulphuric acid were added and the lead sulphate was filtered off; the crude salt crystallised on cooling. Recrystallised readily from water in fine white needles, m.p. 208°. Solubility 0·85/100 at 10°. It did not give a sharp end-point when titrated with sodium hydroxide.

o-Anisidine β-naphthalenesulphonate.—5·5 g. of the barium salt and 2·5 g. of *o*-anisidine were suspended in 120 c.c. of water, 20 c.c. of $N/1$ sulphuric acid were added, and the barium sulphate was filtered off. White needles, m.p. 207°. Solubility 0·26/100 at 15°; 0·4880 g. required 14·8 c.c. of $N/10$ NaOH=100·4% theory.

p-Anisidine α-naphthalenesulphonate.—From the solution of the sodium salt of the acid and the hydrochloride of the base, a very bulky stringy precipitate was obtained, which when recrystallised gives an almost colloidal mass, containing much water. On drying, it contracts to a very small bulk, but holds water very tenaciously: m.p. 182°. Solubility 1·02/100 at 15°; 0·5424 g. required 16·05 of $N/10$ NaOH=97·9% theory.

p-Anisidine β-naphthalenesulphonate.—Recrystallised from water in glistening leaflets which are difficult to dry completely; m.p. 218°. Solubility 0·40/100 at 15°; 0·5314 g. required 15·9 c.c. of $N/10$ NaOH=99·1%.

o-Phenetidine α-naphthalenesulphonate.—Colourless crystals after repeated recrystallisation, m.p. 185°. Solubility 0·65/100 at 15°; 0·6800 g. required 19·7 c.c. of $N/10$ NaOH=100·0% theory.

o-Phenetidine β-naphthalenesulphonate.—Fine white needles from water or alcohol, m.p. 197°. On titration the end-point was indistinct. Solubility 0·22/100 at 10°.

p-Phenetidine α-naphthalenesulphonate.—10 g. of sodium α-naphthalenesulphonate, 5 g. of *o*-phenetidine, 5 c.c. of hydrochloric acid, and 60 c.c. of water were used, "norit" was added, and the solution filtered. On cooling, a very thick precipitate was obtained, which was recrystallised from 150 c.c. of water. Beautiful colourless large thin plates, m.p. 201°–202°. Solubility 0·19/100 at 10°; 0·3138 g. required 9·15 c.c. of $N/10$ NaOH=100·6% theory.

p-Phenetidine β-naphthalenesulphonate.—Colourless vitreous plates, m.p. 207°. Solubility 0·20/100 at 15°; 0·6292 g. required 18·2 c.c. of $N/10$ NaOH=99·8% theory.

ψ-Cumidine α-naphthalenesulphonate.—2·5 g. of *ψ*-cumidine, 5 g. of α-sodium salt, 5 c.c. of hydrochloric acid, and 30 c.c. of water gave oily globules whilst hot, and a white emulsion on cooling which quickly solidified to a white mass, m.p. 198°. Sparingly soluble in alcohol and water. Solubility 0·19/100 at 14°; 0·6196 required 17·9 c.c. of $N/10$ NaOH 99·1% theory.

ψ-Cumidine β-naphthalenesulphonate.—From 2 g. of *ψ*-cumidine, 4 g. of free β acid, 2 c.c. of hydrochloric acid, and 100 c.c. of water. A precipitate was obtained whilst still hot, which recrystallises in fine white needles from a large quantity of hot water. Very sparingly soluble in cold alcohol or cold water. Solubility 0·05/100 at 10°; m.p. 236°; 0·5576 g. required 16·15 c.c. of $N/10$ NaOH=99·3% theory.

m-Aminophenol α-naphthalenesulphonate.—8 g. of α-sodium salt and 3·3 g. of *m*-aminophenol were dissolved in 100 c.c. of water and 4 c.c. of hydrochloric acid, and allowed to stand for three days. Recrystallised from a small quantity of water, m.p. 200°. Solubility 3·08/100 at 15°; 0·6770 g. required 21·4 c.c. of $N/10$ NaOH=100·2% theory.

m-Aminophenol β-naphthalenesulphonate.—Recrystallised readily from hot water, m.p. 247°. Solubility 1·16/100 at 15°; 0·6094 g. required 19·33 c.c. of $N/10$ NaOH=100·6% theory.

p-Phenylenediamine α-naphthalenesulphonate.—Recrystallised from water in fine colourless plates, m.p. above 330°. Solubility 0·26/100 at 10°.

p-Phenylenediamine β-naphthalenesulphonate.—Recrystallised from a large quantity of boiling water, in which it is only sparingly soluble. Almost colourless large plates. Solubility 0·07/100 at 15°; 0·5472 g. required 20·95 c.c. of $N/10$ NaOH=100·2% theory.

Attempts to make the basic salt failed.

m-Phenylenediamine β-naphthalenesulphonate.—This salt was readily formed by mixing a hot alcoholic solution of the β acid and *m*-phenylenediamine, and was recrystallised from dilute alcohol. On heating it blackens at 275°. Solubility 1·27/100 at 17°; 0·5006 g. required 19·3 c.c. of $N/10$ NaOH=101·0% theory (mol. wt. 524).

m-Phenylenediamine α-naphthalenesulphonate is readily soluble in absolute alcohol, but the β-sulphonate is only sparingly soluble.

It is also interesting to note that the corresponding *m*-phenylenediamine salts are much more soluble than the *p*-phenylenediamine salts. For example, the *m*-phenylenediamine salt of the α acid is readily soluble in cold water and extremely soluble in boiling water. The *m*-phenylenediamine salt of the β acid is also readily soluble in hot water, and since the *p*-phenylenediamine salt of the β acid is only sparingly soluble in boiling water, a mixture of *m*- and *p*-phenylenediamines may be easily separated by the aid of the β acid.

m-Nitroaniline α-naphthalenesulphonate.—Recrystallises well from either water or alcohol; m.p. 261°. Solubility 0·15/100 at 15°; 0·5550 g. required 15·95 c.c. of $N/10$ NaOH=99·4%.

m-Nitroaniline β-naphthalenesulphonate.—Recrystallised from hot water gave small yellowish needles, m.p. 260°. Solubility 0·19/100 at 15°; 0·5668 g. required 16·3 c.c. of $N/10$ NaOH=99.5%.

p-Nitroaniline α-naphthalenesulphonate.—Recrystallised from absolute alcohol in yellow needles, m.p. 241° (decomp.); 0·5094 g. required 14·7 c.c. of $N/10$ NaOH=99·9% theory.

p-Nitroaniline β-naphthalenesulphonate.—Colourless needles, m.p. 247° (decomp.). Both the α- and β-naphthalenesulphonates of *p*-nitroaniline are dissociated when recrystallised from water, but they can be recrystallised readily from alcohol.

p-Nitro-o-toluidine α-naphthalenesulphonate.—When 3 g. of *p*-nitro-*o*-toluidine dissolved in alcohol were added to 5 g. of α acid in 100 c.c. of water, an immediate precipitate was formed. Fine, almost colourless needles were obtained by recrystallising from alcohol; m.p. 244° (decomp.). Solubility 0·11/100 at 15°; 0·4210 g. required 11·8 c.c. of $N/10$ NaOH=100·9% theory.

p-Nitro-o-toluidine β-naphthalenesulphonate.—Pale yellow needles on cooling, which may be recrystallised from water or alcohol, m.p. 229°–230°. Solubility 0·12/100 at 15°. 0·4160 g. required 11·37 c.c. of $N/10$ NaOH=98·4% theory.

N-Substituted aniline salts.

The salts of N-substituted anilines are difficult to prepare, inasmuch as they will not crystallise readily from an aqueous solution or alcoholic solution, and frequently two layers are formed which do not crystallise, or else the naphthalenesulphonic acid separates out. When once crystallised, however, they are usually fairly easy to recrystallise.

The following salts were prepared:—

Monomethylaniline α-naphthalenesulphonate.—White needles, m.p. 147°. Solubility, 1·65/100 at 15°: 0·6684 g. required 20·85 c.c. $N/10$ NaOH = 98·3% theory.

Monomethylaniline β-naphthalenesulphonate.—m.p. 213°.

Dimethylaniline α-naphthalenesulphonate was prepared from the lead salt of the acid and dimethylaniline hydrochloride. Long fine needles, m.p. 140°–141°. Solubility, 2·78/100 at 15°.

Diethylaniline β-naphthalenesulphonate was obtained by spontaneous evaporation of a solution of 5 g. of β acid and 5 c.c. of diethylaniline in 25 c.c. of alcohol. Reddish-brown crystals were obtained which were washed with ether and acetone, and further purified by dissolving in alcohol, precipitating by ether, and finally recrystallising from water. Fine white needles, m.p. 219°. Solubility, 0·82/100 at 15°.

Separation of mixtures of α- and β-naphthalenesulphonic acids.

The principle of the method of separating the ds is that if sufficient arylamine is added to m the β salt, that salt is precipitated, leaving the α d in solution. The salts with aniline, p-toluidine, l m-xylidine are the most suitable for this purpose, the β acid forms salts with these substances quite dily and they are easily purified. On the other nd, the p-toluidine and m-xylidine salts of α-phthalenesulphonic acid are less readily formed, l do not crystallise very readily in the crude state. erefore, if only a slight excess of amine is added to tralise the β acid, the α acid is left in the solution l may be obtained in comparatively pure state evaporation, or by the addition of a further antity of the base.

Mixtures containing 15%, 50%, and 85% of each d were made, and then separated by the above thod, the free acids being used in each case.

Separation by means of aniline salts.—(1) 6 g. of naphthalenesulphonic acid ($2H_2O$) and 6 g. of naphthalenesulphonic acid (H_2O) were dissolved in 0 c.c. of water containing a few drops of hydrochloric acid, and 2·5 g. of aniline were added. On oling and standing for one day a precipitate, p. 254°–260°, and weighing 7·21 g., was obtained, hich is equal to 89·6% theory of the β acid. On crystallisation this melted at 265°–269°, and nce was practically pure β salt. To the original other liquor, 2·5 g. of aniline were added; a precipite, weighing 5·23 g., was obtained, m.p. 183°–185°, hich was hence fairly pure α salt.

(2) 1·5 g. of β-naphthalenesulphonate (H_2O) and 5 g. of α-naphthalenesulphonic acid ($2H_2O$) were ssolved in 50 c.c. of water, and a little hydrochloric id and 1 g. of aniline was added. A precipitate on appeared which was allowed to stand for 24 ours; yield 2·18 g. Softened at 214°, and melted 250°. 1 g. of aniline should have given 3·23 g. of ixed α and β salt, and 1·5 g. of β acid should have iven 2·016 g. of aniline salt, containing 0·62 g. of niline. Thus the bulk of the β acid and a small uantity of the α acid separated when the original other liquor was evaporated. A small precipitate rst separated, and then free acid was obtained in uantity.

(3) 8·5 g. of β acid ($1H_2O$) and 1·5 g. of α acid $2H_2O$) were dissolved in 100 c.c. of water, heated to he boil, and 4 g. of aniline added, when an immediate hick precipitate was obtained—11·04 g. of m.p. 262°–267°. Recrystallised, m.p. 268°–269°. 8·5 g. f β acid ($1H_2O$) should have given 11·42 g. of aniline alt, containing 3·53 g. of aniline. Hence, almost the whole of the β acid was thus precipitated.

Separation by means of the p-toluidine salts.—(1) 6 g. f β acid and 6 g. of α acid were added to 100 c.c. of water, and 2·87 g. of p-toluidine were introduced at he boil. After standing one day 6·87 g. of the salt were obtained, m.p. 198°–203°, which is equivalent to 81·5% of β acid, though in this case it should be noted that an excess of p-toluidine was not used. On recrystallisation of the precipitated salt, pure pale yellow needles of the β salt, m.p. 221°, were obtained. When 2·87 g. of p-toluidine were added to the mother liquor a further precipitate, m.p. 169°–181°, was obtained, which consisted mainly of p-toluidine α-naphthalenesulphonate.

(2) 1·5 g. of β acid ($1H_2O$), 8·5 g. of α acid ($2H_2O$), 50 c.c. of water, and 1 g. of p-toluidine after standing for one day, gave only a slight precipitate, but on standing another 24 hours a precipitate, weighing 1·71 g., was obtained, m.p. 196°–202°. On further standing another 0·29 g. of salt was collected. The first precipitate melted at 214°–219° on recrystallisation.

The separation of the α acid from the mother liquor may be best attained by evaporation, as the p-toluidine α salt does not crystallise very well, usually separating as a stringy semi-colloidal mass holding much water.

(3) 8·5 g. of β acid (H_2O), 1·5 g. of α acid ($2H_2O$), 100 c.c. of water, and 4·25 g. of p-toluidine quickly yielded a precipitate weighing 10·62 g., m.p. 211°–213°. This, on recrystallisation, readily gave fine needles of pure p-toluidine β salt, m.p. 221°–222°.

The p-toluidine salts form highly-supersaturated solutions which only crystallise on long standing, hence the above yields are not so good as those obtained when using aniline as a separating agent.

Separation by means of the m-xylidine salts.—(1) 1·5 g. of α salt and 8·5 g. of β salt were dissolved in 100 c.c. of water, and 0·5 c.c. of hydrochloric acid and 4·8 g. of m-xylidine then added. When cold a thick precipitate, weighing 12·13 g., was filtered off (m.p. 201°–206°), which on recrystallisation, melted at 206°–209°. This was again recrystallised and two fractions were obtained, the first melting at 210°–211°, and the second at 204°–208°.

(2) 8·5 g. of α salt, 1·5 g. of β salt, 50 c.c. of water, 0·5 c.c. of hydrochloric acid, 1 g. of m-xylidine. No precipitate was obtained when cold, and on standing 24 hours only a slight precipitate, 0·91 g., m.p. 178°–185°, was obtained. This, on recrystallisation, melted at 198°–201°, and again at 209°–211°.

The aniline salt may be considered the best for separating mixtures of the two acids, but the p-toluidine and m-xylidine salts are also very effective, especially if sufficient time is allowed for the supersaturated solutions to crystallise.

The separation and identification of arylamines themselves may be effected by their salts with the naphthalenesulphonic acids, especially with the β acid. Thus m- and p-phenylenediamines may be separated as already mentioned. A mixture of mono- and di-methylaniline and β acid will first give the β salt of monomethylaniline. It is also possible, generally speaking, to separate mixtures of o- and p-substituted amines, the para salts being usually less soluble than the ortho, though this was more apparent in the case of 2.6- and 2.7-naphthalenedisulphonic acids. Generally speaking, also, these salts have well-defined melting points, and they form ready means of identification of small quantities of such bases.

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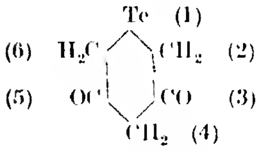
BACTERICIDAL ACTION OF TELLURIUM-β-DI-KETONES.

BY GILBERT T. MORGAN, E. ASHLEY COOPER, AND FREDERICK J. CORBY.

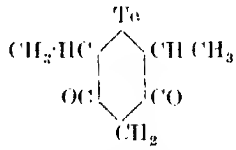
Tellurium derivatives of the aliphatic β-diketones are extremely active germicides (Morgan, Cooper, and Burtt, Biochem. J., 1923, **17**, 30; 1924, **18**, 190): for example, 2.6-dimethyl-*cyclo*-telluro-pentane-3.5-dione (II.) exerts bactericidal action in as low concentrations as 1 in 10,000,000 to 1 in 40,000,000.

The chemical structure of the simplest compound of the series, *cyclo*-telluro-pentane-3.5-dione (I), is indicated thus:—

(I.)



(II.)

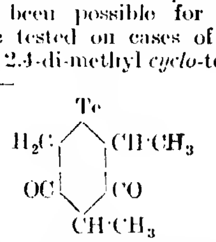


Substitution of groups is possible in any of the three methylene (CH_2) radicals, and the introduction of alkyl groups and their orientation profoundly affect the germicidal power of these new compounds. Recently a large number of additional homologues have been prepared, and the general principles correlating chemical structure and bactericidal power are indicated in this paper. (Compare Morgan, Drew and others, Trans. Chem. Soc., 1920, **117**, 1456; 1921, **119**, 610; 1922, **121**, 922; 1923, **123**, 444; 1924, **125**, 731, 759, 760, 1601.)

It was previously found (*loc. cit.* 1924) that the tellurium compounds lost their powerful germicidal action in serum, and were thus unlikely to be valuable as internal disinfectants. As, however, comparatively unimportant changes in chemical structure greatly influence germicidal power, the possibility of obtaining a compound efficacious in the blood-stream is not precluded.

The tellurium compounds are extremely active as germicides in the presence of urine, and as there is sufficient margin between their bactericidal and lethal doses, there appeared to be scope for their employment in cystitis and as urinary antiseptics. Lethal doses administered to mice induced symptoms of hæmaturia, and death soon followed (*loc. cit.* 1924).

Through the interest and help of Mr. William Gemmill it has been possible for one of these compounds to be tested on cases of cystitis. For the clinical trials, 2.4-di-methyl *cyclo*-telluro-pentane-3.5-dione (III.):—



(III.)

was selected, on account of its ease of preparation and ready solubility, and in cystitis its use has led to very beneficial results.

Mr. H. W. Archer-Hall has also kindly tested the same substance as to its possible application in the treatment of infective conditions of the eye, and has obtained highly satisfactory results in cases of conjunctivitis, blepharitis, and corneal ulceration.

The method of determining the germicidal power of the tellurium compounds generally employed consisted in exposing a definite number of organisms to the action of the compounds in lemco-peptone broth as nutrient medium for 48 hours at 37°. The organisms used were *B. coli*, *typhosus*, *paratyphosus*, *pyocyaneus*, and *Strept. hæm.* Tests have also been made with protozoa (*paramœcia*) grown in hay infusion, but the above tellurium compound acts much more powerfully against bacteria, than against protozoa, comparatively high concentrations, *e.g.* 1 in 400,000, being required to disinfect in the case of *paramœcia*.

Influence of chemical structure on bactericidal power.

Homologous series.—Members of three series as far as the butyl derivatives have been prepared, and their bactericidal power has been determined. The homologous series may be regarded as formed by the introduction of alkyl groups in the molecule of *cyclo*-telluro-pentane-3.5-dione (I) by replacement of hydrogen in one or more of the three methylene groups (2, 4, 6).

It was found that bactericidal power at first increased as the homologous series was ascended, until with the third member a maximum efficacy was attained, and the higher members showed diminishing germicidal action. Chemically, this means that the introduction of two methyl groups produces the zenith in bactericidal power, and further substitution is unfavourable. The results obtained with one typical homologous series are tabulated at the end of the paper.

Isomerism.—As substitution of alkyl groups is practicable in any of the three positions (2, 4, 6), it is evident that there are many possibilities of isomerism.

An examination of the germicidal power of a large number of isomeric compounds has led to the important conclusion that the maximum efficacy is associated with the presence of one methyl group in each of the 2-6 or ortho positions to the tellurium, 2.6-dimethyl-*cyclo*-telluro-pentane-3.5-dione (II) therefore, being the most active of the series and bactericidal in concentrations varying from 1 in 10,000,000 to 1 in 40,000,000 to several coliform organisms.

Dissymmetric substitution in one only of the 2—6 positions or substitution in the 4 or para-position is in general much less favourable, and leads to compounds of lower bactericidal power. Thus, the substance 2.4-dimethyl-*cyclo*-telluropentane-3.5-dione is less active than the above isomeride, being bactericidal in concentrations varying from 1 in 5,000,000 to 1 in 20,000,000. It was employed in the clinical trials, however, as it is more soluble and easily prepared.

Other tellurium derivatives have also been recently prepared, in which the difference in chemical constitution does not depend on the position of the alkyl

groups in the heterocyclic ring, but merely on the structure of the alkyl group itself, for instance as between propyl, $CH_2.CH_2.CH_3$, and *iso*propyl, $CH(CH_3)_2$.

This small local difference was found to affect germicidal power in a somewhat important manner, the *iso*propyl compounds being from two to four times as active as their *n*-propyl isomerides. The *n*-butyl derivative, $-CH_2(CH_2)_2CH_3$, however, was more active than the isomeric *iso*butyl, $-CH_2.CH(CH_3)_2$ compound. The results are of importance insomuch as they indicate that the bactericidal power of the *cyclo*-telluro-pentane-3.5-diones is readily influenced by quite small changes in chemical structure, and there is thus a possibility of obtaining a suitable compound, retaining its germicidal action *in vivo*.

The introduction of an aromatic group, *e.g.*, benzyl, resulted in compounds possessing bactericidal power of very much the same order as that of the aliphatic tellurium derivatives.

It is remarkable that the parent aliphatic β-diketones themselves are only feeble germicides (the bactericidal concentrations varying from 1 in 100 to 1 in 400), showing that the tellurium-carbon heterocyclic ring plays a very important part in the manifestation of bactericidal action. This is confirmed by the observations that the selenium, copper, iron, and cobalt derivatives possess only slight germicidal powers. It is also essential that the tellurium should exist in the unsaturated state, as the oxides and basic derivatives in which the tellurium is quadrivalent are very weak disinfectants.

Germicidal action in serum.

The serum (ox) was first heated at 56° to destroy its bactericidal properties and ensure sterility. The organisms were incubated in the serum, containing varying concentrations of the tellurium compounds, for 24 hours at 37°. Sub-cultures were then made into broth, and the minimum bactericidal concentration could thus be determined for each substance.

It was found that concentrations, ranging from 1 in 50,000 to 1 in 200,000, were required for complete disinfection in serum, indicating a very serious collapse in germicidal power, but notwithstanding this remarkable diminution in efficacy, changes in chemical structure were found to influence bactericidal power in serum in very much the same way as in peptone-broth media.

Serum still reduced the bactericidal power of the tellurium compounds, even after dialysis, showing that the incompatible substance is colloidal in nature. The interfering substance, however, does not appear to be a protein, as serum-proteins, gelatin, egg-albumin, caseinogen, and proteoses had no effect on germicidal power. Lecithin, carbamide, creatinine, and ammonium carbonate were also without effect, but glycine had the noteworthy property of increasing germicidal power.

Influence of the time-factor on germicidal power.

So far the bactericidal action of the tellurium compounds has been studied over periods of 24 or 48 hours. We have found, however, that these germicides are capable of acting much more rapidly than was originally supposed, as they can exert an appreciable bactericidal action in 1 hour, but their maximum efficacy is not attained until after a period of about 4 hours.

This confirms the view already expressed that the foregoing tellurium derivatives are true germicides, and not merely growth-inhibitors.

Results illustrating the germicidal power of the members of a homologous series of tellurium compounds.

(B. coli communis)

Substance	Bactericidal concentrations
cyclo-Telluro-pentane-3.5-dione	1 in 500,000
2-Methyl	1 in 3,000,000
2.4-Dimethyl	1 in 20,000,000
2-Methyl-4-ethyl	1 in 13,000,000
2-Methyl-4-propyl	1 in 8,000,000
2-Methyl-4-butyl	1 in 7,500,000

Summary

1. The *cyclo*-telluropentane-3.5-diones are very powerful germicides, exerting a marked bactericidal action in certain cases in as low concentrations as 1 in 1,000,000 to 1 in 20,000,000. Their maximum effect is observed after about 4 hours' contact with the organisms.

2. The bactericidal power of these substances is influenced by the number and distribution of alkyl groups in the molecule, the maximum activity being associated with the presence of two methyl groups substituted in the 2-6 or ortho-positions to the tellurium atom in the heterocyclic ring.

3. Bactericidal power may also be influenced by even smaller isomeric differences, the *iso*propyl and *iso*butyl derivatives, for example, differing in germicidal power from the corresponding normal isomerides.

4. The toxic effect of the *cyclo*-telluro-pentane-3.5-diones on protozoa is much less marked than their bactericidal action.

5. Aromatic derivatives of these substances offer no special advantage as disinfectants over the aliphatic compounds.

6. The parent aliphatic diketones are very feeble germicides, indicating that the outstanding bactericidal power of their tellurium derivatives is associated with the tellurium-carbon heterocyclic ring. The presence of unsaturated tellurium is also essential for high germicidal power, as the activity of the compounds is greatly diminished when the metalloid is raised to the quadrivalent condition.

7. The tellurium compounds lose their outstanding bactericidal action in the presence of serum. The incompatible constituent is colloidal, but does not appear to be a protein. They retain their germicidal efficacy, however, to a large extent in the presence of urine.

8. Notwithstanding the poisonous nature of the tellurium-β-diketones and their property of inducing haematuria, there is sufficient margin between their lethal and bactericidal concentrations, and 2.4-dimethyl-*cyclo*-telluro-pentane-3.5-dione, which is readily prepared and soluble in water, has been used with success in the treatment of cystitis, and eye infections.

The authors desire to express their best thanks and appreciation to Mr. William Gemmill and Mr. H. W. Archer-Hall for their interest and help in undertaking the clinical trials, to the Government Grant Committee of the Royal Society and to the Advisory Council of the Department of Scientific and Industrial Research for grants which have helped to defray the expenses of this investigation.

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MOULDS ON FROZEN MEATS.

BY F. T. BROOKS.

In a paper by A. M. Wright (J., 1923, 488 T), it is stated that "black spot" of cold-store meat is due not only to *Cladosporium herbarum*, but also to *Mucor mucedo* and *Penicillium glaucum*. On the other hand, Brooks and Kidd and Brooks and Hansford (Special Reports 6 and 17, Food Investigation Board), found in their researches on mould contaminations of meat that "black spot" was exclusively due to the fungus *Cladosporium herbarum*. In view of this discrepancy, two of Wright's experiments of which details are given by him, have been repeated in the Low Temperature Research Station at Cambridge, the results of which invalidate Wright's view that "black spot" of meat may be caused by other fungi than *Cladosporium herbarum*. Thus mutton was inoculated with the spores of *Mucor mucedo*, and kept at a temperature of —1° C. until growth was well established, after which the meat was kept at a temperature of —11° for four and a-half months. Upon examination after this period there was found no trace of "black spot," but only the typical growth of *Mucor*. Similarly mutton inoculated with a species of *Penicillium*, and kept at 4° until the fungus was well developed, showed no trace of "black spot" after being kept for four and a-half months at —11°; again, only the typical growth of *Penicillium* was apparent.

If Wright's contention that "black spot" may be due also to *Mucor* and *Penicillium* be true, one wonders what is the cause of the black colour of such spots, for the hyphæ of both *Mucor* and *Penicillium* are colourless. Brooks and Kidd have shown that in all the "black spots" examined by them the colour was caused by the dark hyphæ of *Cladosporium herbarum*.

Wright states that *Mucor mucedo*, a *Rhizopus* and *Penicillium glaucum* were often isolated by him from "black spots." This is not surprising, as these moulds are often superimposed upon meat contaminated by *Cladosporium herbarum*. Under such conditions special precautions must be taken to isolate *Cladosporium herbarum*, as this fungus grows slightly deeper in the tissues than the other moulds.

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NITRATION OF STEREOISOMERIC AROMATIC DIAMINES.

BY GILBERT T. MORGAN AND WILFRED JOHN HICKINBOTTOM.

It has previously been demonstrated that $\beta\gamma$-di-p-tolyl-aminobutane ($\beta\gamma$-butylene-di-p-toluidine) exists in four stereoisomeric forms (J. Chem. Soc., 1923, **123**, 97), and the present communication deals with the nitration of the externally and internally compensated modifications. The object of the investigation was to ascertain whether the different spatial arrangement of the aromatic radicals of these diamines would be revealed by differences in the behaviour of the bases towards substituting agents.

The experimental results recorded below show that the *dl*-diamine and the *meso*-base (II.) behave in a precisely similar manner. Any slight variations in ease of nitration or in yields are to be attributed merely to differences in the solubility of the products under the conditions of experiment.

Two methods of nitration were adopted :—

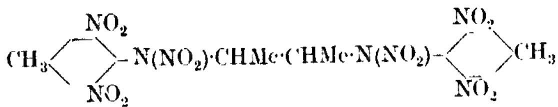
(1) Nitration in acetic acid or acetic anhydride.

(2) Nitration of the sulphate of the base with concentrated nitric and sulphuric acids.

The following diagram, which applies both to *dl*-$\beta\gamma$-di-p-tolylaminobutane (the conglomerate of the *d*- and *l*- forms) and to *meso*-$\beta\gamma$-di-p-tolylaminobutane, illustrates the course taken by each of the methods of nitration.

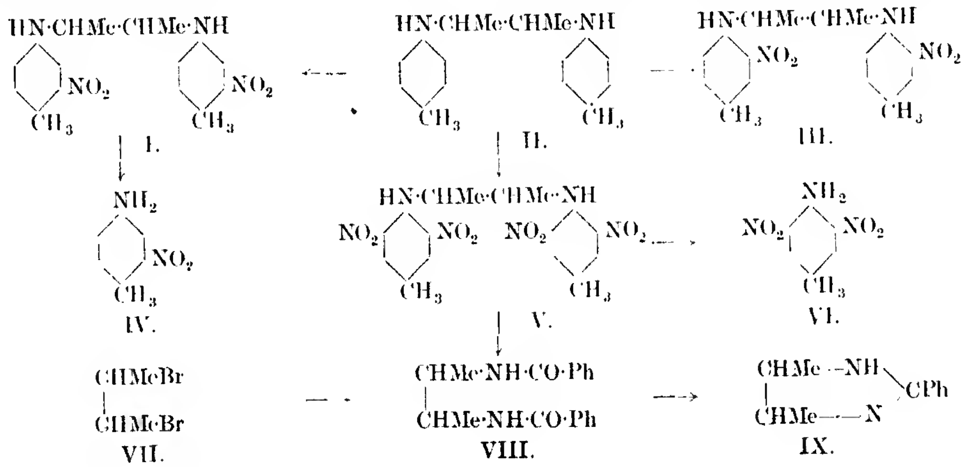
In the absence of any other strong mineral acid, the action of nitric acid on the two stereoisomerides (II.) leads to *dl*- and *meso*-$\beta\gamma$-*3.3'-dinitrodi*-p-*tolylaminobutane* (III.). By more drastic treatment with stronger nitric acid the two stereoisomeric bases yield respectively *dl*- and *meso*-$\beta\gamma$-3.3'.5.5'-*tetranitrodi*p-*tolylaminobutane* (V.).

In this mode of nitration the positions taken up by the nitro groups show that the alkylenediamino group is the orienting agent. This effect is probably due to the circumstance that the first action of the nitric acid is to form a nitrate which becomes dehydrated to a nitramine, the latter compound then undergoing isomeric change by migration of the nitro group into the ortho position in the ring. When both ortho positions are already occupied by nitro groups, this isomeric change is no longer possible, and the nitramine can be isolated. This result was achieved by nitrating the *dl*-diamine with excess of nitric acid in presence of acetic anhydride, when *dl*-$\beta\gamma$-*butylene*-3.3'.5.5'-*tetranitrodi*-p-*tolyldinitramine* (X.) was produced.



Nitration takes a different course, however, when it is effected on the sulphate of the diamine in concentrated sulphuric acid. Here the reactivity of the aminic nitrogen is destroyed by salt formation, and the methyl group becomes the prepotent orienting factor. The stereoisomerides (II.) give rise to *dl*- and *meso*-$\beta\gamma$-*2.2'-dinitrodi*-p-*tolylaminobutane* (I.).

The orientation of the nitro groups in the foregoing nitration products of the di-p-tolylaminobutanes was determined by acid hydrolysis, using moderately concentrated sulphuric acid, when the two dinitrodiamines (I.) obtained by the sulphate method yielded 2-nitro-p-toluidine (IV.). The tetranitrodiamines (V.) produced by nitration in acetic acid when hydrolysed in this way furnished 3.5-dinitro-p-toluidine (VI.). The constitution of the other two dinitrodiamines (III.) is reached by exclu-



sion and confirmed by the fact that further nitration leads to the corresponding 3.5.3′.5′-tetranitrodiamines (V.)

Alkaline hydrolysis in alcohol of these tetranitrodiamines (V.) leads to fission occurring between the aminic nitrogens and the ring. 3.5-Dinitro-*p*-cresol remains in the alkali whilst the stereoisomeric *βγ*-diaminobutanes are obtained by distillation. These are identical with the diamines obtained by the action of ammonia on *sym*-butylene dibromide (VII.), and are characterised by their *dibenzoyl* derivatives (VIII.) and by the conversion of these compounds into *iminazoles* (IX.)

dl-βγ-3.3′.5.5′-Tetranitrodi-p-tolylaminobutane (V.), m.p. 230°, orange-yellow needles from glacial acetic acid, sparingly soluble in acetone and ether; it contained 18·90% N; $C_{18}H_{20}O_8N_6$ requires N=18·75%. Addition of 50% potassium hydroxide to an acetone suspension of the nitroamine produced a reddish-purple coloration; the acetone layer gradually changed colour through light red to orange, whilst the lower layer, initially colourless, assumed a dark red tint. *Preparation.*—A solution of 4 grams of *dl-βγ*-di-*p*-tolylaminobutane in 25 c.c. of glacial acetic acid was added during 30 minutes with stirring to 60 c.c. of colourless fuming nitric acid (*d.* 1·5) and 60 c.c. of glacial acetic acid, maintained below −10° throughout the nitration, which was completed by allowing the mixture slowly to attain the room temperature for 2½ hours. A crystalline deposit separated, and the product, which was isolated by pouring on to ice, was washed with acetone and crystallised from glacial acetic acid (yield 67–75%).

dl-βγ-Butylenetetranitrodi-p-tolyldinitramine (X.), pale yellow tablets, almost white crystalline powder from fuming nitric acid, decomposed at 178°–180° with evolution of oxides of nitrogen; sparingly soluble in alcohol or ether, dissolving more readily in acetone. N=20·87%; $C_{18}H_{18}O_{12}N_8$ requires N=20·82%.

Preparation.—*dl-βγ*-Di-*p*-tolylaminobutane (3 g.) in 7 g. of glacial acetic acid was added to 50 c.c. of fuming nitric acid (*d.* 1·5) and acetic anhydride in equal volumes. After five hours the precipitate on ice was crystallised from glacial acetic acid.

dl-βγ-3.3′-Dinitrodi-p-tolylaminobutane (III.), brownish-red needles, m.p. 200°; not readily soluble in cold acetone or alcohol, more readily in chloroform. N=15·83%; $C_{18}H_{22}O_4N_4$ requires N=15·64%.

Preparation.—The externally compensated amine (1 g.) dissolved in 10 c.c. of glacial acetic acid was added slowly to 10 c.c. of nitric acid (*d.* 1·42) and 25 c.c. of glacial acetic acid at 0°. After four hours the solution was poured on to ice, and the precipitate crystallised from glacial acetic acid.

dl- or r-βγ-2.2′-Dinitrodi-p-tolylaminobutane (I.), m.p. 132°, orange needles from glacial acetic acid; orange hemispherical aggregates of small needles from a mixture of carbon tetrachloride and chloroform. Sparingly soluble in alcohol or carbon tetrachloride, more so in chloroform or acetone. N=15·84%; $C_{18}H_{22}O_4N_4$ requires N=15·64%.

Preparation.—To *dl-βγ*-di-*p*-tolylaminobutane (2·55 g.) dissolved in 110 g. of sulphuric acid (*d.* 1·84) at 0° was added a solution of 1 mol. of nitric acid (*d*=1·42) in 1 vol. of sulphuric acid. After several hours the solution diluted with crushed ice was partially neutralised with aqueous ammonia. The precipitated nitroamine, which crystallised from glacial acetic acid, yielded colourless salts: *hydrochloride*, *hydrobromide*, and *sulphate*, but these were readily dissociated by water. With formaldehyde it furnished a lemon-yellow crystalline condensation product.

meso-βγ-3.3′.5.5′-Tetranitrodi-p-tolylaminobutane (V.), m.p. 212°; minute orange plates or tablets from benzene, giving the same colour reaction as its externally compensated isomeride with sodium hydroxide and acetone. N=19·1%; $C_{18}H_{20}O_8N_6$ requires N=18·75%. *Preparation.*—One gram of *meso*-amine in 5 c.c. of glacial acetic acid was added slowly to 5 c.c. of glacial acetic acid and 15 c.c. of colourless fuming nitric acid (*d* 1·5) cooled to −15°. After keeping at −10° for fifteen minutes the mixture was poured on to ice and the bulky yellow precipitate extracted with small quantities of warm acetone. The residue consisted of practically pure *meso-βγ-3.3′.5.5′-tetranitrodi-p-tolylaminobutane.*

The weight of tetranitro compound varied in different preparations, but with efficient cooling a 40–50% nitration was effected. The yield was greatly reduced if during nitration the temperature reached 0°, and the product then contained a considerable proportion of a substance readily soluble in acetone, which separated from acetic acid in bright yellow slender needles, melting and decomposing at 163°–164°. Its reactions indicated that it was probably the tetranitrodinitrosamine of ditolylaminobutane.

meso-βγ-3.3′-Dinitrodi-p-tolylaminobutane (III.), m.p. 195°; scarlet platelets from acetone, sparingly soluble in alcohol or glacial acetic acid. Neither this substance nor the corresponding *dl*-compound gave any colour with sodium hydroxide and acetone. N=15·86%; $C_{18}H_{22}O_4N_4$ requires N=15·64%. *Preparation.*—By nitrating the *meso*-amine under the same conditions as those described for the preparation of externally compensated 3.3′.5.5′-tetranitrodi-*p*-tolylaminobutane. It also resulted from the nitration of the *meso*-base with a more dilute solution of nitric acid in glacial acetic acid.

meso-βγ-2.2′-Dinitrodi-p-tolylaminobutane (I.), m.p. 186°; from ethyl acetate in nodular masses, from acetic acid in yellowish-orange needles; sparingly soluble in benzene, more so in xylene. N=15·74%; $C_{18}H_{22}O_4N_4$ requires N=15·64%. *Preparation.*—By nitration of *meso* di-*p*-tolylaminobutane in a large excess of sulphuric acid (see nitration of *dl*-amine in presence of sulphuric acid).

The action of acids on meso- *and* dl-*βγ-2.2′-dinitrodi-p-tolylaminobutane.*

meso-2.2′-Dinitrodi-*p*-tolylaminobutane when heated with concentrated hydrochloric or hydrobromic acid for 9—10 hours in sealed tubes at about 170°, gave small yields of 2-nitro-*p*-toluidine together with crystalline halogenated products. The corresponding externally compensated nitro compound behaved in a similar manner.

A more satisfactory degradation of these isomerides into 2-nitro-*p*-toluidine was effected by means of moderately concentrated sulphuric acid. To the dinitro compound (1·2 g.) suspended in 10 c.c. of water, 10 c.c. of concentrated sulphuric acid were added; the white precipitate of the sulphate dissolved on heating to a solution which became violet and finally almost black. When the suspended solid had dissolved, 60 c.c. of water were added and the heating was continued for about 15 minutes. The solution was then diluted further, made alkaline by dilute ammonia, and filtered from a flocculent impurity. The filtrate on extraction with benzene and ether furnished 2-nitro-*p*-toluidine mixed with a small quantity of tarry matter. By crystallisation from petroleum (b.p. 80°–100°), 2-nitro-*p*-toluidine was obtained in flattened yellow needles, m.p. 76°—77·5°.

The nitro-*p*-toluidines from externally compensated 2 2′-dinitrodi-*p*-tolylaminobutane and the analogous *meso*-isomeride were identical and were characterised as 2-nitro-*p*-toluidine.

The action of sulphuric acid on meso- *and* dl-$\beta\gamma$-*3 3′.5.5′-tetranitrodi-*p*-tolylaminobutane.*

The tetranitro compound (0·7 g.) was moistened with water (about 1 c.c.) and 10 c.c. of concentrated sulphuric acid were added. A reddish solution resulted which, on further heating, darkened in colour. During the heating water was gradually added. When yellowish vapours appeared the solution was cooled, diluted largely, and the precipitated nitro compound collected and crystallised from benzene, alcohol, or carbon disulphide. The crude product from the externally compensated tetranitro compound melted at 165°–166° after softening slightly from 155°. Successive crystallisation from alcohol and carbon disulphide raised the melting point to 167°–168°.

The crude product from *meso*-$\beta\gamma$-3.3′.5.5′-tetranitrodi-*p*-tolylaminobutane melted at 165°–167° after washing with alcohol and crystallisation from benzene, it separated in yellow flattened needles.

There was no depression of melting point when the products from the *meso*- and externally compensated nitro compounds were mixed together, or when admixed with a specimen of 3.5-dinitro-*p*-toluidine.

*The action of sodium hydroxide on $\beta\gamma$-3 3′.5.5′-tetranitro-di-*p*-tolylaminobutane.*

The externally-compensated tetranitro compound (2 g.) was heated with 4 g. of sodium hydroxide in 75 c.c. of aqueous alcohol until the solid had dissolved. The volatile products of the decomposition were removed by distillation in steam, the distillate was acidified with hydrochloric acid and evaporated to dryness. The crude hydrochloride, after redissolving in water and filtering to remove the small amount of insoluble matter, was converted into the benzoyl compound. It was found advisable after rendering alkaline to remove traces of ammonia by subjecting the solution to diminished pressure before adding benzoyl chloride.

The benzoyl compound melted at 220°—224° after washing with ether, and did not depress the melting point of *dibenzoyldiaminobutane* of similar purity. It was characterised by conversion into the *iminazole* by heating in a current of hydrogen chloride (see p. 310 T). The *picrate* of the cyclic base melted at 175°—178° after commencing to soften at 165°. No depression of the melting point was observed when it was mixed with a specimen of *2-phenyl-4 5-dimethyliminazole* of similar purity (p. 310 T).

The decomposition of the *meso*-tetranitro compound was effected in a manner similar to that used for the externally compensated isomeride. The amount of material available was small, but the resulting diaminobutane was identified as its benzoyl derivative.

The action of ammonia on $\beta\gamma$-dibromobutane.

A mixture of 700 c.c. of alcoholic ammonia saturated at 0° and $\beta\gamma$-dibromobutane (93 g.) was left for a week at the ordinary temperature, then resaturated with dry ammonia and heated at 110°—125° in a rotating autoclave (Morgan and Vining, Chem. Soc. Trans., 1920, **117**, 780) for ten hours. The reaction product was then cautiously neutralised with hydrochloric acid and the excess of solvent and volatile bromo compounds were removed by distillation (A). A brownish residue remained, which, after evaporating to dryness twice with hydrochloric acid, was extracted with absolute alcohol to eliminate the bulk of ammonium salts. The alcoholic extract was evaporated and the resulting dark viscid mass of hydrochlorides treated at 0° with concentrated aqueous sodium hydroxide. A dark oil (B) having a strong basic odour separated and was dried over solid potassium hydroxide. From the strongly alkaline aqueous layer remaining after the removal of (B) further amounts of amines were obtained by extraction with ether or by steam distillation.

Isolation of bromobutylene (*Δ^{β}-bromobutene*).—Dilution of the distillate (A) with a large volume of water precipitated a heavy, colourless oil which after washing and drying distilled chiefly between 88° and 93°. On re-fractionation the bulk of the liquid was collected between 87·5° and 92° as a dense colourless liquid, which reduces a cold neutral aqueous solution of potassium permanganate. Its properties agree with those recorded for β-bromobutylene (Wislicenus and Schmidt, Annalen, 1900, **313**, 215). In two experiments the yield amounted to 44 g. from 187 g. of dibromobutane.

Isolation of $\beta\gamma$-diaminobutane.—The dark basic oil (B) left over solid potassium hydroxide for two weeks was systematically fractionated. The molecular weight of each fraction, determined by titration against standard acid assuming that only dibasic amines are present, is given in the following table:—

Fraction collected at.	Mol. wt.	Nitrogen. %
—120°	133	—
120°—130°	118 5	—
130°—135°	107	26 15
135°—145°	112	25 5
145°—150°	125	—
150°—160°	138	20·13

$C_4H_{12}N_2.H_2O$ requires N=26·39%, mol. wt.=106·1. The fractions 120°–150° all had a characteristic odour, fumed in moist air or in presence of acid vapour, and gradually became solid when exposed to

the atmosphere in an open dish. A drop when rubbed between the fingers had a slight "soapy" feel.

An examination of the fraction 130°—135°, which appeared to consist of approximately pure diaminobutane hydrate, showed that it was probably a mixture of stereoisomerides. Benzoylation gave a product melting at 195—205° after washing with ether. After several crystallisations it melted at 236°—238°. Similar results were obtained by crystallisation of the benzoyl derivatives of other fractions, and by benzoylation of the purified oxalate; m.p. 235° with decomposition. Angeli (Ber., 1890, **23**, 1358) gives m.p. 237·5—238° with decomposition.

βγ-Dibenzoylaminobutane, prismatic needles from alcohol. N = 9·45%; $C_{18}H_{20}O_2N_2$ requires N = 9·45%.

βγ-Di-p-toluenesulphonylaminobutane, flattened needles or plates from alcohol, the highest melting point being 178°—179°. A number of fractions were obtained melting between 140° and 170°. N = 7·39%; $C_{18}H_{24}O_4N_2S_2$ requires N = 7·07%.

βγ-Diaminobutane picrate, bright yellow crystalline powder decomposing at 250°—252° after darkening from about 220°; purified by repeated extraction with water. N = 20·62%; $C_4H_{12}N_2,2C_6H_3O_7N_3$ requires N = 20·51%.

2-Phenyl-4.5-dimethyliminazole (IX.).—Dry hydrogen chloride was led over fused dibenzolyaminobutane of highest melting point until no more benzoic acid sublimed away; the residue then contained the hydrochloride of *2-phenyl-4.5-dimethyliminazole*. The base itself crystallised from a mixture of benzene and light petroleum in needles, m.p. 101°—103°. Its *picrate* formed small, light yellow tufts from alcohol, m.p. 190°. N = 17·45%; $C_{11}H_{14}N_2,C_6H_3O_7N_3$ requires N = 17·37%.

From dibenzoylaminobutane of lower melting point, cyclic bases were obtained having the properties of iminazoles. They were either semi-solid or oily and yielded *picrates* of lower melting points which could not readily be separated by crystallisation.

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AROMATIC HYDROCARBONS IN BURMAH PETROLEUMS.

BY H. M. MULANY, M.SC., AND E. R. WATSON, D.SC.

The petroleums of Assam and Burmah are known to contain high percentages of aromatic hydrocarbons, and a process was recently worked out for the manufacture of trinitrotoluene from Assam and Burmah petrols (Indian Patent 6802 of 1921; see also Indian Industries and Power, March, 1923).

Our present research is an extension of the work then done, and was undertaken in order to identify the more important aromatic hydrocarbons in the petrol and kerosene fractions of Burmah oil.

The kerosene was fractionated from a flask using an eight-pear Young's column, and nineteen fractions were collected, the first being below 100°, the second up to 130°, and every successive one at an interval of 10°. The residue was a dark liquid. Several distillations were carried out to collect a sufficiently large quantity of each fraction.

When the specific gravity of each fraction was determined and plotted against its boiling point an almost smooth straight-line graph was obtained; it had been hoped to obtain well marked maxima of points of inflexion where the fractions would contain the highest percentage of aromatic compounds.

The bulkier fractions were then taken for examination. The percentage of aromatic hydrocarbons was determined by Thole's method (J., 1919, 39T), and the first few fractions were mononitrated, but this method was soon abandoned, as some polynitro-compounds which were always formed simultaneously gave trouble in purification by distillation. The method then adopted was to form the polynitro compound or the barium salt of the sulphonic acid so as to obtain a crystallisable product.

Later it was found better to isolate the aromatic hydrocarbons by Armstrong's method (Chem. Soc. Trans., 1884, **45**, 148). The total aromatic hydrocarbons recovered were then fractionally distilled, and the larger fractions were polynitrated, sulphonated, and oxidised. In one case a picrate was obtained. The chief aromatic compounds thus identified in the kerosene oil were *m*-xylene, *p*-cymene, and *β*-isoamylnaphthalene.

The petrol was fractionally divided into three parts, the first two being distilled at temperatures calculated to separate the benzene and toluene. The second part had been already examined during the investigation on the manufacture of TNT. The first part showed benzene and also quite a large quantity of toluene. The third part contained not only *o*- and *p*-xylenes as expected, but also some mesitylene and perhaps higher hydrocarbons.

The kerosene.

"B.O.C. Water White" kerosene was chosen for our experiments. Its fractionation has already been described. The specific gravity determinations and mononitration of some of the fractions having proved useless, attention was directed on obtaining crystallisable products by polynitration or by sulphonation.

Fraction No. 5 (150°—160°).—This was the first large fraction in the series.

1. *Polynitration.*—50 c.c. of the fraction, containing roughly 22·5% of aromatic compounds, were mononitrated by adding a cold mixture of 8·05 c.c. of sulphuric acid (*d* 1·84) and 6·35 c.c. of nitric acid (*d* 1·4), keeping the temperature below 50°. The acid was then run off and the mononitro compound

extracted from the aliphatic hydrocarbon layer by 36·2 c.c. of cold concentrated sulphuric acid in several successive fractions. Trinitration or polynitration was then carried out by cautiously adding 11·35 c.c. of nitric acid (*d* 1·5) to the sulphuric acid extract obtained above, keeping the temperature below 50°. The temperature was then raised to 70° in half an hour and from 70° to 120° in 3½ hours. The mixture was kept at 120° for one hour, and when cooled was poured into an excess of cold water and the solid crude product filtered, washed at the pump with cold water, dried, washed with ether, and crystallised from alcohol. Recrystallisation yielded mainly yellowish-white needle-shaped crystals, m.p. 181°—182°, apparently of trinitro-*m*-xylene (m.p. 182°). A small quantity, remaining insoluble in hot alcohol, gave crystals melting at 185° out of glacial acetic acid.

2. *Sulphonation* was effected with three volumes of 98% sulphuric acid in the cold. The barium salt was prepared and crystallised. An end crop gave on analysis Ba 25·72, C 40·69, H 4·62%; the barium salt of the cumenemonosulphonic acid $(C_9H_{11}SO_3)_2Ba$ contains Ba 25·65, C 40·33, H 4·11%. Also, the melting point of 3.5.6- trinitrocumene is 185°, which agrees with the melting point of the smaller crop of polynitro compound crystallised from acetic acid.

Recovery of the aromatic hydrocarbons.—Armstrong's method (*loc. cit.*) was found to be the most suitable for this purpose. 1300 c.c. of kerosene thus treated yielded 120 c.c. of aromatic hydrocarbons, which were then fractionally distilled, using a column of 8 pears and an air condenser. The quantities of fractions obtained were as tabulated below:—

No of fraction.	Range of temperature.	Weight of fraction. g.	Possible hydrocarbons.
1	44°—50°	1·0	
2	76°—80°	1·2	benzene.
3	90°—105°	0·4	
4	120°—130°	2·3	
5	130°—140°	3·5	*m*- and *p*-xylenes
6	140°—150°	12·4	*o*-xylene, much between 141° and 144°
7	150°—160°	5·4	much between 152° and 154°; cumene.
8	160°—170°	2·4	mesitylene, pseudocumene
9	170°—180°	9·2	hemimellithene, *m*-cymene, butylbenzene.
The flask had to be changed during this range.			
10	180°—190°	9·0	*o*- and *p*-cymenes, butylbenzene. durene.
11	190°—200°	0·6	
12	200°—210°	1·4	prehnitene.
13	210°—220°	4·1	naphthalene.
14	220°—230°	2·3	
15	230°—240°	3·7	pentamethylbenzene
16	240°—250°	8·1	methylnaphthalene.
17	250°—260°	3·7	ethylnaphthalene.

Residue, 12·6 g.

Fractions 6, 9, 10 and 16 are thus the most important. It is also probable that there are only three chief substances represented by fraction 6, fractions 9 and 10, and fraction 16. Our efforts were therefore concentrated on these fractions. In a later experiment to recover a further quantity of aromatic hydrocarbons the conditions were slightly changed to avoid the use of a large volume of acid, by heating the kerosene with only an equal volume of 100% sulphuric acid on a water bath, under a reflux condenser, for three hours, with occasional shaking. Much sulphur dioxide was evolved this time and the yield of aromatic hydrocarbons was smaller; the three maxima were also not so marked in this case.

I. *Aromatic fraction* 6 (b.p. 140°–150°) was polynitrated as described above. 8 g. of the hydrocarbon thus yielded 7 g. of a crude whitish-yellow solid which, after washing with ether and then with cold alcohol, and crystallising from hot absolute alcohol yielded needle-shaped crystals of m.p. 183°–185° (mainly 185°) containing 17·46% of nitrogen. 2.4.6Trinitro-*m*-xylene melts at 182° and contains 17·42% N, whilst trinitrocumene (m.p. 185°) contains only 16·47%. The boiling point of the fraction is 140°–150°, but most of it distilled between 141° and 144°. The boiling point of *m*-xylene is 139°. It appears therefore that this fraction corresponds with the aromatic compounds in the fifth fraction of kerosene already examined.

II. *Aromatic fractions* 9 *and* 10 *mixed* (b.p. 170°—190°). It was believed that these fractions represented mainly one prominent hydrocarbon, b.p. approx. 180°. The mixed fraction was examined as follows:—

Trinitration was carried out as previously, the solid crude product was washed with light petroleum ether and then with cold alcohol and purified by repeated crystallisation from hot alcohol. The product had m.p. 176°–178°, and contained 16·50% N. $C_{10}H_{11}(NO_2)_3$ requires 15·5% N, and $C_9H_9(NO_2)_3$ 16·64%; but compounds of the latter formula are mostly ruled out by their melting point or the boiling points of their parent hydrocarbons. Trinitro-*p*-cymene melts at 178°–180°, whilst *p*-cymene itself has b.p. 175°.

Sulphonation was effected by heating with an equal volume of 100% H_2SO_4 at 100° for 3 hrs. The barium salt was obtained in four crops of feathery, needle-shaped crystals containing $Ba(SO_3)_2$, 52·85%, C 42·12%, H 5·21% $(C_{10}H_{13}SO_3)_2Ba$ requires $Ba(SO_3)_2$ 53·19, C 42·20, H 4·61%.

Oxidation with aqueous permanganate.—Oxidation by Semmler's method ("Die aetherischen Oele," vol. 5, 22) yielded a substance of m.p. above 300°, and showing a tendency to sublime and flash back during combustion; it gave a methyl ester of m.p. 139°—140° by Mulliken's test for the phthalic acids: the corresponding ester of *p*-phthalic acid melts at 140°. Elementary analysis showed C 57·79% H 4·67%; phthalic acid requires C 57·83% H 3·61%.

The evidence given by all these results is strongly in favour of the presence of *p*-cymene.

Aromatic fraction 16 (*b.p.* 240—250°).—The boiling point of this third largest fraction would suggest the presence of a homologue of anthracene or naphthalene. But the former class is ruled out, being all solids; the latter type of compounds are possible, being mostly liquids. This fraction was rather troublesome to handle. Neither its polynitro compound nor its barium sulphonate could be obtained in a crystalline condition, and a quantity was prepared directly from the corres-

ponding fraction (*i.e.*, the fourteenth) of the kerosene by Armstrong's method.

The barium sulphonate was prepared directly from the corresponding kerosene fraction by heating on a water-bath with 1/10 vol. of 100% H_2SO_4 for three hours. The salt was obtained in four crops, all of which were amorphous. The first three consisted of one substance, containing C 36·69%, H 3·79%, Ba 27·92%; $C_{15}H_{16}(SO_3)_2Ba$ requires C 36·46%, H 3·24%, Ba 27·84%.

The molecular weight of the aromatic hydrocarbon recovered from the fourteenth fraction of kerosene was determined by the cryoscopic method in glacial acetic acid solution. Two experiments, each involving two determinations, gave a mean value of 143. This is much lower than that calculated from the estimation of barium in the second crop of the barium sulphonate—viz., 195. Perhaps the hydrocarbon is not so pure as the barium salt.

Oxidation with permanganate in aqueous solution was incomplete, but gave a small quantity of a product resembling β-naphthoic acid. Oxidation in acetone solution also gave no definite results.

The theoretical quantity of picric acid dissolved in boiling benzene, calculated on the formula $C_{15}H_{18}$, was added to 2 g. of the hydrocarbon. The picrate on recrystallisation from alcohol had m.p. 108°–110°. The picrate of β-isoamylnaphthalene—a hydrocarbon of the formula $C_{15}H_{18}$—melts at 110°. This, together with the results of the analysis of the barium sulphonate and the character of its oxidation product identifies the hydrocarbon as β-isoamylnaphthalene.

The petrol.

B.O.C. Petrol was distilled with the same 8-pears Young's fractionating column and two fractions were collected at 95° and 122°, using Thole's "cutting" temperatures (J., 1919, 39 T). Of these, the second fraction was already examined by one of us for the manufacture of T.N.T.; and found to contain 21·2% of toluene.

First fraction. The fraction collected by distilling the petrol containing approximately 10% of aromatic hydrocarbons, on nitration yielded a product, which from its b.p. range appeared to consist of nitrobenzene, with a larger quantity of nitrotoluene. Reduction of the nitro compound with tin and hydrochloric acid yielded a product resembling aniline in odour, and consisting of a mixture of aniline and toluidine, as indicated by the b.p. ranges, the production of a violet colour changing to dark red on treatment with bleaching powder solution and ether, and an acetylation test.

The third fraction or residue was found by Thole's process to contain 12% of aromatic hydrocarbons. It was expected to contain the xylenes, as the first large fraction of the kerosene had been found to contain a large proportion of *m*-xylene.

Trinitration, effected as in the case of the fifth kerosene fraction, gave only a small yield of trinitro-compound, and the first crop of crystals from alcohol had m.p. 236°; the nearest to this is 232°, the m.p. of trinitromesitylene. The next two crops had indefinite melting points, even after recrystallisation from alcohol, ranging between 176° and 184° and 140° and 156° respectively.

Sulphonation with an equal volume of cold 98% sulphuric acid gave a product of which the crystalline barium salt contained 37·50% Ba; $C_8H_7(SO_3Ba)_3$ requires 36·95% Ba. This shows the presence of a hydrocarbon of the order of xylenes.

It was felt necessary at this stage to isolate and oxidise the aromatic hydrocarbons. 350 c.c. of the residue from the distillation of one litre of petrol were sulphonated as above, and the aromatic compounds recovered by means of superheated steam. The product (31 g.) was distilled and three fractions collected, viz., 134°–150° (mostly 134°–142°), 19 c.c.; 156°–160°, 9 c.c.; residue, mostly below 170°, 7 c.c. Thus more than half the bulk distils at a temperature range corresponding with the boiling points of the xylenes, viz., 139°–142°. There is also evidence of the presence of higher homologues like mesitylene (b.p. 163°), the trinitro compound of which was detected in the product of polynitration.

To ascertain whether the hydrocarbon C_8H_{10} was one of the xylenes or ethylbenzene, the first fraction of the aromatic hydrocarbons was oxidised by means of chromic acid. A smell of benzaldehyde was detected at first, but the oxidation product was mainly *p*-phthalic acid mixed with a little *o*-phthalic acid—the former being identified by its infusibility, and the formation of a methyl ester of m.p. about 140°, the latter being identified by the resorcinol test.

Thus the main aromatic hydrocarbon of this fraction seems to be *p*-xylene mixed with a little *o*-xylene and an appreciable quantity of mesitylene and some other higher-boiling homologues.

Conclusions.

The Burmah Oil Co.'s petrol and kerosene contain on an average about 10% of aromatic hydrocarbons, which can be separated from the aliphatic portion by sulphonation and distillation with superheated steam, and the residues used for burning and illuminating purposes as usual.

The main constituents of these aromatic hydrocarbons are:—

Benzene, which is present in the petrol and the lowest-boiling fraction of the kerosene.

Toluene, which forms more than 7% of the petrol, and is the main constituent of the aromatic hydrocarbons therein.

The xylenes, all the three isomerides of which are present in the higher fraction of the petrol and the lower fraction of the kerosene, *o*- and *p*-xylenes forming about 2% of the petrol and *m*-xylene about 1·1% of the kerosene.

p-*Cymene*, the main aromatic hydrocarbon of the kerosene, forming 20% of the total aromatic compounds, and thus approximately 2% of the kerosene.

β-Isoamylnaphthalene, which is the main aromatic constituent of the higher fractions of the kerosene, forming 10% of the total aromatic compounds and thus 1% of the kerosene.

In addition to these, mesitylene and cumene have been found in the higher fraction of the petrol and the lower fraction of the kerosene respectively.

The most important of these hydrocarbons, from an industrial point of view, looking also to the proportions in which they are present, would be toluene in the petrol fraction and *p*-cymene in the kerosene fraction. One of us has shown the commercial possibility of this toluene for the manufacture of T.N.T. in a previous paper. The utility of *p*-cymene in the manufacture of thymol and synthetic essential oils is well-known.

Attention must be drawn incidentally to the work started by Gordon and his collaborators (J., 1923, 105 T).

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THE PREPARATION OF CYANOACETIC ESTER (ETHYL CYANOACETATE).

BY OSWALD C. STEPHENS, M.SC.

Cyanoacetic ester is usually prepared by the esterification of cyanoacetic acid, made by the action of potassium cyanide on chloroacetic acid. The discovery by Imbert (G.P. 212,592) of a method for preparing chloroacetic ester directly without the previous isolation of chloroacetic acid, suggests the possibility that the preparation of cyanoacetic ester direct from chloroacetic ester may be a more useful and less laborious operation.

The preparation of cyanoacetic ester from trichloroethylene and otherwise has been investigated and is described in this paper in three stages:

1. A quantitative investigation of the preparation of chloroacetic ester by Imbert's method.

2. An investigation of the preparation of cyanoacetic ester from chloroacetic ester.

3. A study of alternative methods of preparing cyanoacetic ester.

The preparation of chloroacetic ester.

Tompkins (J., 1907, 167) showed that when trichloroethylene is treated with a hot solution of sodium or potassium ethoxide in ethyl alcohol, dichlorovinyl ether is formed, and Imbert (*loc. cit.*) later discovered that if this dichlorovinyl ether is heated with alcohol to which a trace of anhydrous aluminium chloride is added, chloroacetic ester is formed.

The preparation of the dichlorovinyl ether is best effected as follows.

To 83 g. of trichloroethylene in 150 c.c. of absolute alcohol, are added in small quantities, 11·5 g. of sodium dissolved in 90 c.c. of absolute alcohol, the mixture is warmed to 65°–75° to start the reaction, and stirred vigorously, the reaction being allowed to moderate before adding further quantities of ethoxide and the mixture cooled before each addition. If the temperature is allowed to rise much above 70° the reaction may be very violent. The mixture is boiled on the water-bath for one hour after all the ethoxide has been added, poured into water, the vinyl ether is separated, dried over calcium chloride and distilled, the fraction distilling at 122°–126° being collected as dichlorovinyl ether (17 g. of trichloroethylene were recovered and 58 g. of dichlorovinyl ether obtained 81% yield calculated on trichloroethylene consumed).

The effect of using an excess of trichloroethylene is to minimise the formation of reduction products. In earlier experiments the theoretical quantity of trichloroethylene was added to the sodium ethoxide in alcohol and the mixture cautiously warmed on the water-bath. The reaction was very vigorous, necessitating cooling, and, in addition, a spontaneously inflammable and explosive gas, probably monochloroacetylene, was formed in small quantity (Wallach, J. Chem. Soc., 1878, 653).

Conversion of dichlorovinyl ether into chloroacetic ester.

The ether is converted into chloroacetic ester by boiling with ethyl alcohol to which a trace of anhydrous aluminium chloride has been added (Imbert, *loc. cit.*). The reaction once begun is very vigorous and ethyl chloride is given off in quantity. Owing to the vigour of the reaction a specially wide reflux condenser is necessary. The ethyl chloride can be collected in a suitable condensing apparatus. 75 g. of dichlorovinyl ether and 70 c.c. of absolute alcohol yielded 55 g. of chloroacetic ester (88·7% yield). A further experiment gave a 90% yield.

The use of rectified spirit in place of absolute alcohol in the conversion, lowered the yield of ester by 13%, and, in addition, a quantity of hydrogen chloride was formed as well as ethyl chloride (*cf.* Crompton and Vanderstichele, Chem. Soc. Trans., 1920, **117**, 691).

It is not possible to recover the alcohol from the dichlorovinyl ether by fractional distillation, as a considerable amount of the ether distils over with the alcohol even with a three-section still-head. The conversion into chloroacetic ester can, however, be effected without separating the vinyl ether from the original reaction mixture, and, after conversion, the alcohol can be recovered by fractional distillation at reduced pressure. 166 g. of trichloroethylene ($1\frac{1}{4}$ mols.) to which were added 23 g. of sodium in 340 c.c. of absolute alcohol, gave 98 g. of chloroacetic ester, and 34 g. of trichloroethylene were recovered. Calculated on trichloroethylene consumed, this is an 80% yield. In other experiments yields of 79% and 76% were obtained.

As the trace of alkali present may cause the aluminium chloride to lose its activity, a further addition of catalyst towards the end of the reaction may be necessary.

Preparation of cyanoacetic ester from chloroacetic ester.

The preparation of cyanoacetic ester from chloroacetic ester seems very straightforward, and Muller

(J. Chem. Soc., 1864, 109) stated that this was the most satisfactory way of obtaining cyanoacetic ester. It is found, however, that when chloroacetic ester and potassium cyanide react in alcoholic solution a quantity of material of higher boiling point is obtained. The explanation of this is found in the work of Haller (J. Chem. Soc., 1888, 937) and Zelinsky (Ber., 1888, 3398), who showed that chloroacetic ester in reacting with potassium cyanide gives a monopotassium derivative which reacts with more chloroacetic ester giving cyanosuccinic ester and cyanotricarballylic ester. The low yield of cyanoacetic ester is largely due to the formation of these secondary products, the production of which is accompanied by a great darkening in colour owing to the formation of azulmic acid (Zelinsky, *loc. cit.*).

The reaction was carried through as follows: To the chloroacetic ester dissolved in alcohol the cyanide was added, and the whole boiled on the water-bath under a reflux condenser until the reaction was completed. The alcohol was distilled off at reduced pressure, the residue poured into water, and the cyanoacetic ester separated. The aqueous layer was then extracted with ether, and the ether extract added to the separated ester. This is necessary as cyanoacetic ester is difficult to separate from water containing even a small quantity of alcohol. The ether was distilled off and the residue fractionated at reduced pressure, the fraction distilling at 95°–102° at 14 mm. being collected as ester. 41 g. of chloroacetic ester, refluxed with 19 g. of 94% sodium cyanide in 100 c.c. of absolute alcohol for four hours, gave 12 g. of cyanoacetic ester (30% yield).

Other cyanides (sodium silver cyanide, sodium cuprous cyanide, mercuric cyanide, and lead cyanide), possible from an industrial standpoint, were tried in the hope of obviating the formation of these secondary products, but all gave negative results.

As the cyanoacetic ester competes with the chloroacetic ester for the sodium cyanide and so reduces the yield, the relative concentration of the chloroacetic ester was increased by taking only half the theoretical amount of sodium cyanide. Also, as the darkening due to the formation of azulmic acid indicated the condensation of the cyanoacetic ester with the chloroacetic ester, the action was stopped when the dark colour became at all pronounced. Under these conditions 81 g. (2/3 mol.) of chloroacetic ester with 17 g. (1/3 mol.) of sodium cyanide in 100 c.c. of absolute alcohol boiled for 90 minutes on the water-bath gave 18 g. of cyanoacetic ester, and 9 g. of high-boiling product, and 43 g. of chloroacetic ester were recovered. The yield calculated on chloroacetic ester consumed is 51%.

By the addition of the cyanide in small portions it was hoped that, by thus still further increasing the relative concentration of the cyanoacetic ester, the cyanide would react more quickly and, owing to its rapid removal, the cyanoacetic ester formed would not be able to condense with the excess of chloroacetic ester.

Using the same quantities as in the previous experiment, 25 g. of cyanoacetic ester were obtained, 11 g. of high-boiling product and 37 g. of chloroacetic ester being recovered. This yield is 61%. The use of an efficient motor stirrer to avoid any local excess of cyanide gave similar results. The effect of very finely divided cyanide was tried as possibly giving a quicker reaction, but was no more satisfactory. With the same quantity a 60% yield was obtained.

It was thought that bromoacetic ester, being more reactive towards sodium cyanide than chloroacetic ester, should give a quicker reaction, thus avoiding the formation of the more complex products. It was, however, no improvement.

The important point in this preparation seems to be to bring about as vigorous a reaction as possible between the ester and the cyanide. The reaction in absolute alcohol is slow, as sodium cyanide is only slightly soluble in absolute alcohol. It seemed possible that, if the cyanide were dissolved in the least quantity of aqueous spirit, the action would be vigorous and complete, and thus the more complex products would not be formed.

To 42 g. of chloroacetic ester dissolved in 70 c.c. of rectified spirit and 20 c.c. of water, 8·5 g. (½ theory) of sodium cyanide were added, and the flask was warmed on the water-bath until the reaction commenced. The reaction was very vigorous, and ebullition went on for some time after the flask was immersed in cold water. After boiling for one hour the cyanoacetic ester was separated as described previously. 12 g. of cyanoacetic ester and 2 g. of high-boiling products were obtained, and 13 g. of chloroacetic ester were recovered.

The yield calculated on cyanide taken is 66%: calculated on chloroacetic ester consumed, 47%. This loss of chloroacetic ester was probably due to hydrolysis to glycollic ester.

(To be concluded.)

ARYLAMINE SALTS OF THE NAPHTHALENESULPHONIC ACIDS. II.

BY R. B. FORSTER AND C. M. KEYWORTH.

(J., Oct. 3, 1924, 299T—303T.)

ERRATA.

Page 299, col. 1, line 4 from bottom, for "*o*-toluidine" read "*o*-tolidine."

Page 300, col. 1, line 5 from top, for "0·716" read "0·7016."

Page 300, col. 1, line 7 from bottom, for "229°" read "230°."

Page 301, col. 1, line 6 from top, for "7%" read "99·7%."

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

TRANSACTIONS

Vol. XLIII., No. 44.] [October 31, 1924.

THE ACTION OF SALT SOLUTIONS ON IRON AND STEEL IN THE PRESENCE OF OXYGEN.

BY U. R. EVANS.

The effect of various salts on the corrosion of iron and steel by water in the presence of oxygen has been studied by Heyn and Bauer,[1] Friend and Brown,[2] Friend and Barnet,[3] as well as other investigators. In these researches, plates of metal were immersed below the surface of water, whilst other similar plates were immersed in a similar position below the surface of solutions of various salts made up with the same water; after a considerable period, the amount of corrosion was ascertained (by determining the loss of weight), and by comparing the figures obtained, the effect of the various salts was arrived at.

Clearly, however, the process of corrosion, under such conditions, consists of two separate stages —

(*a*) The transport of oxygen from the air through the liquid to the metal, either by diffusion, convection, or both;

(*b*) The consumption of oxygen, directly or indirectly in the corrosion of the metal.

Usually the addition of a salt to water will be unfavourable to stage (*a*) owing to a decrease in the oxygen-solubility, an increase in viscosity, and other causes. Often, however, it may stimulate stage (*b*), the corrosion process proper. Obviously if the specimen is very deeply immersed in liquid, the results will mainly show the effect of salts upon the transport of oxyen; if it is merely covered with a film of liquid so thin as to be perpetually saturated with oxygen, the results indicate, to some extent at least, the specific effect of the salt on the corrosion proper. Heyn and Bauer, as well as Friend and his colleagues, used intermediate conditions, and their results are therefore difficult of interpretation. In many cases, Friend found that the addition of small amounts of salts increased the corrosion, but larger amounts again reduced it. As would be expected, the curves connecting corrosion-rate with concentration vary with the condition of immersion; Heyn and Bauer's curves, for instance, do not agree with those obtained by Friend and his collaborators. Moreover, whilst Friend[4] has shown that the addition of 3% of sodium chloride to distilled water actually reduces the corrosion of deeply immersed specimens of iron, the present author[5] has shown that if the action of shallow drops of 3% sodium chloride solution is compared with that of similar drops of distilled water, the rusting is far quicker in the case of the salt solution. Apparently sodium chloride is unfavourable to stage (*a*), but favourable to stage (*b*) of the process.

The more destructive types of corrosion are now known to be of an electrochemical character. The direct attack of oxygen upon a metal usually leads to the production of a compact oxide film *in situ* which, being in mechanical contact with the metal, interferes with further attack, producing ennoblement or protection. On the other hand, indirect electrochemical action, although often finally leading to the formation of an insoluble oxide or hydroxide, usually causes it to be produced by precipitation at a sensible distance from the surface, where it does not necessarily put a stop to further corrosion. For example, in the attack of sodium chloride solution on iron, ferrous chloride is produced at the anodic portions, and alkali at the cathodic portions; both these substances are soluble, although where they meet, they will produce the sparingly soluble ferrous hydroxide (oxidising to ferric hydroxide); this will usually occur at an appreciable distance from the surface of the metal, and the precipitate will have a non-compact, non-protective form.

It was, until recently, believed that the distribution of cathodic and anodic areas depended only on the distribution of impurities in the metal. It is undoubtedly a fact that, if the distribution of oxygen over the surface is uniform, such substances as the carbide, phosphide, sulphide, and oxide of iron (and particularly graphite, if present) do tend to act as cathodes towards the grains of pure α-iron, which become anodes.[6] But the present author[7] has shown that under ordinary conditions, it is mainly the distribution of oxygen which dictates the polarity of different parts of the surface. Thus if two strips of iron joined to a galvanometer are placed in sodium chloride solution in a divided cell, and air is bubbled over one strip only, an electric current is produced at the expense of the unaerated electrode, which serves as the anode or attackable pole. We thus arrive at an explanation of the specially rapid corrosion observed at just the places to which oxygen has no direct access; for instance, it is possible to understand the localised corrosion seen at points where metallic specimens are supported through contact with glass, porcelain, thread or other material; it is easy to account for the rapid pitting observed in crannies and the localised corrosion produced where porous débris settles on a metallic surface —cases which cannot be explained on any view which regards corrosion as a phenomenon of direct oxidation.

Corresponding results were obtained by the author[8] by the study of drops of water or salt solution placed on a sheet of clean iron. Here the peripheral portion at the edge of the drop, to which oxygen has direct access, becomes ennobled and cathodic, whilst the interior portion to which oxygen can diffuse less readily becomes the anode; corrosion occurs, therefore, only at the centre, not round the edge. The

[1] Mitt. k. Materialprüf., 1908, 26, 1.
[2] J. Iron Steel Inst., 1911, 83, 125.
[3] *Ibid.*, 1915, 91, 336.
[4] Trans. Chem. Soc., 1923, 123, 2996.
[5] Proc. Camb. Phil. Soc., 1924, 22, 54.
[6] J. W. Cobb, J. Iron Steel Inst., 1911, 83, 170.
[7] J. Inst. Metals, 1923, 30, 239.
[8] J. Oil and Colour Chem. Assoc., 1923, 6, 150; J., 1924, 127T.

present paper describes a more detailed study of the action of drops of solutions of different salts on iron, with special regard to the factors which cause some salts to stimulate corrosion and others to reduce it. It is easy to see why salts like sodium chloride, which yield soluble products both at cathode and anode, stimulate corrosion. Three cases, however, suggest themselves where salts might actually reduce the rate of attack of the water to which they are added :—

(*a*) Salts which yield, as the anodic product, an insoluble iron salt, in a compact and protective form, which is able to put a stop to further anodic attack.

(*b*) Salts which yield, as the cathodic product, a porous, non-conducting, insoluble substance, which (whilst unable itself to act as cathode) will interfere with the diffusion of oxygen to the metal below.

(*c*) Oxidising agents which can produce a protective layer over the parts to which oxygen itself cannot diffuse, and thus produce passivity beneath the central part of the drop, as well as in the peripheral portions.

The results of the research seem to provide examples of all three classes of salts.

Materials and experimental method.

The material used in the experiments specifically described below was a steel sheet containing 0·39% of carbon. Experiments were also conducted with annealed sheets of low-carbon steel, such as is employed in tin-plate manufacture, and also with "Armco" iron, a soft iron comparatively free from carbon, and containing less than 0·16% of total impurities. The phenomena observed with both materials were qualitatively the same as those met with in the 0·39% carbon steel.

Immediately before use the sheets were rubbed several times in each direction with coarse emery paper (Oakey's "$1\frac{1}{2}$" quality), washed with distilled water, dried with filter-paper, re-ground with emery to give an entirely new surface, and again wiped. They were then cut into convenient sizes (2 cm. squares in the quantitative experiments) and the drops dropped from a height of 3·4 cm. from a pipette (the same pipette was used through the research). This gave a drop of diameter about 1 cm., and volume 0·05 c.c.

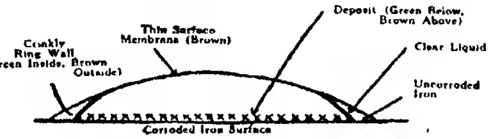
The distilled water used in the experiments was that used in the laboratory for conductivity purposes, and was condensed in block-tin, and collected in a flask which had been used for the purpose for some years, closed with a soda-lime tube. The early distillates were rejected, but finally a sample of 2 litres was collected for use in the "distilled water" experiments; the sample was employed in the preparation of the solutions used in the quantitative work. Ordinary laboratory distilled water gave qualitatively the same phenomena.

To prevent evaporation of the drops, the early experiments were conducted in a "water-sealed vessel" made by placing a glass plate $6\frac{1}{2}\times4\frac{3}{4}$ in. on four cork legs on the floor of a 10×8 in. developing dish, containing a shallow layer of water ; the square of steel on which the drops had been placed were laid on the glass plate, and a "half-plate" dish wa placed in an inverted position over the whole, thu completely sealing the drops from the externa atmosphere. In this apparatus, the various sample competed with one another for a limited quantity o air, and the temperature was not constant.

Where a constant temperature and a constan supply of air were desirable, a thermostat apparatu was used. The reaction-vessel consisted of a vacuun desiccator, two-thirds filled with water to prevent i floating, and immersed up to the stopper in a ther mostat bath ; the specimens were placed on a hori zontal glass plate, within the reaction vessel, sup ported above the level of the water upon a glas tripod ; the cover of the vessel was luted on witl thick grease. The air was freed from carbon dioxid and ammonia by passage through wash-bottles con taining caustic soda and Nessler solution, and thei bubbled through two wash-bottles containing water the second being placed in the thermostat bath itself Finally the air entered the reaction vessel by a glas tube passing down through the stopper and wa bubbled through the water in the lower part of th vessel itself. It passed out of the reaction vesse through an ordinary trap. The object was to insur that the air which passed through the reaction vesse was approximately saturated with water vapour, i order that its passage through the vessel should no tend to cause evaporation of the drops.

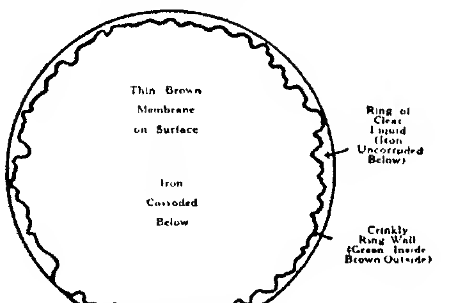
Results obtained with water and different solutions.

Action of distilled water. After being placed on iro for one night (either at 29°, or at ordinary tem



Distilled water, section.

FIG. 1.



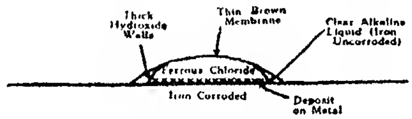
Distilled water, plan.

FIG. 2.

perature) drops of distilled water show the phenomen illustrated diagrammatically in Figs. 1 and 2. crinkly ring (brown on the outside, dark green on th

ide) occurs all round the drop very close to the dge, and a thin brown membrane extends over the op of the drop; outside this membrane there is a arrow ring of liquid, below which the metal is quite nattacked. Within the membrane the steel is dis-inctly corroded; the ground of the metal is also vered with a loose deposit, green below and brown bove.

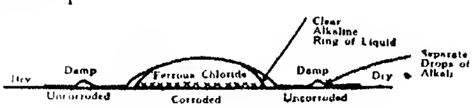
The probable explanation is as follows. Close to he edge of the drop where oxygen has direct access the metal, the direct production of an oxide film curs, which, being formed *in situ*, is protective; efore it has reached the thickness sufficient to show



Potassium chloride, first stage, section.

FIG. 3.

he first interference-tint, this film ceases to grow urther. Naturally the protected (ennobled) iron is athodic towards the iron in the centre of the drop, o which oxygen does not diffuse so readily. There-ore, anodic attack will proceed everywhere except ust around the margin of the drop, and this attack will produce ferrous hydroxide—a substance, which, s pointed out by Whitman, Russell, and others, has very perceptible solubility.[9] Where the ferrous hydr-xide comes in contact with diffusing oxygen, it is xidised first to the green intermediate oxide, and hen to the brown ferric hydroxide (or hydrated xide); these compounds are much less soluble, and will ppear as a precipitate (or perhaps to some extent n colloidal solution), and since they are formed, not *n situ*, but at an appreciable distance from the netal, they will not be protective or closely adherent. A large quantity is formed close to the surface of the netal, and by its formation helps to absorb diffusing xygen and thus to keep the surface below it anodic. There is naturally a special amount of ferric hydroxide ormed close to the edge at the junction between the erated and unaerated areas, and also over the surface f the drop.



Potassium chloride, second stage, section.

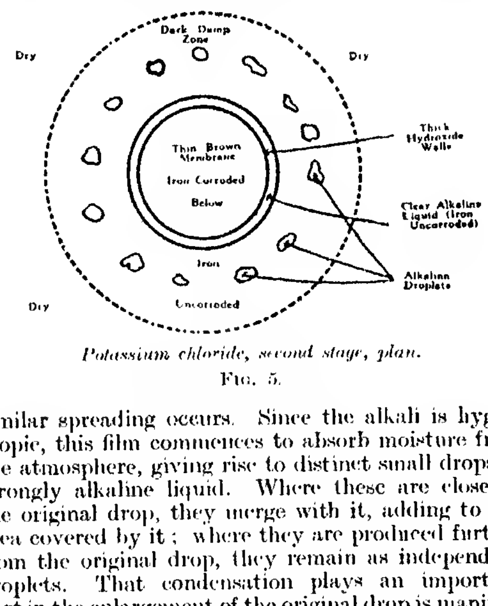
FIG. 4.

Action of N/10 potassium chloride. Drops of this solu-tion placed on iron or steel give—as shown in previous papers—ferrous chloride in the central (anodic) portions, and alkali in the peripheral (cathodic) por-tions. A ring of white cloudy ferrous hydroxide appears where the ferrous chloride and alkali meet, and this soon turns brown; finally a complete but thin membrance of ferric hydroxide covers the top of the drop (Fig. 3).

[9] According to W. G. Whitman and R. P. Russell (J., 1924, 193T), ferrous hydroxide is sufficiently soluble to alter the p_H value of water from p_H 7 to p_H 9·5.

The most remarkable feature of the action is that the drop tends to spread during the corrosion process. Five drops having an initial diameter of 0·9 to 1·0 cm. were placed on steel; after a few hours each drop (Figs. 4 and 5) was surrounded by a circular patch of moisture upon the metal; over this patch the metal was covered with a thin film of alkaline liquid, and assumed a darkish appearance due to the dampness; a ring of small drops of alkaline liquid (about 0·07 cm in diameter) surrounded the large drop. The metal was quite uncorroded over this outer area; all the corrosion which had occurred was confined to the portion within the membrane. The diameter of the dark, damp circle was about 1·3 to 1·4 cm. after 3 hours, and 1·8 to 2·0 cm. after 24 hours.

The cause of the spreading was clearly due to the formation of alkali. It is easy to show that a drop of caustic alkali placed on emery-treated steel imme-diately spreads itself out over the surface as a thin film. When, therefore, a drop of potassium chloride solution is placed on steel, as soon as any serious amount of alkali has been formed at the edges a



Potassium chloride, second stage, plan.

FIG. 5.

similar spreading occurs. Since the alkali is hygro-scopic, this film commences to absorb moisture from the atmosphere, giving rise to distinct small drops of strongly alkaline liquid. Where these are close to the original drop, they merge with it, adding to the area covered by it; where they are produced further from the original drop, they remain as independent droplets. That condensation plays an important part in the enlargement of the original drop is manifest from the fact that the enlargement was much less marked in the experiments conducted in the ther-mostat than in those carried out at variable temperature.

The production of multiple membranes was fre-quently observed, and is a natural consequence of the spreading. In the early stages, the portion of the iron just within the edge of the drop itself is cathodic, and the first hydroxide wall is in the position indicated in Fig. 3. When the thin film of alkaline liquid has been formed over the surrounding iron (Fig. 4), this represents a portion far more accessible to oxygen than any part covered by the drop proper; consequently the whole part below the drop now becomes anodic and a fresh membrane appears, roughly covering the area of the original drop

(Fig. 6). The gradual extension of the liquid outwards causes the formation of wrinkles on the thin membrane covering the original drop.

The formation of this thin membrane over the top of the drop was the subject of special experiments. When a portion of the liquid from the inside of the membrane was withdrawn by means of a glass tube drawn out to a fine point, and placed on a glass plate, no fresh membrane appeared over the surface. This showed that the membranes formed upon drops placed on iron do not represent an oxidation product of the anodic ferrous chloride, but are produced by the precipitation of that salt by the alkali formed in the peripheral portions.

Potassium chloride, third stage, section.

FIG. 6.

When the thin membrane over the top of the drop is washed away by a gentle stream of water, so as to leave the truncated remains of the circular wall, it is seen that—in addition to the formation of the membranous hydroxide—the ground of the centre of the drop is covered with a thin, dark deposit (brown on the top and green below), beneath which the steel is distinctly corroded. The deposit is probably not a direct anodic product, since it is quite loose, and can be rubbed away readily with the fingers. It is probable that since the solution contains OH' ions in addition to Cl' ions, a certain amount of ferrous hydroxide is produced anodically, as well as ferrous chloride; this yields the green and brown deposit by oxidation, and the change itself helps to prevent access of oxygen to the metal below.

Action of N/10 (M/20) potassium sulphate and N/10 potassium nitrate solutions. Drops of these solutions gave results which were almost exactly similar to those obtained with potassium chloride; the formation of the ring of hydroxide, developing into a membrane, and the spreading out of the drop as a dark, damp patch with independent small droplets of alkaline liquid were plainly shown.

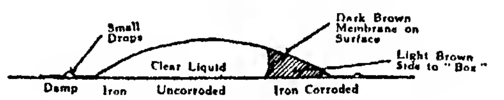
Quantitative experiments with distilled water and potassium chloride, nitrate, and sulphate. Although—owing to the familiar variation which occurs from point to point on all samples of sheet-metal in regard to susceptibility to rusting—it seemed hopeless to expect that all the drops of a given liquid would develop exactly the same amount of corrosive action, it seemed worth while to carry out some quantitative determinations on the amount of iron rusted by drops of different solutions. Three series of experiments were carried out in a thermostat at 29·2°, one for 5½ hours, one for 18½ hours, and one for 48¾ hours; these "nominal" times were measured from the instant of placing of the specimens in the thermostat, and no account was taken of the initial time taken in placing the drops on the metal; the initial disturbance due to this cause, together with the time required to bring the specimens to the temperature of the thermostat, must be borne in mind in comparing the results of the three series of experiments. In each series, four squares of metal were exposed to each of the four solutions used, making 16 squares in all. When the vessel was opened at the end of the experiment, each drop (and the rust contained in it) was washed into a test-tube, a glass rod with rounded end being used to loosen the corrosion-product; 2 c.c. of dilute hydrochloric acid were added to each tube and, after dissolution was completed by warming, hydrogen peroxide was added, and the whole heated until oxygen ceased to be evolved. The liquid in each tube was made up to 250 c.c., and 5 c.c. were then drawn out and added to 1 c.c. of 10% pot sium thiocyanate; in another vessel 1 c.c. of 1(potassium thiocyanate was placed, and standard ir solution (1 c.c. = 0·01 mg. ferric iron) was run in match the colour, water being added to both vess to give an appropriate dilution; the requisite num of c.c., divided by 2, gave the number of milligra of iron in the drop in question.

The results obtained were:—

Time from moment of introduction into thermostat	5½ hrs. mg.		18½ hrs. mg.		48¾ hr mg.
Distilled water	0·26	..	0·73	..	0·95
	0·30	..	0·77	..	1·47
	0·25	..	0·75	..	1·47
	0·25	..	0·70	..	1·40
$N/10$ KCl	0·65	..	1·91	..	3·50
	0·65	..	2·10	..	2·57
	0·66	..	2·00	..	3·25
	0·66	..	1·94	..	5·12
$N/10$ K_2SO_4	0·71	..	2·22	..	3·25
	0·73	..	2·07	..	3·27
	0·77	..	2·15	..	4·35
	0·77	..	1·97	..	3·05
$N/10$ KNO_3	0·80	..	2·08	..	3·00
	0·75	..	2·64	..	3·02
	0·82	..	2·32	..	3·57
	0·77	..	2·35	..	3·07

Owing to the expected variation between the amounts of iron oxidised by drops of the same liquid—especially in the longer period experiments—it is impossible to draw very exact conclusions. But there is no doubt that all three salts, in the concentrations employed, very distinctly stimulate corrosion, and that there is no very marked difference between the stimulating power of the three.

Action of N/10 (M/20) sodium carbonate. Man of the drops of sodium carbonate solution place on steel produced no visible alteration after a few days at ordinary temperature; the drops

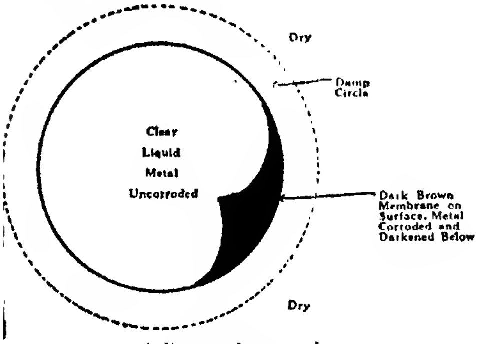


Sodium carbonate, section.

FIG. 7.

remained clear and colourless, and the metal surface was bright and unchanged. Occasionally, however, at some one point within a drop, marked local attack would take place, although elsewhere over the surface in the same drop, the metal was unchanged; from this one point, the attack would gradually extend outwards, as described below. Wherever local attack occurred anywhere within a drop, marked spreading of the liquid was observed all round the

ge of that drop, no doubt owing to the formation lkali hydroxide (Figs. 7 and 8); there was no ading at the edges of those drops within which local attack took place.



Sodium carbonate, plan.
FIG. 8.

Only a fraction of the drops of $N/10$ sodium bonate solution caused local attack in the manner cribed within the period of the experiment; the bility to local attack, however, increased considery when the solution was diluted. In the following periment, drops of solutions of 9 different concentions (12 drops of each) were placed on steel sheet the water-sealed vessel, and were uncovered and amined at the intervals shown below.

The number of drops of each concentration which showed local attack at each examination is indicated n the following table:—

oncen-ration.	No. of drops showing local attack after 1 hr.	2 hrs.	3 hrs.	4 hrs.	5 hrs.	6 hrs.	7 hrs.	8 hrs.	24 hrs.	48 hrs.
·1 N	0	0	0	0	0	0	0	0	0	0
·09 N	0	0	0	0	0	0	0	0	0	0
·08 N	0	0	0	0	0	0	0	0	1	2
·07 N	0	0	0	0	0	0	0	0	4	6
·06 N	0	0	0	2	2	2	2	2	8	10
·05 N	0	1	4	8	9	9	10	11	12	12
·04 N	0	3	0	12	12	12	12	12	12	12
·03 N	0	11	12	12	12	12	12	12	12	12
·02 N	0	12	12	12	12	12	12	12	12	12
·01 N	12	12	12	12	12	12	12	12	12	12

Total number of drops of each concentration - 12.

Not only does the initiation of local attack occur very much more quickly in the dilute solutions, but the rapidity with which the attack spreads out from the original starting point is much greater where the concentration is lowest.

The initiation of local attack also appears to be favoured by the addition of potassium chloride or other salts. In one experiment ten drops of $N/10$ sodium carbonate, and ten drops of $N/10$ sodium carbonate containing 1/100 of its volume of $N/10$ potassium chloride were placed close together on a sheet of iron in the water-sealed vessel. After $2\frac{1}{2}$ hours, they were examined, and it was found that one drop containing potassium chloride showed local attack; all the others were unchanged. After $3\frac{3}{4}$ hours, 7 out of 10 drops containing potassium chloride showed local attack, but only one out of the 10 free from potassium chloride.

The liability to local attack is not seriously increased by addition of similar small quantities of sodium bicarbonate; on the other hand, drops of the liquid made by mixing equal amounts of $N/10$ sodium carbonate and $N/10$ sodium bicarbonate produced rapid marginal attack; out of 14 drops, 7 showed this phenomenon after $1\frac{1}{2}$ hours, and 12 after 6 hours. To test the effect of carbon dioxide, 20 drops of $N/10$ sodium carbonate were placed on a steel sheet in the water-sealed vessel; after one day only two showed local attack. The sheet was then exposed to a stream of carbon dioxide for two minutes, and was returned to the vessel; after two days it was again examined, but there was no further case of local attack.

Quantitative experiments showed that where no breakdown had occurred, the amount of iron brought into solution in a drop was extremely small. Thus three drops of $N/10$ sodium carbonate, after standing on iron for two days at the ordinary temperature, contained 0·003, 0·008, and 0·004 mg. of iron respectively. Three drops placed on iron at 27°–29° for one day showed a local breakdown in every case, and at the end of the time contained 1·72, 1·50, and 1·75 mg. of iron; this is a larger amount than was obtained with three drops of distilled water in the same vessel (1·0, 1·0, and 1·55 mg.).

In the great majority of cases, the local attack set up in drops of sodium carbonate solution commenced at the edge of the drop, and extended gradually; the area undergoing attack in this case had the form of a triangle with curved sides (Figs. 7 and 8); a triangular dark brown membrane formed over it, on the surface of the drop, whilst the sides were completely cased in by nearly vertical walls of light brown membranous matter. Outside this triangular "box," the steel was quite unchanged; inside the "box," the metal was corroded, and covered with a thin dark grey, rather adherent deposit, which remained even after rubbing.

In a few cases the attack commenced in the centre, and a sack-like cylindrical membrane then arose from the point undergoing change. Drops containing much potassium chloride (made by mixing equal volumes of $N/10$ sodium carbonate and $N/10$ potassium chloride) produced zonal phenomena, recalling those which appear with drops containing potassium chloride alone. The central portion of the steel became covered with a green deposit surrounded by a brown ring, and around the edge was a ring of clear liquid below which the steel was unattacked. Evidently the central (unaerated) portion was anodic, and the direct anodic product was ferrous chloride, yielding both hydroxide and carbonate by precipitation.

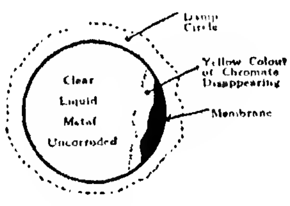
Action of N/10 (M/30) sodium phosphate (Na_2HPO_4). Sodium phosphate behaves in the same way as sodium carbonate, but it is a more efficient inhibitor of corrosion, as the film breaks down less frequently. Four drops placed on steel for 48 hours at ordinary temperature remained at the end of the time quite clear and unaltered; the steel was unchanged in appearance. Analysis showed that the drops contained respectively only 0·004, 0·004, 0·005, and 0·005 mg. of iron.

Three more drops were placed on steel, and exposed in the thermostat at 29·2° for 24 hours. Of these, one showed complete breakdown of the film, and contained 0·65 mg of iron at the end of the period. The other drops produced no apparent change; one contained 0·005 mg. of iron, whilst in the other iron was scarcely detectable.

In another experiment, three drops were kept on steel for a day at 27°–29°, and caused no visible alteration in the metal; the drops only contained 0·005, 0·007, and 0·006 mg. respectively at the end of the test.

Action of N/10 (M/20) potassium chromate. Drops of this solution produced no visible change upon the iron, and the actual amount of iron which passed into solution was very small. Two drops of the solution placed on iron for one day at 27°–29° were found at the end of that time to contain 0·006 mg. of iron each. Evidently the protective film produced is highly efficient.

No local breakdown of this protective layer was ever observed with pure potassium chromate; even the addition of small amounts (1/100 or 1/10 volume) of N/10 potassium chloride produced no failure. However, when drops of a solution made by mixing equal volumes of N/10 potassium chloride and N/10 potassium chromate were placed on iron, brown spots appeared within five minutes, at the extreme edge of the drops (often 3 or 4 spots on each drop), and the brown substance fairly quickly extended inwards over the surface of the drop; after a time it could be seen that a complete "box" had been formed by the iron hydroxide membrane, similar to that produced with sodium carbonate, except that it had a rounded rather than a triangular form



Potassium chromate, plan.

FIG. 9.

(Fig. 9). Inside the box, the liquid contained ferrous salts, and the iron was notably attacked; outside the box there was no attack upon the iron, and the liquid remained clear, but near the advancing edges of the box, the yellow colour of the chromate disappeared, indicating probably that the chromate, and not merely dissolved oxygen, was acting as the oxidising depolariser at the cathodic places. In some cases, the attack commenced not at the edge but at some point in the centre, the cylindrical form of "box" being produced.

It was noticed that where a mixture of chromate and chloride was placed on a sheet of steel covered with small rust spots, marked local attack often occurred below the rust, through which pale brown tumours of hydroxide grew up rapidly. Possibly the chromate failed to diffuse rapidly through the porous rust; if so, the conditions below the rust would become ideal for anodic attack.

The addition of an equal volume of N/10 potassium nitrate to N/10 potassium chromate was also found to be capable of producing marginal breakdown, but the attack spread inwards very much less quickly than where potassium chloride was used. Solutions containing potassium sulphate along with potassium chromate acted still more slowly. After 24 hours there were only tiny brown specks on the edges of the drops, although drops containing an equivalent concentration of chloride had in some cases become half-covered with membrane within this time. In all cases of "breakdown," spreading was noticed; where there was no breakdown, there was no spreading.

Cause of local breakdown of protective films. It is not difficult, in a general way, to offer an explanation of the behaviour of sodium carbonate, phosphate and chromate. In a drop of potassium chromate a protective film will at once be produced by direct chemical oxidation, and will inhibit electrochemical action. In a drop of sodium carbonate, or phosphate, electrochemical action may commence momentarily, but the anodic product will be insoluble, and if it is adherent the anodic action is likely soon to become very slow; even if the anodically produced skin is not itself entirely protective, oxygen diffusing to the surface is likely to render complete the passivity.

But now suppose that at one place the protective film fails to adhere to the metal, but forms a loose porous diaphragm over it, the contrary result will be produced. The diaphragm will shield the underlying surface from oxygen, and thus stimulate the continuance of anodic attack; the shielding of the metal from oxygen will be partly mechanical, but, since ferrous carbonate is an oxygen-absorbent, it will also be partly chemical. Furthermore, to some extent, a loose, porous skin may act as a semi-permeable membrane, and the concentration of sodium carbonate, sodium phosphate, or potassium chromate below it may soon come to be less than in the main portion of the drop; if so, a considerable amount of the comparatively soluble substance ferrous hydroxide, will be formed as the immediate anodic product, although it will be converted into ferric hydroxide, carbonate, or phosphate further out from the place of formation; if the solution contains chlorides, the freely soluble ferrous chloride will be formed as the anodic product, and this fact represents one reason why the presence of chlorides facilitates the local breakdown of the film. It must also be remembered that many other protective films (*e.g.*, the oxide film formed on an aluminium anode polarised with an external E.M.F.) are pervious to Cl′ ions, and tend to break down in the presence of chlorides. Iron provides an analogous case; chlorine ions readily cause local breakdown of the film, NO_3' ions appear to be distinctly less effective in piercing the protective layer, and SO_4'' ions have still less power to produce that result.

It is clear, therefore, that if at any point the film once becomes non-adherent, anodic attack is likely to be stimulated—rather than obstructed—

that point, and corrosion, when once initiated, ll continue apace; from this point, the loosening the film, and therefore the area susceptible to odic attack, may gradually extend. We have ill to consider what might cause the skin locally become porous or non-adherent. As pointed out the author in previous papers,[10] the manner in hich the corrosion-product will cling to the surface ll be determined largely by the relative values of e interfacial energies between the metal, liquid, d corrosion-product; even where the corrosion-oduct is normally protective, some local peculiarity the surface of the metal may easily cause a change the character of the adhesion. Particularly is this ange expected to occur at the edge of the drop, ere (as suggested by Bengough and May[11]) the rrosion-product may sometimes adhere to the -liquid interface instead of to the liquid–metal erface; it is significant to notice that, in the at majority of cases, local attack does actually mmence at the edge of the drops.

It was thought that possibly the presence of grease ght increase the chance of non-adhesion; but tempts to increase the liability of the metal to local eakdown by means of the application of vaseline ve negative results. It was also thought that possibly particles of metallic dust might be the cause of e breakdown; but experiments showed that parts a sheet which had not been "wiped" after the al grinding with emery were no more susceptible local breakdown than those which had been oroughly freed from dust with filter-paper. The tion of rust in stimulating local action in mixtures chloride and chromate has already been referred to; seems possible that sub-microscopic crannies of such rrow dimensions as to allow chlorides to enter more adily than chromates, carbonates, or phosphates ight act in the same way.

Sodium carbonate, sodium phosphate, and potassium chromate have all been used in anti-corrosive eparations, water-treatment mixtures, boiler compounds, etc. All these salts greatly reduce corrosion long as there is no breakdown in the protective film oduced; but they produce localised corrosion (the ost dangerous of all types) in the event of a breakdown. Such results serve to explain the distinctly ntradictory statements often found in literature garding the effect of these substances on corrosion, d show how carefully any process of corrosion-revention which depends on the formation of a protective film must be tested, before it is put into technical use; a comparatively small alteration in conditions (*e.g.*, the access of chlorides, or the presence of air-space) may sometimes greatly increase the robability of a film-breakdown. Chromates seem produce a much more reliable protective film than rbonate or phosphates, but in the event of local reakdown the corrosion may be very rapid, since in e presence of chromates it will not be limited by e rate of supply of oxygen.

Action of N/10 (M/30) potassium ferricyanide. Drops of this solution placed on steel turned slightly greenish after a day, but remained clear and without visible action on the metal. On washing away the solution, a very thin, pale blue film was left over the area occupied by the drop (barely visible until the specimen was held in a favourable position to the light). This film was sufficiently adherent to resist the action of a water-jet, but could be largely rubbed off with filter-paper; the film consisted of Prussian blue. In addition, there were in some cases a few more distinct spots of blue at the edge of the drop, suggesting local breakdown of the protective film.

The addition of a trace of chloride greatly promotes the action of ferricyanide on iron and steel. A $N/10$ solution of potassium ferricyanide to which 1/100 volume of $N/10$ potassium chloride had been added, turned green within 2 minutes of being placed on the iron surface. After a day the centre of the drop was full of a blue, stringy precipitate, whilst around this there was a brown coloration due to a smaller amount of a fine precipitate (no membrane); at the edge of the drop the liquid was perfectly clear. A good deal of spreading was noticed, indicated by the formation around the original drop of a dark, damp circle with small droplets on it. Here we evidently have an ordinary case of electrochemical attack; at the edges (aerated) the cathodic product is alkali, which causes the spreading, whilst in the interior, the immediate anodic product is ferrous chloride, which yields ferrous ferricyanide by precipitation; being formed at a sensible distance from the metal, this precipitate is naturally not protective, but may even help the anodic reaction by absorbing oxygen.

Action of N/10 zinc sulphate. Drops of zinc sulphate solution placed on steel produced no membrane, but a greyish-buff deposit appeared over the ground covered by the drops; there was distinctly more deposit round the edges of the drops than in the centre—in striking contrast to most other cases of drop-corrosion. Much of the deposit could be rubbed off with the fingers, but there remained an adherent layer, brownish-grey at the edges and gradually passing to purer grey in the centre. This was partly dissolved, partly loosened, by sodium hydroxide solution, and after treatment with that reagent, rubbing revealed the bright steel below.

The explanation of the action of zinc sulphate would appear to be as follows. The primary anodic product must be a soluble salt (ferrous sulphate), but the cathodic product will be sparingly soluble zinc hydroxide, which will appear mainly around the edges of the drop. In the outer part to which oxygen can penetrate most easily, zinc hydroxide may react with the ferrous sulphate, partially precipitating iron as ferric hydroxide, and thus the final insoluble product will contain both zinc and iron hydroxides.

Five drops of zinc sulphate solution placed on iron for 24 hours at 29° contained 0·17, 0·12, 0·17, 0·30, and 0·16 mg. of iron; three drops of distilled water acquired 1·0, 1·05, and 0·95 mg. in the same time. It would seem that the insoluble cathodic product (zinc hydroxide) prevents the access of oxygen to the outer part of the metallic surface, and thus retards corrosion, notwithstanding the

[10] Trans. Faraday Soc., 1922, 18, 1; 1923, 19, 789.
[11] Engineer, July 6, 1923.

fact that the anodic product is more soluble than in the case of distilled water.

Action of N/10 nickel sulphate. Nickel sulphate produces a similar effect to zinc sulphate, but the deposit—which is mainly to be seen around the edge and least in the centre—is rich brown instead of buff in colour; the deposit is much less closely adherent than in the case of zinc sulphate. Possibly for this reason the amount of iron taken up by the drop is greater than in the case of zinc sulphate; six drops after 24 hours at 29° contained 0·75, 0·55, 0·48, 0·55, 0·90, and 0·82 mg. of iron respectively.

Classification and summary.

The corrosion of iron or steel by a drop of aqueous liquid depends in most cases on electrochemical action between the central, unaerated area, which becomes anodic and suffers attack, and the peripheral, aerated portions, which become cathodic, and in general remain unattacked. The velocity of attack depends largely on whether the anodic and cathodic products are soluble or insoluble. In the case of pure water, the anodic product, ferrous hydroxide, is perceptibly soluble, and spreading outwards becomes oxidised at the junction between the aerated and unaerated regions, yielding a brown ring of the nearly insoluble ferric hydroxide, which extends over the top of the drop as a membrane. The action of salts (in N/10 concentration) may be classified as follows:—

(1) Salts like potassium chloride, potassium sulphate and potassium nitrate yield a soluble anodic product (ferrous chloride, sulphate, or nitrate) and a soluble cathodic product (potassium hydroxide), and increase the velocity of corrosion; where the ferrous salt and alkali mingle, a ring of ferrous hydroxide, oxidising to ferric hydroxide appears, and extends as a membrane over the surface. Outside the membrane the iron is unattacked, but the formation of alkali at the periphery (cathodic portion) causes spreading of the liquid.

(2) Salts like zinc sulphate yield a soluble anodic product, but an insoluble cathodic product (zinc hydroxide), which shields the cathodic area from diffusing oxygen, slightly diminishing the rate of corrosion.

(3) Salts like sodium carbonate, sodium phosphate, and potassium ferricyanide yield a soluble cathodic product and an insoluble anodic product, which forms a closely adherent protective skin, usually invisible, over the metal. In such cases corrosion is almost prevented; but occasionally at certain points, especially at the edge of the drop, the film fails to adhere, and at such points marked localised anodic corrosion occurs; this breakdown occurs quite quickly in more dilute solutions of sodium carbonate.

(4) Potassium chromate causes passivity even in the parts to which oxygen cannot diffuse; no differential-aeration currents are set up, and there is practically no corrosion. If, however, chlorides also are present in large quantity, the protective film breaks down at the edge, and serious localised corrosion will result; nitrates act more slowly than chlorides in causing the breakdown of the film, whilst sulphates are still less active in this respect.

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IE VISCOSITY OF SYRUPY CONDENSATION PRODUCTS OF PHENOL AND FORMALDEHYDE.

BY ALAN A. DRUMMOND.

niformity in composition and properties of the hed material is an essential in the commercial luction of synthetic resins, especially such as are ined from the condensation of phenol and formhyde. Such uniformity can only be effected ystematic control of the manufacture from its l stages. Methods based on chemical analyses been indicated for application to the raw rials and the aqueous liquors involved (Ormandy Craven, J., 1923, 18T), but it is recognised that iderable difficulty exists in checking effectually constancy of composition and condition of the lensation products in their viscous syrupy form.

o deal with these syrups physical methods natur- suggest themselves. Attempts have been made ontrol the condensation by observations of the ge in density (Jablonower, J. Amer. Chem. Soc., 3, 35, 811), but beyond a certain point in the rse of the condensation density is of little use in ecting differences in the condition of the syrup. as, however, been shown generally (Batschinski others, see "Fluidity and Plasticity," Bingham) t the rate of change of viscosity is very much higher n that of density, and consequently viscosity ues offer a delicate means of control in factory ocesses, and particularly has this been found to be case in the manufacture of formaldehyde condenion products. It can be shown that in a series of ndensation syrups having practically identical sities, one syrup may have at least three times viscosity of another in the series.

It is the intention to indicate briefly here the thods which have been usefully employed in the asurement of the viscosity of condensation syrups, l to give certain figures obtained, and the deducns made therefrom as to the physical character condensation syrups.

Very little reference can be found in the literature the viscosity of condensation products of phenol l formaldehyde. Van Voorhout (Chem. Weekblad, 20, 17, 2) draws conclusions as to the condensing wer of various catalysts from a study of the visity of the reaction mixture, but does not quote y figures. R. S. Morrell (Third Report on Colloid emistry, 1920, p. 113) calls attention to the necesy for the study of physical constants in relation synthetic organic colloids such as the phenolic xymethylene resins, and states that viscosity, ation, relaxation effects, and dielectric properties await investigation.

Where accurate absolute values are required the ling sphere viscosimeter is of particular value bson and Jacobs, Chem. Soc. Trans., 1920, 117, 473) and was used in the investigation of these syrups, castor oil being employed as calibrating liquid.

The usual air-bubble viscosimeter of the varnish maker is not altogether satisfactory for general use, particularly where more viscous liquids are concerned, although in the hands of the experienced varnish foreman it serves as an excellent guide, is readily applied and is simple in construction. In this connexion, attention may be drawn to an improved factory viscosimeter used by E. I. du Pont de Nemours and Co., which has been described recently by Marasco (Ind. Eng. Chem., 1924, 16, 172), and is capable of development in many industries.

For fairly rapid comparative determinations of viscosity of factory products in the industrial condensation of phenol and formaldehyde, useful results have been obtained by the adaptation of a method originally described for use in controlling the preparation of insulating varnishes of low viscosity (Whalley, Analyst, 1919, 44, 288). It can, however, be applied to liquids of viscosity at least as high as that of golden syrup.

In this method the values obtained appear to have no simple relation to absolute viscosity. An attempt was made to establish a definite relationship between these values and absolute values obtainable by means of the falling sphere viscosimeter. Within certain limits of viscosity a smooth curve was arrived at, but beyond these limits the relation was uncertain. A rough working curve was, however, drawn from a large number of comparative determinations by the two methods. With this curve it was possible to obtain an approximate idea of the absolute viscosity from results obtained with the Whalley method.

In spite of the drawback stated, the method was useful in works control, and gave satisfactory and concordant figures in routine use. It consists in immersing a definite portion of a microscope slide in the liquid under examination, withdrawing the slide, and weighing the residue on the slide after drainage for a stated time. Precautions as to temperature and rate of withdrawal are taken. It was found more convenient in using this method to lower the viscosities of the syrup samples by the use of a diluent to bring them within the region of greater accuracy. Aqueous glycerol (70%) was found suitable for this purpose.

The viscosities of mixtures of condensation syrup with glycerol are shown in Table I. with the value for castor oil added for comparison.

TABLE I.

Composition of sample (Parts by wt.) Condensation syrup.	70% Glycerol.	Viscosity at 25° C. Poises.
100	0	112
80	20	10·5
75	25	5·6
70	30	3·6
60	40	2·0
Castor oil	..	6·5

It is more satisfactory, in viscosity work, for the viscosities determined to be nearly the same as

that of the fluid used for calibrating the instrument, which was castor oil in this case. Now the value obtained with an addition of 25% of aqueous glycerol approximated to the viscosity of castor oil (see Table I.), so that this addition was standardised for all routine determinations of viscosity.

The viscosity-temperature relation and its bearing on colloidal character.

A study of the change of viscosity with temperature is of considerable value in certain industries, particularly that of oil, and where lubricating oils are concerned. The various empirical formulæ connecting viscosity and temperature have been thoroughly investigated in this connexion (Herschel, J. Ind. Eng. Chem., 1922, **14**, 715; Fortsch and Wilson, *ibid.*, 1924, **16**, 789). Bingham and his co-workers have given the question close attention in their study of fluidity.

It is frequently found that the expression of viscosity as its reciprocal (namely, "fluidity"), helps to a more simple elucidation of relationships. Thus, the relation between fluidity and temperature of many chemical individuals appears an almost linear one, particularly at high temperatures (Bingham, 'Fluidity and Plasticity," 1922, p. 133). Again, in connexion with the viscosity of oils, Oelschlager (Z. Ver. deut. Ing., 1918, **62**, 422) and Herschel (*loc. cit.*) have pointed out the value of the logarithmic diagram in ascertaining viscosities at different temperatures. Herschel has shown that the result of plotting the logarithm of the viscosity against the logarithm of the temperature in degrees Fahrenheit is practically a straight line with a large number of oils, and also with a number of other substances both aqueous and non-aqueous.

The viscosity-temperature relationship in these cases is in accordance with the mathematical expression due to Slotte (Beibl. Ann. Physik, 1892, **16**, 182), $\eta = c/(a+t)^n$: when a is zero the equation becomes $\eta = c/t^n$ (Herschel, *loc. cit.*, p. 717), which represents a straight line on a logarithmic diagram.

Herschel discusses the application of such straight line diagrams to the viscosity of oils and points out the significance of using the Fahrenheit scale for expressing the temperature instead of Centigrade in that it can be shown to be equivalent to using the correct value of a in the foregoing equation.

Logarithmic diagrams of this nature reveal abnormal conditions in certain materials by departure from the normal linearity. A connexion has been traced between such abnormality and the presence of colloidal material in the substance under examination (Herschel, *loc. cit.*). For instance, a sample of Mexican fuel oil showed strong curvature on such a diagram, and the sample gave evidence of marked viscosity hysteresis, a phenomenon attributed by Dunstan and Thole (J. Inst. Petrol. Tech., 1917-18, **4**, 201) to the presence of colloids. Again, Fortsch and Wilson (*loc. cit.*) have shown the same tendency to curved lines in the above relationship in the case of heavy petroleum residues, and also "road oil" from pressure tar, materials which might be suspected to contain colloids (see Fig. 1).

The possibility of colloidal character being [i]cated by the form of the logarithmic viscos[ity-]temperature graph is of sufficient interest to exa[mine] further with other classes of material.

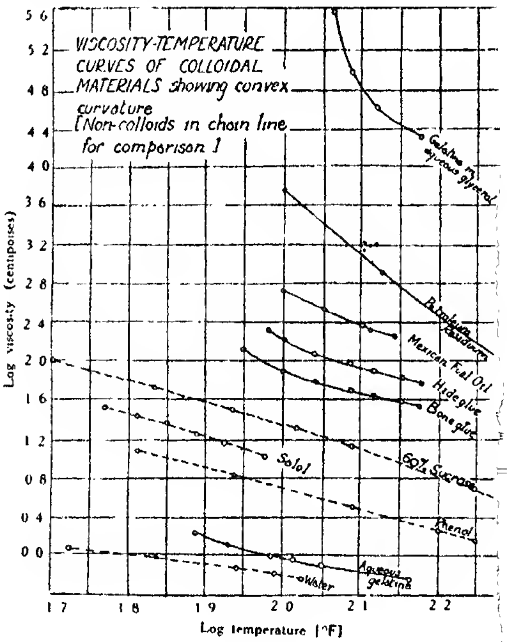

FIG. 1.

Seaton, Probeck, and Sawyer (J. Ind. Eng. Che[m.,] 1917, 9, 35) have associated the viscosity-temperat[ure] relationship with colloidal character in the case [of] varnishes. The shape of the curve varies accord[ing] to the presence or absence of highly polymerised oi[l.] Their observations are to be received with cauti[on] (H. H. Morgan, Ann. Repts., 1921, p. 339), si[nce] the type of viscosimeter used (Doolittle torsion) do[es] not lend itself readily to the presentation of absol[ute] values. It was, however, thought to be of interest [to] calculate some of their values on the logarithmic ba[sis] described, assuming that the Doolittle degrees [of] retardation, in which their viscosities are expresse[d,] are directly proportional to absolute viscosities, [an] assumption which is perhaps approximately true [for] the more viscous varnishes they examined are co[n]sidered in the re-calculation of the linear relatio[n]ship on the MacMichael torsion instrument, whi[ch] was true only above a certain minimum viscosit[y] where turbulence and centrifugal forces becar[ne] negligible (Herschel, J. Ind. Eng. Chem., 1920, 1[2,] 282).

It is interesting to find that the curves plotted fro[m] the figures thus obtained are in line with the observ[a]tions made with oils. A varnish containing a highl[y] polymerised oil and considered to be colloidal (showi[ng] Tyndall effect) is represented on the logarithm[ic] diagram by a well-curved line, whilst the same varnis[h] thinned down somewhat with acid linseed oil, an[d] thus presumably sufficiently dispersing the colloid t[o]

m a molecular or true solution, is represented by a aight line between 20° and 50° C. (see Fig. 2).

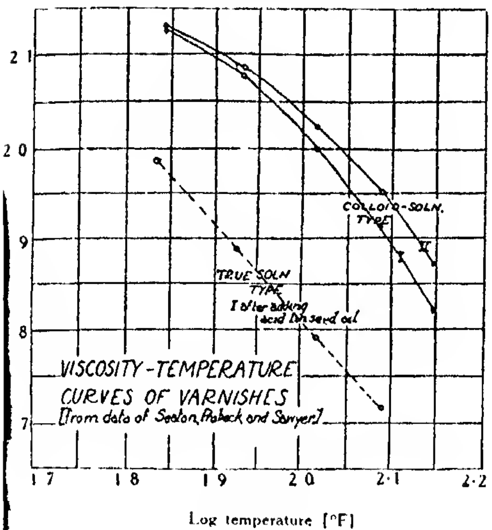

FIG. 2.

elatins and glues are of acknowledged colloidal acter. Bogue ("Gelatine and Glue," 1922, 189) studied the viscosity-temperature variation of se materials, and his values plotted as loga- ms reveal a definite curvature, both with bone hide glue. Curvature is also found with solutions elatin in water (calculated from the data of Davis Oakes; J. Amer. Chem. Soc., 1922, 44, 477), in aqueous glycerol (calculated from data of sz; Kolloidchem. Beih., 1915, 7, 1). It should be d that the curvature observed is convex to the rithmic temperature axis as distinct from the avity with pure water and ordinary aqueous tions (see Fig. 1).

ttention has been called to the foregoing general siderations with a view to their particular applica- to the problem of the physical condition of the lensation products of phenol and formaldehyde. ves connecting temperature and viscosity of con- sation syrup have been constructed by three hods: (1) where the viscosities are expressed in olute units; (2) where the viscosities are expressed heir reciprocals (fluidities); (3) where the loga- ms of the viscosities are plotted against the rithms of the temperatures in degrees Fahrenheit. shapes of the curves (see Fig. 3, Table II.) are as ws:—

) The viscosity-temperature (Centigrade or Fah- eit scale) graph is hyperbolic in form, flattening considerably at temperatures below about 15° C.

) The fluidity-temperature graph is definitely ed at low fluidities (high viscosities), becoming nptotic to the temperature axis, an effect to be ed with most liquids (water, alcohols, mineral fatty oils, etc.). At temperatures above about . a rapid fall in viscosity takes place with small ases in temperature.

(3) The logarithmic viscosity-temperature graph is practically a straight line when the temperature scale is Fahrenheit, and for a minimum range of 15° to 50° C., and its steep slope is only approached by substances like heavy oils. Calculation of the numerical relation between viscosity and temperature of condensation syrup from phenol and formaldehyde (basic catalyst) on the basis of the linearity of the logarithmic curve leads to the formula:—

$$\eta = 453 \times 10^{11} / t_f^{5 \cdot 2}$$

where η is the absolute viscosity measured in cen- tipoises and t_f is the temperature in degrees Fahren- heit.

TABLE II.

Temperature. °F.		Viscosity. Poises.		Fluidity (1/Viscosity in poises).
15	..	240		0.42
23	..	90	..	1.11
27.5	..	50	..	2.00
35	..	20	.	5.00
50	..	6	..	16.67

In the earlier general discussion the possibility of deductions from the form of the logarithmic curve as to colloidal character was shown. On these grounds, and in view of the facts mentioned in the fore- going paragraph, it would appear that syrups in the early stages of condensation of phenol and formalde- hyde (such as have been dealt with in the present work) contain no appreciable amount of colloidal matter.

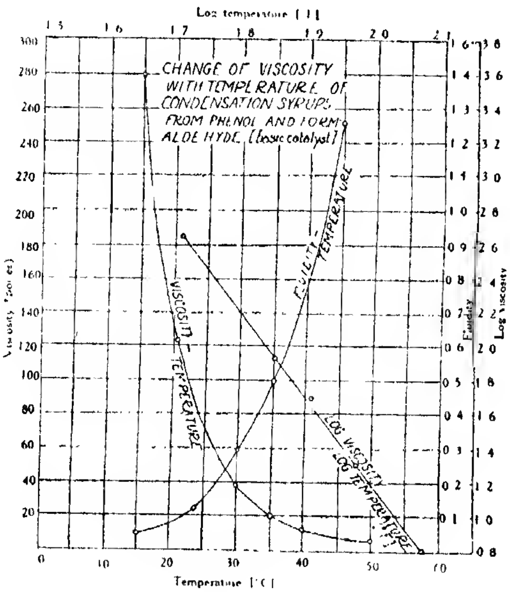

FIG. 3.

Physical character of condensation products in both syrupy and resinous condition.

In considering the physical and colloidal charac- teristics of the complete range of condensation pro- ducts of phenol and formaldehyde it is well to deal separately with (1) the initial syrupy product; (2) the intermediate soluble fusible solid resin; and (3)

the final infusible and insoluble resin. The data supplied in the work described above apply to the initial syrupy product.

One of the first products of the condensation is hydroxybenzyl alcohol. Van Voorhout (*loc. cit.*) was able to separate and identify *o*- and *p*-hydroxybenzyl alcohols from the product condensed with basic catalysts. Moreover, amongst the products of an acid condensation the same worker was able to identify dihydroxydiphenylmethane. Both Raschig and Baekeland have shown that *o*- and *p*-hydroxybenzyl alcohols are susceptible to polymerisation under the action of catalysts, giving first fusible soluble resins and finally resins which are softened by heat but do not melt, and are only slightly affected by solvents. In the light of Van Voorhout's work it may be supposed that this reaction consists in the condensation of the hydroxybenzyl alcohols to form dihydroxydiphenylmethane. Continued heating brings about polymerisation (Baekeland, J. Ind. Eng. Chem., 1909, 1, 159) which probably takes place simultaneously with the later stages of condensation (Jablonower, *loc. cit.*), the physical state gradually passing from the mobile condition of the fused hydroxybenzyl alcohols to a viscous syrupy mixture with ultimate formation of a slightly plastic resin hardly affected by solvents. The final resin would, following the conclusions of Van Voorhout, consist of polymerised dihydroxydiphenylmethane in solid solution in the normal dihydroxydiphenylmethane. In fact, it would then be comparable with the resinous or glassy forms of substances belonging to the group of iso-colloids, such as phosphoric acid or styrene, which in arriving at their solid forms pass through stages, gradually increasing in viscosity, of colloidal solution of the solid form in the liquid, both forms being of the same chemical constitution (Ostwald, "Colloid Chemistry," 1919, p. 104).

This picture might be considered to represent the stages of formation of the commercial hard, infusible and insoluble resin, such as transparent Bakelite, which frequently contains in addition residues of free phenol (Herzog, Z. angew. Chem, 1921, 34, 97).

As far as the initial syrups are concerned, from the conclusions summarised above and from the viscosity-temperature relationship, a working conception of their nature may be further developed. They may be looked upon as consisting of a combination of the following crystalline solid substances in a state of ordinary molecular solution :—*o*-hydroxybenzyl alcohol, m.p. 82° ; *p*-hydroxybenzyl alcohol, m.p. 110° ; dihydroxydiphenylmethane, m.p. 158° phenol (see Ormandy and Craven), m.p. 42·5°, including a small percentage of aqueous and uncombined formaldehyde. The mutual influence of each tends to lower the solidifying point and, owing to the rapid rise in viscosity as the temperature is decreased, crystallisation is permanently retarded. The retarding influence of viscosity on the rate of crystallisation has been studied in the case of liquids cooled below their solidifying point, such as salol (Wilson, Phil. Mag., 1900, 50, 238). The linear rate of crystallisation of salol measured in long glass tubes is found to be of the order of 1 mm. per minute, the viscosity of undercooled salol* at ordinary temperature being about 36 poises (see Fig. 1). The viscosity of the initial condensation syrup from phenol and formaldehyde (basic catalyst) at ordinary temperature is about four times this value.

The presence of foreign matter is also known to depress the rate of crystallisation of a substance and this is attributed to adsorption. Freundlich ("Kapillarchemie," 1922, p. 449) states that the lowering of the rate of crystallisation by impurities depends on the amount of impurities adsorbed by the crystals that are endeavouring to form. This effect is undoubtedly contributory to the non-crystallisation of condensation syrups.

Summary.

(1) The applications of viscosity determinations to the manufacture of condensation products of formaldehyde, are discussed.

(2) The relation between viscosity and temperature of the initial syrupy condensation product of phenol and formaldehyde, made with basic catalysts, is shown to be a linear one when logarithmic values are taken, and capable of expression by a simplification of Slotte's formula $\eta = K/t^n$, where t is in degrees Fahrenheit.

(3) The interpretation of viscosity-temperature relations in its bearing on colloidal character is applied to condensation syrups, and appears to indicate freedom from colloids while in the initial syrupy condition.

(4) The colloidal character of the resinous product is discussed.

* It may be noted that the logarithmic viscosity-temperature relations with undercooled salol is a linear one (see Fig. 1), which is of interest in relation to condensation syrups regarded as undercooled liquids, which, as has been stated, also show linearity in this relationship.

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TRANSACTIONS

Vol. XLIII., No. 46.] [November 14, 1924.

THE PREPARATION OF CYANOACETIC ESTER (ETHYL CYANOACETATE).

BY OSWALD C. STEPHENS, M.SC.

(*Concluded from p.* 314 T.)

Alternative methods for preparation of cyanoacetic ester.

/ the action of potassium cyanide in aqueous :ion on potassium chloroacetate an almost ititative yield of cyanoacetic acid can be obtained. separation of the cyanoacetic acid is, however, laborious, necessitating repeated crystallisations alcohol. There did not seem any valid objec- to esterifying the cyanoacetic acid directly out separation. According to Phelps and Tillot- (Amer. J. Sci., 1908, **26**, 243) the use of hydro- ic acid as a catalyst in the esterification caused formation of malonic ester, whilst no hydrolysis very little) occurs when sulphuric acid is used. seemed very improbable, so determinations were ed out on the esterification of cyanoacetic acid, on the rate of hydrolysis of cyanoacetic ester acid using alcoholic hydrochloric acid.

terification of cyanoacetic acid.—The esterification ed out according to Phelps and Tillotsen (*loc. cit.*) te an 85% yield.

Esterification of cyanoacetic acid using alcoholic rochloric acid.—50 g. of cyanoacetic acid were erified with 2 g. of hydrochloric acid in 200 c.c. of solute alcohol. By titrating 1 c.c. with baryta intervals the course of the esterification was lowed. The esterification was finished in one ur. 44 g. (65%) of cyanoacetic ester and 8 g. of lonic ester were obtained. An esterification using g. of hydrochloric acid to 50 g. of cyanoacetic acid is carried out in the same manner, and 1 c.c. rated with $N/4$ baryta. Using half the quantity of drochloric acid, the reaction took two hours to ich equilibrium. The contents of the flask were en heated on a water-bath under slightly reduced ssure until no further distillate was obtained. iother 200 c.c. of absolute alcohol, containing 1 g. hydrochloric acid, were added, and the mixture was luxed one hour. The titration then required 0·8 c.c. $N/4$ baryta, corresponding approximately to the ydrochloric acid taken. The product was distilled *in vacuo* to avoid volatilisation of the small amount of ammonium chloride formed by hydrolysis of the cyanoacetic acid. 46 g. of cyanoacetic ester were obtained (75%) and 8 g. of malonic ester.

In order to test the effect of the hydrochloric acid on the cyanoacetic ester, 10 g. of cyanoacetic ester in 20 c.c. of absolute alcohol with 0·2 g. of hydrochloric acid were boiled on the water-bath under a reflux condenser and 1 c.c. was removed at intervals and titrated with $N/20$ baryta, the hydrolysis of the ester being shown by the decrease in acidity due to hydrochloric acid forming ammonium chloride.

Time in minutes	0	5	20	60	120	180	300	360
Titration ..	6·1	6·1	5·9	5·55	4·9	4·9	3·7	3 c.c.

Thus the hydrolysis of cyanoacetic ester to malonic ester under these conditions is practically negligible.

The ordinary laboratory preparation of malonic ester is carried out in the presence of a large excess of sulphuric acid. It is not practicable to esterify the sodium cyanoacetate by means of alcohol and sulphuric acid without, at the same time, hydrolysing and esterifying the cyanogen group; for it is impossible to control the addition of sulphuric acid just sufficient for the esterification, owing to the formation of acid salts or acid esters. There is not the same difficulty with hydrochloric acid: and, considering the results just recorded, it seemed possible by the use of hydrochloric acid to secure a satisfactory esterification of the cyanoacetic acid without previous separation from the salt. 50 g. of chloroacetic acid were converted into sodium cyanoacetate in the usual way. The aqueous solution of the cyanoacetate was then evaporated to dryness, with constant stirring, and heated until the temperature reached 135°, the mass was allowed to cool in a desiccator and, when cool, rapidly broken up into lumps, and covered with absolute alcohol. Then just sufficient alcoholic hydrochloric acid was added to set free the cyanoacetic acid and leave 2 g. excess to act as a catalyst in the esterification. 25 g. of hydrochloric acid were needed. This was added in 186 c.c. of alcohol. When the mixture boiled, hydrogen chloride was given off, so a further 100 c.c. of absolute alcohol were added. The course of the reaction was followed by withdrawing 1 c.c. at intervals and titrating with $N/4$ baryta. 24 g. of cyanoacetic ester and 9 g. of malonic ester were obtained. Thus the yield was 40% calculated on the chloroacetic acid taken.

Comparing this yield with that obtained by first esterifying chloroacetic acid by the Fisher–Speier method and subsequent conversion of the chloroacetic ester into cyanoacetic ester, we find that the esterification gives a 77% yield and the conversion into cyanoacetic ester a 60% yield. Thus the yield over the whole process is $77 \times 60 \div 100 = 46\%$.

The fact that hydrogen chloride is given off would indicate a slow reaction between the sodium cyanoacetate and the hydrochloric acid, thus explaining the large amount of malonic ester formed, as the cyanoacetic acid first set free is, to a large extent, hydrolysed to malonic ester. To obviate this, after evaporation of the solution of sodium cyanoacetate to dryness, the fused mass is broken into lumps (it is too deliquescent to be ground into a mortar), rapidly placed in a round-bottomed flask, and covered with absolute alcohol. This is then boiled for 30

minutes on the water-bath to secure a partial disintegration, cooled, the calculated amount of hydrochloric acid added, and the mixture allowed to stand for 12 hours. It is then heated on the water-bath to esterify the acid in the usual way. As in the last experiment, the course of the esterification was followed by titrating 1 c.c. of the mixture against $N/4$ baryta. 36 g. of cyanoacetic ester and 11 g. of malonic ester were obtained (yield 63%).

Further experiments have given most conflicting results, and varying yields of 20%, 42%, and 60% have been obtained. The reaction seems very sensitive to conditions. A certain amount of hydrolysis does occur in the evaporation of the aqueous solution of cyanoacetate, but with careful control an average yield of 50% should be obtainable.

Summary.

1. By the preparation of cyanoacetic acid from chloroacetic acid in aqueous solution, separation of the cyanoacetic acid, and subsequent esterification, a yield of 85% is obtained. This entails the laborious separation of cyanoacetic acid.

2. By the preparation of chloroacetic ester from trichloroethylene and its conversion into cyanoacetic ester in alcoholic solution, a yield of 48% is obtained. The cheapness of trichloroethylene and the relative simplicity of the method may render it more economical than 1.

3. Esterifying the chloroacetic acid and then transforming the chloroacetic ester into cyanoacetic ester in aqueous alcohol, gives a yield of 35%.

4. Preparing cyanoacetic acid from chloroacetic acid in aqueous solution and then esterifying the cyanoacetic acid without separation may give a yield up to 60%. In addition to this, malonic ester is formed as a valuable by-product.

The author desires to express his thanks to Dr. J. K. H. Inglis, of Otago University, for his unfailing assistance and helpful suggestions throughout the course of this research.

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Dunedin, New Zealand.

ERRATUM.

THE VISCOSITY OF SYRUPY CONDENSATION PRODUCTS OF PHENOL AND FORMALDEHYDE.

BY A. A. DRUMMOND.

(J., Nov. 7, 1924, 323—326 T.)

Page 324 T, col. 2, lines 14 and 13 from bottom should read ". . . . . recalculation (*cf.* the linear relationship . . . . ."

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

TRANSACTIONS

[. XLIII., No. 47.] [November 21, 1924.

'HE DESIGN AND OPERATION OF GAS SCRUBBING TOWERS.

BY H. D. H. DRANE.

l'he problem of the design of gas scrubbing towers in general exceedingly complicated, because of ; many variable factors affecting the rate of ition of the constituent to be dissolved; and an ;t experimental study of the operation with the ct of obtaining design data is rendered difficult use of the cumbersome analytical expressions ssary. It is, however, possible by proper choice, udy the operation of a gas scrubbing tower under specified conditions, where the number of ables is reduced to a minimum, and under exact rol, thus permitting the study of these controlled ables.

urter[1] in 1885 to 1893 carried out much in- lative experimental work, and summarised y of the important factors governing the various s of scrubber in use. More recent contributors paid due regard to specific properties of the solvent, and packing, and have deduced relation- which are capable of experimental study r certain specified conditions. Thus, Lewis[2] leveloped very fully the theory of counter-current scrubbing towers and analogous apparatus, ıg general relationships which are applicable such processes as heat transfer, leaching, and absorption. More recently, Partington and ker[3] have successfully dealt with the specific blem of the absorption of nitrous gases by dilute ric acid, in which special considerations arise. nnan and Masson[4] have dealt analytically with process of gas scrubbing in general, making t several necessary simplifying assumptions.

'he factors affecting the operation of a gas ubbing tower may be summarised:—

a) Solubility relationships of gas and scrubbing iid.

b) Scrubbing surface, nature and extent.

c) Rates of liquid and gas flow.

d) Special considerations: (i.) Temperature nges, (ii.) formation of compounds, (iii.) viscosity,

n a preliminary study it is desirable to reduce se factors to the three first mentioned, in which the operation may be analytically expressed ply. In the present paper, attention is cted to the operation of a tower under the lowing conditions: (*a*) Counter-current flow; (*b*) nstant flow rates; (*c*) absorbable constituent eys Henry's law; (*d*) process is isothermal. This the case treated by Donnan and Masson.

Assuming that the process of solution of the luble gas is governed by the law[5]

$$dx/dt = SK_2(KM - N) \qquad \text{(i.)}$$

[1] Hurter, J., 1885, 639; 1887, 607; 1893, 227, 989.
[2] Lewis, J. Ind. Eng. Chem., 1916, 8, 825.
[3] Partington and Parker, J., 1919, 75T.
[4] Donnan and Masson, J., 1920, 236T.
[5] Adeney and Becker, Proc. Roy. Dub. Soc., 1918, 15 (N.S.), 385, 609.

where K_2 = dissolution coefficient of the gas defined from the above equation, K = Henry coefficient, S = surface of solvent, M = concentration of absorbable gas in gas phase, N = concentration of absorbable gas in liquid phase, x = weight of dissolved gas.

And writing in an actual scrubbing tower:— M_1 = concentration of absorbable constituent X in gas phase at entry (in grams per litre), M_2 = ditto at exit, m = ditto at a section of the tower AA, N_1 = concentration of X in liquid phase at entry (in grams per litre), N_2 = ditto at exit, n = ditto at a section of the tower AA, h = total length of packing in tower (in metres), x = distance (in metres) of AA from entry of liquid. V_g = flow of gas in litres per minute, V_l = flow of liquid in litres per minute, S = area of cross-section of tower, K = absorption coefficient of X in the scrubbing liquid defined by the ratio at equilibrium (grams X per litre liquid/ditto gas), K_1 = square metres of wetted surface per cubic metre of tower. K_2 = dissolution coefficient of X (expressed as grams per square metre per minute).

$$V_g/V_l = f$$

By application of equation (i) to the process occurring in a small horizontal section of the tower at AA of thickness dx:—

$$V_g.dm = V_l.dn = K_1K_2S(Km - n).dx \qquad \text{(ii.)}$$

From these relationships Donnan and Masson were able to write:—

$$\log_e \frac{(K-f)n + K(fM_2 - N_1)}{f(KM_2 - N_1)} = \frac{K_1K_2S}{V_g}(K-f)x \qquad \text{(iii.)}$$

$$\log_e \frac{(K-f)m + (fM_2 - N_1)}{KM_2 - N_1} = \frac{K_1K_2S}{V_g}(K-f)x \qquad \text{(iv.)}$$

If N_1 is zero (*i.e.*, pure solvent enters the scrubbing tower) these equations simplify; thus equation (iii.) becomes:—

$$\log_e \left(1 + \frac{K-f}{KfM_2}n\right) = \frac{K_1K_2S}{V_g}(K-f)x \qquad \text{(v.)}$$

In these relationships the working of a gas scrubbing tower is characterised by the two coefficients K_1 and K_2; and by inspection it is possible to see the type of experiment required to enquire into their nature and value. In the foregoing relationships, as also in any others which may be deduced relating to the operation of a tower, the coefficients K_1 and K_2 occur in product form, and consequently any separation will be arbitrary. In making such a separation, it is helpful to regard K_1 as invariant and equal to the simple geometric surface of the packing used, treating any variation in the product as due to a change in K_2, *i.e.*, a change (or an apparent change) in the rate of solution of the gas.

Equations iii. and iv. give relationships capable of experimental examination between x (the distance traversed by the gas and liquid through the tower) and m and n (the concentrations of dissolved gas, in the gas and liquid phases, respectively, at the point x), in terms of K_1, K_2, and factors such as K, f, and M_2,

which may also be determined experimentally. The method of enquiry into the nature and value of K_1 and K_2 is thus to study the variation of gas and liquid concentration throughout a tower, under known conditions of flow and packing, etc. Such a study was desirable as a preliminary step in the classification of various types of commercial packing and of types of scrubbers (plate columns etc.), and the investigation described herewith was undertaken.

To study the process upon a scale corresponding to that likely to be met in actual practice, an experimental tower was used as shown in Fig. 1, which allowed the use of commercial packings. The use of a comparatively large apparatus was considered essential, in view of the misleading results likely to be obtained by experiments with small apparatus, though these latter might conceivably be exact small-scale models. The packing used in the tower (4-in. "propeller" tower filling) was such as to afford a surface, the area of which could be computed and was arranged uniformly, in view of the purpose to which the tower was to be put. As a gas supply a mixture of air and carbon dioxide (up to 12% CO_2) was used, since the solubility relationships of carbon dioxide are well established[6] and known to be according to Henry's law and the law of dynamic solution expressed by equation (i.) (*supra*). Moreover, under the conditions of experiment the process of solution was practically isothermal, no detectable temperature variations due to solution of the gas being observed. In order to avoid any undesirable temperature changes in the body of the tower due to evaporation, a preliminary saturating tower as shown in Fig. 1 was incorporated in the apparatus, and was supplied with an excess of water of the same temperature as that used in the tower, the spray being carried forward and deposited in the compartments of the mixing box where the carbon dioxide was introduced. The arrangements for metering the streams of air and carbon dioxide are shown, these being by means of two Kent orifice meters reading accurately to 0·5%. It was found necessary to introduce loaded, water sealed gasometers in the carbon dioxide main in order to maintain a steady pressure, the supply being unsatisfactory when taken directly from a battery of cylinders. Facilities were provided for the insta

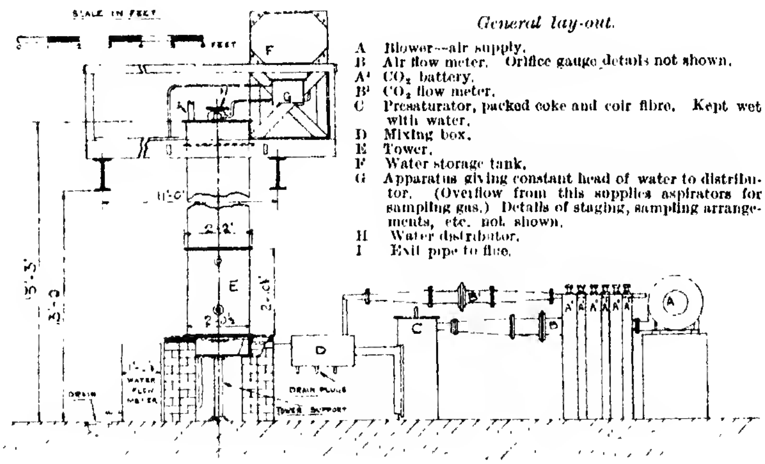


FIG. 1.

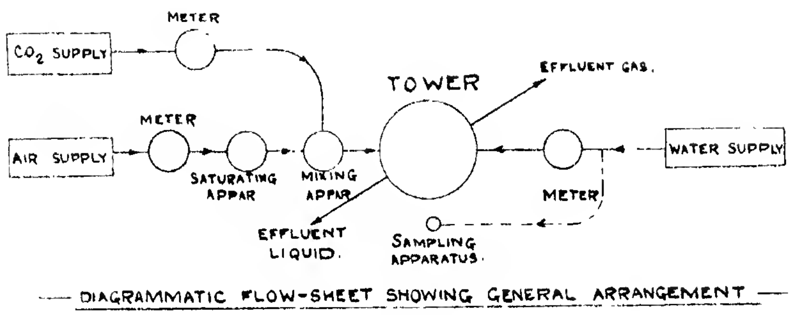


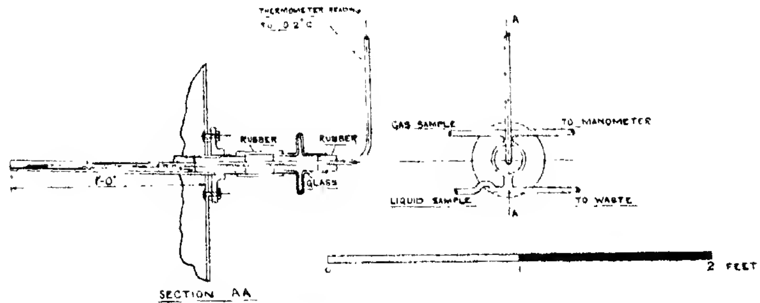
FIG. 1A.

[6] Bohr, Ann. Physik, 1899, 500.

ous removal of samples of gas and liquid at vals of their progress through the tower by the ratus shown in Fig. 2. In an actual experiment, was necessary to assure that steady conditions ined throughout the tower. To this end, the r was first supplied to the tower for some time, der to attain a uniform temperature throughout, e adjusting the flow to the particular rate desired. gas and air supplies were then also adjusted and apparatus was allowed to run until the issuing concentration became constant, as shown by the val and analysis of successive samples. At this samples of gas and liquid were removed for sis from each orifice fitted to the tower, and also issuing and entering gas and liquid. These ses were performed: (*a*) for the gas, directly easurement of volume contraction on treatment caustic potash; (*b*) for the liquid, by measure- of the contraction obtained on treatment with appreciable quantities of dissolved carbonates, and these values, slightly lower than those applying to air-free distilled water, were used throughout in the calculation of results. From the results of the analyses of the gas and liquid samples, the curves giving m and n as functions of x were first constructed, and from these one of the derived expressions such as $\log_e [1+n(K-f)/KfM_2]$ was plotted as a function of x. The derived curve indicated was found in all cases to approximate to a straight line, thereby confirming the applicability of the relationships used. From its gradient the values of the coefficient K_2, were obtained, which are shown attached.

The temperature throughout an individual experiment was constant. Range of temperature of above experiments, 7°—10·5°C. No temperature corrections have been applied.

It will be seen that the value of K_2 is not influenced greatly by change in liquid flow rate, but increases



SAMPLING APPARATUS

FIG. 2.

stic potash of the gases evolved upon boiling under uced pressure.[7] Experiments were made to ermine the value of Henry's constant for carbon xide in the water supply used, which contained

TABLE I.

of gas flow. Litres per minute	Rate of liquid flow. Litres per minute.	Value of K_2.
20—250	8	1·44
20—250	12·5	1·12
20—250	19·5	1·28
20—250	21	1·40
20—250	33	1·36
20—250	40	1·12
20—250	44	1·5

TABLE II.

te of gas flow. Litres per min.	Linear velocity Metres per min.	Rate of liquid flow. Litres per min.	Value of K_2.
910	3·13	30—45	8·8
590	2·05	30—45	5·0
520	1·8	30—45	4·4
520	1·8	30—45	3·5
440	1·51	30—45	3·7
390	1·34	30—45	3·7
390	1·34	30—35	2·25
240	0·83	30—45	0·8
220	0·76	30—45	1·2
165	0·57	30—45	1·0
100	0·35	30—45	0·8

[7] This was found to be the only satisfactory method applicable to these alyses. Titration or precipitation methods gave extremely inaccurate sults when applied to the determination of carbon dioxide in solution. Many of these inaccuracies are ably reviewed and criticised in a paper by Johnstone (J. Amer. Chem. Soc., 1916, 38, 947).

rapidly with increase in gas flow rate over the range studied. The variation may be expressed approximately by:—

$$K_2 = 2{\cdot}43\,L_g\overline{K}_2 - 1{\cdot}0 \qquad \text{(vi)}$$

Where L_g denotes the linear velocity of the gas through the packed tower (metres/minute) and $\overline{K}_2$ denotes a specific value of K_2 ($\overline{K}_2 = 1{\cdot}15$: see further below).

The rapid increase of K_2 with increase in gas-flow rate is considered due to a turbulence effect (*cf.* heat transfer coefficients, pipe resistances, etc.), which hastens the removal of impoverished gas from the liquid surfaces. The fact that no consistent variation was observed in K_2 as due to variation in liquid flow, indicates that over the range examined the packed surface was completely wetted, and that increase in liquid-flow rate mainly increased the thickness of the film of water trickling over the packing. It is probable that an increased surface will be afforded at still higher rates of liquid flow (increase in scrubbing surface would appear as an increase in K_2) due to splash and drip effects, but because of experimental limitations this could not be tried. A more exact relationship will probably give K_2 as some power function of the gas velocity and a value of K_2 under certain specified conditions. Clearly, the most

readily realisable conditions under which a value of K_2 can be specified and experimentally determined on a small scale, are those of zero gas velocity—*i.e.*, the simple efflux rate of gas from a solution into an atmosphere free of the dissolved gas. Determination of this limiting value of K_2 for any particular gas, permits by means of equation (vi.), the calculation of the value of K_2 at any specified gas-flow rate which applies in the design of a tower to effect absorption at that flow rate.

To test the validity of the suggestion outlined above, experiments were carried out to determine the value of K_2 for carbon dioxide with respect to the water used in the tower, by a small-scale method, and the values so obtained were compared with those obtained in working with the tower at low-gas velocities.

K_2 = velocity constant of solution, K_3 = velocit constant of loss of gas.

1. Loss of gas to atmosphere

$$dx/dt = -K_3Sx/V$$
$$K_3 = V/St. \log_e(x_0/x_t) \qquad \text{(vii.)}$$

where K_3 is a coefficient governing rate of loss.

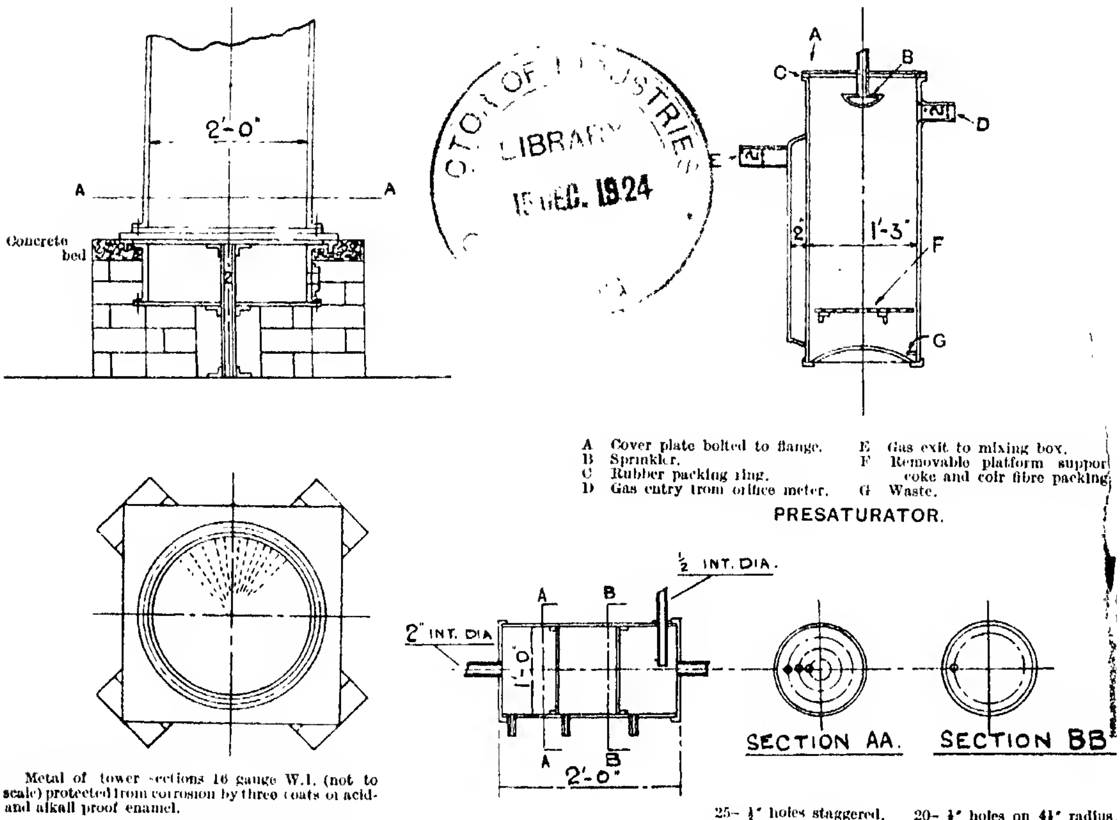
The process of solution from an atmosphere co taining M grams per litre, however, procee according to :—

$$dx/dt = SK_2(KM - x/V)$$

which may be written separately

$$dx/dt = KK_2SM - K_2Sx/V$$

showing the dynamic nature of the process, in w the constant K_3 evidently is identical with K_2.



Metal of tower sections 16 gauge W.I. (not to scale) protected from corrosion by three coats of acid- and alkali proof enamel.

Plan on A.A showing disposition of gas passages (⅜" dia.)

BASE OF TOWER

A Cover plate bolted to flange.
B Sprinkler.
C Rubber packing ring.
D Gas entry from orifice meter.
E Gas exit to mixing box.
F Removable platform suppor coke and coir fibre packing.
G Waste.

PRESATURATOR.

25- ¼" holes staggered.
10- on 1½" inner radius.
12- on 3" ditto.
3- on 4" ditto.

20- ¼" holes on 4½" radius.

MIXING BOX

FIG. 3.

Consider a solution containing dissolved gas exposed to an atmosphere free of the dissolved gas: Let S = surface in sq. m, x = weight dissolved in grams, V = volume in litres, t = time in minutes,

The method of experiment used was to take water solution of carbon dioxide (about 1500 c.c in a glass vessel of circular horizontal cross-secti (115 sq. cm.), the liquid reaching to the lip of the vess

vas found necessary to screen the surface of the tion from any direct draught, otherwise the s of K_2 determined did not approach constancy. ng of the solution was effected at such a rate the surface remained unbroken and approxi-ely horizontal. Provided that these conditions observed, consistent results were readily ined, the rate of stirring being capable of varia-over a considerable range with little influence . Samples of the solution were run off for s, without disturbing the surface or stirring, inute intervals and the values of K_2 determined m equation (vii.) above, with the following :—

Temp. °C.	8·7	10·2	10·2	11·7	14·5.
K_2	0·97	1·15	1·03	1·13	1·22.

to be noted that (1) the temperature coefficient ll and insufficient to justify corrections on ount to values of K_2 obtained in working with er; (2) the value is of the same order as that ined in experiments with the tower at low f gas flow.

Hence

$$\int_0^h (Km-n).dx=(KM_2-N_1)\ (e^{ph}-1)/p$$

$$=h\ \frac{(K-f)\ M_1+f\ (M_2-N_1)-(KM_2-N_1)}{\log_e [(K-f)\ M_1+f(M_2-N_1)]/(KM_2-N_1)}$$

Hence $W=K_1K_2Sh\ \dfrac{(KM_1-N_2)-(KM_2-N_1)}{\log_e (KM_1-N_2)/(KM_2-N_1)}$ (ix.).

This relationship is strictly similar to that applying to the process of heat transfer, and an application is indicated in the problem given below. In applying the experimental data it is not possible to discuss the effect of different packings, and the data are applicable strictly only within the range studied (*i.e.*, to a linear gas velocity of 3 metres per minute). It is justifiable, however, to apply the results to the consideration of towers of different dimensions, but retaining the same packing and corresponding flows of gas and liquid.

Problem.—A supply of gas 5000 litres per minute containing 0·1 g. per litre of a soluble gas having a Henry coefficient of 1·3 expressed as g.p.l. liq./

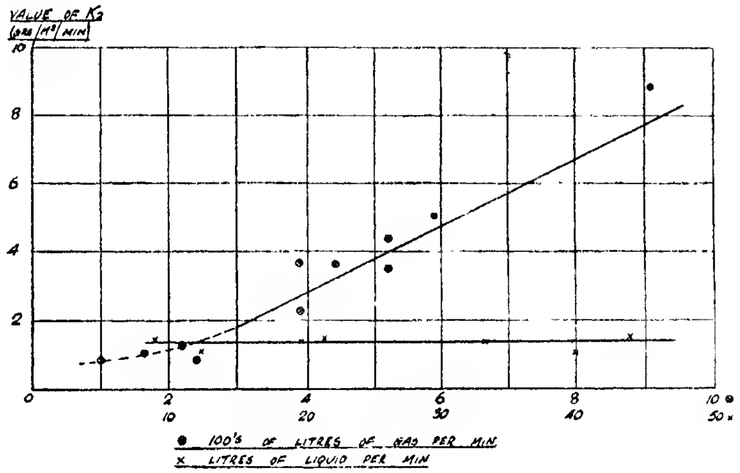


FIG. 4.

proceeding to apply values of dissolution co-nts in the design of a tower, it is desirable to relationships more convenient in their application the differential relationships used in the earlier on of this paper.[8]

ing the previous notation: For the material fer per minute:—

$$dW=K_1K_2S(Km-n)dx.$$

$$W=K_1K_2S\int_0^h (Km-n)\ dx. \qquad \text{(viii.)}$$

From equations (iii.) and (iv.) and writing

$$(K-f)\ K_1K_2S/V_g=p,$$

$$m-n)=\frac{K}{K-f}\ (KM_2-N_1)e^{px}-\frac{f}{K-f}(KM_2-N_1)e$$

$$=(KM_2-N_1)e^{px}$$

g.p.l. gas at equilibrium, is to be scrubbed to a concentration of 0·08 g.p.l. Its dissolution co-efficient determined statically is 1 (gram, litre, sq. m. minute units). Efficiency of scrubbing required =80%.* To determine suitable dimensions for a scrubbing tower.

Gas exchange per minute=5000×0·02 g.=100 g.

At 80% efficiency, issuing liquid concentration =0·104 g. per litre, and very approximately 1000 litres per minute of solvent are required. Applying equation (ix.)

$$100=\text{surface}\times K_2\times(-0{\cdot}078)/\log_e\ [0{\cdot}026/0{\cdot}104]$$

If the gas velocity, through the packed tower is kept above 2 metres per minute, K_2 may be taken as 3. Hence the required surface is 600 sq. m.

Using a packing affording 90 sq. m. per cub. m. packed, the packed volume required =6·7 cub. m.

[8] The logarithmic relationship given was published (J. Ind. Eng. Chem., 12, 115) by Van Arsdel during the progress of this work and was also d ind endently. See also Lewis, *loc. cit.*

*Efficiency of scrubbing $=\dfrac{\text{g.p.l. leaving liquid}}{\text{g.p.l. entering gas}}\div K.$

Suitable dimensions for the tower are: Height, 7 metres; diameter, 1·1 metres.

Summary.—The operation of gas scrubbing towers is considered from the standpoint of the influence of rate of gas and liquid flow upon the dissolution coefficient of the gas to be extracted.

An experimental study of tower operation with carbon dioxide is described. The results show that the dissolution coefficient is independent of liquid flow rate over the packing, but increases rapidly with increase in gas flow rate.

A relationship analogous to that applying to heat interchange is given and applied to the design of a tower.

In conclusion the author wishes to thank Prof. F. G. Donnan for his interest and suggestive criticism during the progress of the work described.

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THE RECIPROCAL SALT-PAIR $Na_2Cr_2O_7 + 2KCl \rightleftarrows K_2Cr_2O_7 + 2NaCl$.

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Since one of the processes used for the manufacture of potassium bichromate depends upon the double decomposition of sodium bichromate with potassium chloride and subsequent crystallisation of the potassium bichromate formed either spontaneously or by evaporation, the determination of the phase-rule equilibria existing in the above system has a certain importance.

A series of determinations has been made by the author of the composition of solutions which are in equilibrium with one, two, or three of the salts of the system existing as solid phases. This involves a survey of the following:—

Three-component systems: $KCl—K_2Cr_2O_7—H_2O$; $NaCl—Na_2Cr_2O_7—H_2O$; $KCl—NaCl—H_2O$, and $K_2Cr_2O_7—Na_2Cr_2O_7—H_2O$. Four-component system: $(K, Na)—(Cl, Cr_2O_7)—H_2O$.

The system $KCl—NaCl—H_2O$ has already been investigated by Reinders (Z. anorg. chem., 1915, **93**, 202). Data for the other systems are here given. Three isotherms have been constructed, namely at 25°, 50°, and 100°. In order to obtain the solutions for analysis, mixtures of the pure salts were dissolved in water at a higher temperature than that of the isotherm and the flasks containing these solutions then immersed in thermostats. Equilibrium was reached in a few hours, but generally the solutions were allowed to remain at constant temperature for at least twelve hours before sampling. The nature of the solid phase or phases separating out could usually be determined by inspection, the distinctive colours and crystalline forms of the salts rendering this possible, but in every case invariant points were checked by at least two analyses, the second being made after further addition of one of the solid phases or after considerably evaporating the solution. The solutions were sampled by rapidly sucking up a portion through a plug of cotton wool into a piece of glass tubing and decanting t clear liquid obtained into a tared weighing bot After weighing, the whole was made up to defin volume in a graduated flask and the various radic were determined in aliquot parts. The analyti procedure was as follows:—

System $KCl—K_2Cr_2O_7—H_2O$.—The chlorine w determined by titration with $N/10$ silver nitrate, us potassium chromate as indicator. The end-po

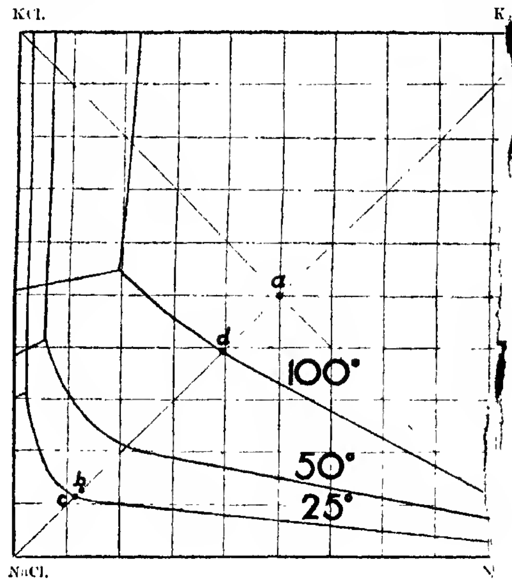


FIG. 1.

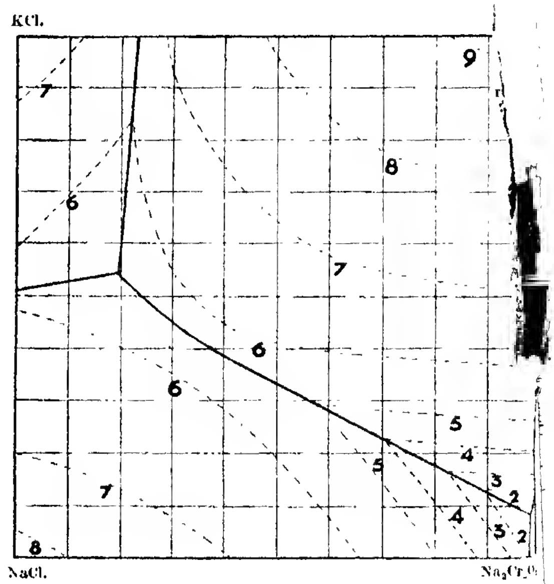


FIG. 2.

of the titration was quite definite and sharp, even in presence of considerable bichromate ion provided the solution was sufficiently diluted. Bichromate

s determined by liberation of iodine from potassium lide in a solution acidified with hydrochloric acid, d titration of the liberated iodine with $N/10$ thiolphate. These two determinations gave the perntages of potassium chloride and potassium bichrom- in the original solution and, by difference, its iter content.

System $NaCl$—$Na_2Cr_2O_7$—H_2O.—This was analysed a manner similar to the above.

System $K_2Cr_2O_7$—$Na_2Cr_2O_7$—H_2O.—The analysis his system involves a determination of the alkalis ent. This was done by the indirect method liquot part of the solution was reduced by alcohol r acidification with hydrochloric acid, and the mium precipitated as hydroxide by ammonia and oved by filtration. The filtrate was evaporated ryness, the ammonium salts were ignited off, the lue was dissolved in water and traces of carbonaceous matter and chromic oxide were removed by filtration through a small filter paper. The filtrate was collected in a crucible, carefully evaporated to dryness, and the residue gently ignited, and weighed. This gave the weight of mixed potassium and sodium chlorides. The residue was dissolved in water and titrated with standard silver nitrate. This gave the chlorine content, which allowed the relative proportions of potassium and sodium chlorides (and therefore of potassium and sodium bichromates in the original solution) to be calculated. Analyses of a known mixture of sodium chloride and potassium bichromate showed that the experimental error to be allowed for using this method was in the neighbourhood of 1%. All analyses in the system were checked by determining the bichromate content of each solution, and any in which this differed from the value calculated from the alkali determinations by more than 1% were discarded or repeated

	2	3	4	5	6	7	8	9	10	
	Grams per 100 g. solution.					Equivalent proportions.			Mols.	Solid phases.
l.	KCl.	$Na_2Cr_2O_7$.	$K_2Cr_2O_7$.	H_2O.	Na.	K.	Cl	Cr_2O_7.	H_2O.	
						25°.				
	26.3	0	0	73.7	0	1.000	1.000	0	11.61	KCl
	26.1	0	1.05	72.85	0	1.000	0.980	0.020	11.33	,,
	26.0	0	1.2	72.8	0	1.000	0.977	0.023	11.32	KCl + $K_2Cr_2O_7$
	23.0	0	1.57	75.43	0	1.000	0.967	0.033	13.10	$K_2Cr_2O_7$
	21.2	0	1.7	77.1	0	1.000	0.961	0.039	14.48	,,
	18.6	0	2.2	79.2	0	1.000	0.943	0.057	16.04	,,
	15.7	0	2.6	81.7	0	1.000	0.922	0.078	19.88	,,
	11.4	0	3.07	82.53	0	1.000	0.905	0.096	21.48	,,
	13.0	0	3.36	83.64	0	1.000	0.881	0.116	23.68	,,
	11.6	0	3.9	84.5	0	1.000	0.854	0.146	25.78	,,
	10.0	0	4.55	85.45	0	1.000	0.813	0.187	28.77	,,
	8.2	0	5.5	86.3	0	1.000	0.746	0.254	32.52	,,
	6.32	0	6.53	87.15	0	1.000	0.656	0.344	37.50	,,
	4.3	0	8.3	87.4	0	1.000	0.505	0.495	42.55	,,
	2.1	0	10.0	87.9	0	1.000	0.293	0.707	50.76	,,
	0	0	13.1	86.9	0	1.000	0	1.000	54.20	,,
	0	0	0	73.6	1.000	0	1.000	0	9.05	NaCl
	0	5.18	0	70.82	1.000	0	0.912	0.088	8.74	,,
	0	11.7	0	67.3	1.000	0	0.801	0.199	8.33	,,
	0	17.8	0	64.2	1.000	0	0.694	0.306	8.03	,,
4	0	23.8	0	60.8	1.000	0	0.592	0.408	7.59	,,
3	0	28.8	0	57.9	1.000	0	0.509	0.491	7.19	,,
7	0	35.0	0	54.3	1.000	0	0.407	0.593	6.70	,,
8	0	39.3	0	51.9	1.000	0	0.331	0.666	6.40	,,
61	0	45.1	0	48.29	1.000	0	0.247	0.753	5.87	,,
67	0	50.6	0	44.73	1.000	0	0.171	0.829	5.33	,,
10	0	57.1	0	39.8	1.000	0	0.109	0.891	4.52	,,
13	0	64.6	0	31.27	1.000	0	0.038	0.962	3.73	NaCl + $Na_2Cr_2O_7,2H_2O$
	0	65.5	0	34.5	1.000	0	0	1.000	3.84	$Na_2Cr_2O_7,2H_2O$
	0	61.4	5.25	33.35	0.929	0.071	0	1.000	3.67	$Na_2Cr_2O_7,2H_2O + K_2Cr_2O_7$
	0	55.5	5.16	39.34	0.923	0.077	0	1.000	1.76	$K_2Cr_2O_7$
	0	13.2	5.46	51.34	0.809	0.101	0	1.000	7.77	,,
	0	33.6	6.52	59.88	0.853	0.117	0	1.000	11.06	,,
	0	26.9	7.70	65.4	0.797	0.203	0	1.000	14.09	,,
	0	20.0	8.97	71.03	0.715	0.285	0	1.000	18.47	,,
	0	16.1	8.68	75.22	0.676	0.324	0	1.000	22.97	,,
	0	4.38	12.2	83.42	0.287	0.713	0	1.000	39.85	,,
5	4.76	0	0	69.74	0.897	0.103	1.000	0	8.53	NaCl
3	9.1	0	0	66.6	0.805	0.195	1.000	0	8.09	,,
3	13.0	0	0	63.7	0.720	0.280	1.000	0	7.72	,,
8	11.1	0	0	63.1	0.697	0.303	1.000	0	7.63	NaCl + KCl
7	17.8	0	0	65.5	0.505	0.159	1.000	0	8.77	KCl
0	19.7	0	0	67.3	0.437	0.563	1.000	0	9.45	,,
7	21.1	0	0	68.2	0.364	0.636	1.000	0	9.84	,,
	K.	Cl.	Cr_2O_7.	H_2O.						
0.39	13.57	12.62	0.93	72.49	0.047	0.953	0.978	0.022	11.06	KCl + $K_2Cr_2O_7$
0.64	13.53	12.98	0.93	71.92	0.075	0.925	0.979	0.021	11.68	,,
1.10	12.75	12.98	0.86	72.31	0.128	0.872	0.979	0.021	10.74	,,
1.68	12.09	13.23	0.97	72.03	0.101	0.800	0.970	0.021	10.47	,,
3.98	9.35	14.33	0.86	71.48	0.420	0.580	0.981	0.019	9.64	,,
1.72	8.91	15.04	0.97	70.30	0.473	0.527	0.970	0.210	9.03	,,
6.12	7.51	15.92	0.97	69.18	0.581	0.419	0.980	00.02	8.43	,,
7.13	6.88	16.88	1.08	68.03	0.038	0.362	0.979	0.021	7.78	,,
7.82	6.06	17.09	1.08	67.95	0.687	0.313	0.980	0.020	7.63	KCl + $K_2Cr_2O_7$ + NaCl
11.49	0.53	0.84	52.86	31.28	0.974	0.026	0.016	0.954	3.71	NaCl + $K_2Cr_2O_7$ + $Na_2Cr_2O_7,2H_2O$
0.23	3.48	0.35	9.61	86.33	0.101	0.899	0.101	0.890	48.16	$K_2Cr_2O_7$
0.46	3.52	0.71	9.72	85.59	0.182	0.818	0.182	0.818	43.23	,,
0.69	3.52	1.00	9.72	85.01	0.250	0.750	0.750	0.750	39.35	,,
0.92	3.52	1.42	9.72	84.42	0.308	0.692	0.308	0.092	36.07	,,
1.10	3.48	2.16	9.61	83.35	0.407	0.593	0.407	0.593	30.86	,,
1.86	3.44	2.87	9.50	82.33	0.479	0.521	0.497	0.521	27.00	,,
2.97	3.32	4.57	9.18	79.96	0.603	0.397	0.603	0.397	20.75	,,
3.63	3.25	5.60	8.96	78.56	0.656	0.344	0.656	0.344	18.11	,,
5.04	3.01	7.76	8.32	75.87	0.740	0.260	0.740	0.260	14.24	,,
6.28	2.74	9.68	7.56	73.74	0.796	0.204	0.796	0.204	11.04	
9.42	2.11	14.52	5.83	68.12	0.884	0.116	0.884	0.116	8.10	$K_2Cr_2O_7$ + NaCl
5.69	3.91	16.13	2.48	68.79	0.791	0.209	0.952	0.048	8.00	,,

System (K, Na)—(Cl, Cr_2O_7)—H_2O.—all four radicals were determined by the methods detailed above. As in each case equivalents K + equivalents Na must equal equivalents Cl + equivalents Cr_2O_7, and as, in general, complete agreement was not obtained, it was assumed that the Cl and Cr_2O_7 values were correct, and the values obtained for K and Na were increased or diminished accordingly so long as the total discrepancy did not exceed 1%.

The analytical results obtained are given below. Those marked with an asterisk are taken from the paper by Reinders (*loc. cit.*). Columns 1–4 give the weight of each salt or radical in grams per 100 g. of solution, and column 5 the weight of water. Columns 6–9 give the results expresed as equivalents and as proportional parts where equivalents K + equivalents Na = 1 and equivalents Cl + equivalents Cr_2O_7 = 1, and column 10 the number of g.-mols. of water associated with each gram-equivalent of total dissolved salts.

The isotherms are represented graphically according to Jänecke's projection in Figs. 1 and 2. In Fig. 1 all three isotherms are shown. In Fig. 2 the isotherm at 100° is represented alone, the broken lines in th diagram indicating the number of molecules of wate associated with one equivalent of total salts i solution. Fig. 3 shows models built in the form of sections of square prisms, where the heigh of any point on the surface is proportional to th water value for a solution having that composition These show the contours of the saturation surfaces

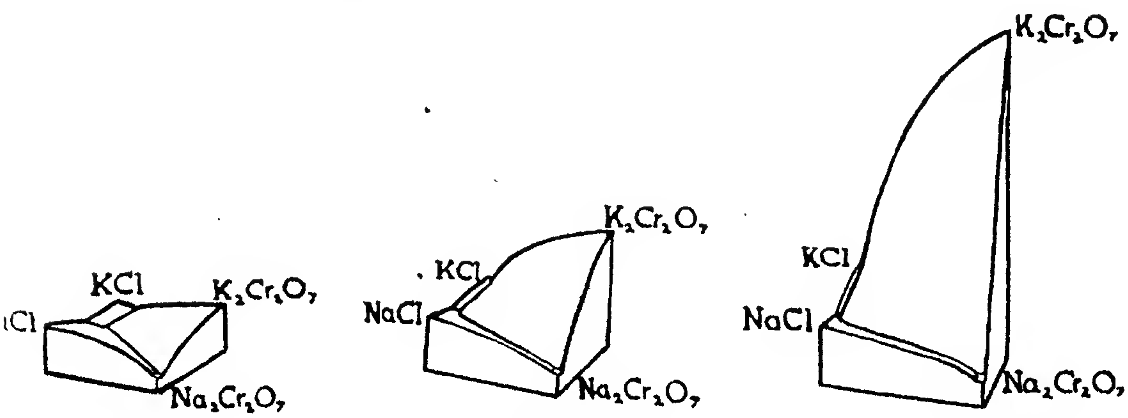
It will be seen from the diagram that at all tem peratures the salts potassium bichromate and sodiu chloride are the compatible pair, whilst the saturati surfaces of sodium bichromate and sodium chlor are in each case widely separated. As the tempe ture is raised the potassium chloride and sodiu chloride fields increase considerably in extent, t potassium bichromate field being thereby diminish The sodium bichromate field is in every case ve small. It is also noteworthy that at 50° and m so at 25° the intersection curves of the sodi chloride and potassium bichromate fields assu pronouncedly curved shapes.

1	2	3	4	5	6	7	8	9	10	
Grams per 100 g. solution					Equivalent		Proportions.		Mols.	Solid phases.
NaCl.	KCl.	$Na_2Cr_2O_7$.	$K_2Cr_2O_7$	H_2O.	Na	K.	Cl	Cr_2O_7.	H_2O.	
						50°.				
0	30·6	0	0	69·4	0	1·000	1·000	0	9·10	KCl
0	29·8	0	1·9	68·3	0	1·000	0·969	0·031	9·20	,,
0	29·0	0	3·7	67·3	0	1·000	0·939	0·061	9·03	,,
0	28·9	0	4·1	67·0	0	1·000	0·933	0·067	8·98	KCl + $K_2Cr_2O_7$.
0	24·0	0	5·7	70·3	0	1·000	0·892	0·108	10·83	$K_2Cr_2O_7$
0	21·1	0	6·8	71·8	0	1·000	0·861	0·139	11·98	,,
0	18·1	0	8·8	73·1	0	1·000	0·802	0·108	13·42	,,
0	11·8	0	11·0	74·2	0	1·000	0·726	0·274	15·08	,,
0	13·3	0	12·4	74·3	0	1·000	0·679	0·321	15·71	,,
0	11·9	0	13·2	74·9	0	1·000	0·640	0·360	16·70	,,
0	10·3	0	14·9	74·8	0	1·000	0·577	0·423	17·36	,,
0	8·6	0	16·7	74·7	0	1·000	0·504	0·496	18·14	,,
0	6·6	0	18·9	74·5	0	1·000	0·408	0·592	19·16	,,
0	4·6	0	21·3	74·1	0	1·000	0·299	0·701	19·03	,,
0	2·1	0	23·8	73·8	0	1·000	0·166	0·834	21·14	,,
0	0	0	27·4	72·6	0	1·000	0	1·000	21·65	,,
26·9	0	0	0	73·1	1·000	0	1·000	0	8·82	NaCl
24·2	0	5·87	0	69·93	1·000	0	0·902	0·098	8·47	,,
20·8	0	13·0	0	66·2	1·000	0	0·782	0·218	8·08	,,
10·1	0	16·4	0	64·5	1·000	0	0·723	0·277	7·93	,,
15·8	0	23·1	0	61·1	1·000	0	0·605	0·395	7·60	,,
13·1	0	29·1	0	57·5	1·000	0	0·500	0·500	7·12	,,
11·1	0	34·3	0	54·6	1·000	0	0·420	0·580	6·71	,,
8·43	0	41·3	0	50·27	1·000	0	0·314	0·686	6·08	,,
6·46	0	45·9	0	47·61	1·000	0	0·240	0·760	5·74	,,
4·57	0	52·3	0	43·13	1·000	0	0·164	0·836	5·02	,,
2·71	0	58·1	0	39·19	1·000	0	0·095	0·905	4·44	,,
1·94	0	63,4	0	34·66	1·000	0	0·064	0·936	3·72	,,
0·94	0	70·2	0	28·86	1·000	0	0·029	0·971	2·90	NaCl + $Na_2Cr_2O_7,2H_2O$
0	0	70·3	0	29·7	1·000	0	0	1·000	3·07	$Na_2Cr_2O_7,2H_2O$
0	0	63·3	7·02	28·78	0·900	0·100	0	1·000	2·98	$Na_2Cr_2O_7,2H_2O$ + $K_2Cr_2O_7$
0	0	52·5	9·36	38·14	0·863	0·137	0	1·000	4·56	$K_2Cr_2O_7$
0	0	48·5	9·47	42·03	0·852	0·118	0	1·000	5·37	,,
0	0	43·6	11·3	45·1	0·812	0·188	0	1·000	6·12	,,
0	0	34·0	12·3	52·8	0·761	0·239	0	1·000	8·38	,,
0	0	29·3	13·6	57·1	0·708	0·292	0	1·000	10·04	,,
0	0	21·0	17·8	61·2	0·570	0·430	0	1·000	12·09	,,
0	0	16·3	19·3	64·4	0·486	0·514	0	1·000	13·98	,,
0	0	6·5	24·2	69·3	0·232	0·768	0	1·000	17·97	,,
*22·1	18·8	0	0	59·1	0·610	0·390	1·000	0	6·99	NaCl + KCl
*13·8	22·6	0	0	63·6	0·410	0·590	1·000	0	8·35	KCl
Na.	K	Cl	Cr_2O_7.	H_2O.						
0·57	15·53	13·90	3·24	66·76	0·059	0·941	0·929	0·071	8·79	KCl + $K_2Cr_2O_7$
1·40	14·71	11·50	3·1[illegible]	66·23	0·130	0·861	0·934	0·066	8·40	,,
3·27	12·16	15·10	2·92	66·55	0·313	0·687	0·940	0·060	8·16	,,
3·93	11·42	15·10	2·92	66·27	0·369	0·631	0·942	0·058	7·95	,,
5·29	10·13	16·37	3·0[illegible]	65·21	0·470	0·530	0·943	0·057	7·41	,,
6·92	8·43	17·27	3·19	64·19	0·583	0·417	0·943	0·057	6·90	KCl + $K_2Cr_2O_7$ + NaCl
12·00	1·13	0·62	58·38	27·57	0·935	0·065	0·032	0·968	2·74	NaCl + $K_2Cr_2O_7$ + $Na_2Cr_2O_7,2H_2O$
0·57	7·04	0·89	19·44	72·06	0·122	0·878	0·122	0·878	19·53	$K_2Cr_2O_7$
1·10	6·88	1·70	19·01	71·31	0·214	0·786	0·214	0·786	17·69	,,
1·63	6·65	2·51	18·36	70·85	0·295	0·705	0·295	0·705	16·33	,,
2·32	6·41	3·58	17·71	69·98	0·381	0·619	0·381	0·619	14·67	,,
3·27	6·02	5·04	16·6[illegible]	69·04	0·480	0·520	0·480	0·520	12·95	,,
4·12	5·63	6·35	15·55	68·35	0·551	0·446	0·554	0·446	11·75	,,
5·43	5·08	8·37	14·04	67·08	0·645	0·355	0·645	0·355	10·18	,,
8·71	3·95	13·42	10·91	63·01	0·790	0·210	0·790	0·210	7·30	$K_2Cr_2O_7$ + NaCl
7·87	6·22	15·85	5·83	64·23	0·683	0·317	0·892	0·108	7·12	,,
9·45	2·11	14·57	5·83	68·04	0·884	0·116	0·884	0·116	8·13	NaCl

Technical application.—The phase-rule diagram ly be employed usefully in the technical manu-ture of bichromate, as by its means the yield to expected on mixing any given solutions of sodium hromate and potassium chloride can be readily iculated. Further, the process of recovery of hromate from mother liquors by evaporation can controlled as will be shown.

The liquor from which the bichromate crystallises is prepared by adding an equivalent quantity of potassium chloride in solution to a solution of sodium bichromate of known strength. The resulting mixture according to the notation here used would then have the composition 0·5Na, 0·5K, 0·5Cl, 0·5Cr_2O_7. This is represented by point "a" in Fig. 1. Now at 25° such a mixture is associated with 26 mols.

2	3	4	5	6	7	8	9	10	
Grams per 100 g. solution				Equivalent proportions				Mols.	Solid phases
KCl.	$Na_2Cr_2O_7$.	$K_2Cr_2O_7$.	H_2O.	Na	K.	Cl.	Cr_2O_7.	H_2O.	
					100°.				
35·9	0	0	64·1	0	1·000	1 000	0	7 40	KCl
31·9	0	6 4	61 7	0	1·000	0 908	0 092	7 27	,,
29 6	0	11 6	58·8	0	1 000	0 834	0 166	6 87	,,
27 6	0	16 2	56 2	0	1·000	0 771	0 229	6 50	KCl + $K_2Cr_2O_7$
24 0	0	18 2	56 9	0	1 000	0 730	0 270	6 94	$K_2Cr_2O_7$
22·1	0	20 6	57·3	0	1 000	0 670	0 321	7 20	,,
15 6	0	27 6	56 8	0	1 000	0·527	0 473	7 95	,,
11 4	0	32 2	56 4	0	1 000	0 411	0·589	8 43	,,
7 2	0	37 1	55 7	0	1 000	0 277	0·723	8 87	,,
3 5	0	42 1	54 4	0	1·000	0·141	0·859	9 07	,,
0	0	47 2	52 8	0	1 000	0	1·000	9 16	,,
0	0	0	71·9	1 000	0	1 000	0	8 31	NaCl
0	6·28	0	68 62	1 000	0	0 900	0 100	7 99	,,
0	20 0	0	61·7	1 000	0	0 672	0 328	7 36	,,
0	26·5	0	58·1	1·000	0	0 566	0 434	6 93	,,
0	34 9	0	53·4	1·000	0	0 429	0 571	6 36	,,
0	41 1	0	49 84	1 000	0	0·331	0 669	5 91	,,
0	47·1	0	45·82	1·000	0	0·252	0·748	5 30	,,
0	50 9	0	43·51	1·000	0	0·198	0 802	4 90	,,
0	55·4	0	40·46	1 000	0	0·143	0 857	4 55	,,
0	62 3	0	35 04	1 000	0	0·087	0·913	3 74	,,
0	68 6	0	29 76	1 000	0	0 051	0 949	3 00	,,
0	71·9	0	26·88	1 000	0	0 037	0·963	2 60	,,
0	80 0	0	19 26	1 000	0	0 020	0·980	1 72	NaCl + $Na_2Cr_2O_7$
0	80·1	0	19 9	1 000	0	0	1·000	1 81	$Na_2Cr_2O_7$
0	70 8	9 96	10·24	0 889	0 111	0	1 000	1·76	$Na_2Cr_2O_7$ + $K_2Cr_2O_7$
0	60·6	12 4	27·0	0 846	0·154	0	1 000	2·76	$K_2Cr_2O_7$
0	56 1	13·4	30·5	0 825	0·175	0	1·000	3 26	,,
0	48 0	14 5	37 5	0 788	0·212	0	1 000	4 48	,,
0	44·4	16·4	39 2	0 753	0 247	0	1 000	4 84	,,
0	36 5	20·3	43·2	0 669	0 331	0	1 000	5 76	,,
0	29 6	24·2	46·2	0·579	0 421	0	1·000	6 57	,,
0	23 0	29 0	48 0	0 471	0·520	0	1 000	7 15	,,
0	14 1	36·5	49·4	0 303	0 697	0	1·000	7 71	,,
0	6 30	42 1	51 6	0·144	0 856	0	1 000	8 57	,,
26 6	0	0	51 9	0 490	0 510	1 000	0	5 83	NaCl + KCl
K.	Cl.	Cr_2O_7.	H_2O.						
18 14	13 69	11·23	56 34	0 053	0 947	0·788	0 212	6 39	KCl + $K_2Cr_2O_7$
17 44	14 19	11 12	55 94	0 113	0 887	0·795	0·205	6 18	,,
16 70	14 36	11·45	55·56	0 164	0 836	0·793	0·207	6 04	,,
13·76	15 39	11 77	54 59	0 352	0 648	0 709	0 20.	5 59	KCl + $K_2Cr_2O_7$
12 11	16·17	11 77	54 07	0 452	0 548	0·807	0·193	5 31	KCl + $K_2Cr_2O_7$ + NaCl
1·78	0 43	65 61	18·97	0 926	0 074	0 981	0 019	1 70	NaCl + $K_2Cr_2O_7$ + $Na_2Cr_2O_7$
11·93	1 60	32 94	52·49	0 129	0 871	0 129	0 871	8 33	$K_2Cr_2O_7$
10 83	3 40	29 92	53·64	0 257	0 743	0 257	0 743	7 99	,,
9 82	5·92	27 11	53·31	0·400	0·600	0 400	0 600	7·08	,,
8 33	9·18	23 01	53 52	0 549	0·451	0 549	0 451	6 30	,,
7 84	11 05	21 66	52 28	0 609	0 391	0 609	0 391	5 67	$K_2Cr_2O_7$ + NaCl
6 22	12 30	17·17	56 33	0 686	0 314	0 686	0·314	6 18	NaCl
4 30	13 86	11 88	60 07	0 780	0 220	0 780	0 220	6·76	,,
2 27	15 25	6 26	66 33	0 881	0 119	0·881	0 119	7 55	,,



100% 50 % 25%

FIG. 3.

H_2O and this is therefore the limiting concentration for crystallisation. Expressed in grams this solution would be 29·25 g. NaCl, 73·55 g. $K_2Cr_2O_7$, 468 g. H_2O, and would be obtained by dissolving 37·28 g. of KCl and 65·5 g. of $Na_2Cr_2O_7$ in 468 g of water. This solution contains 65·5 ÷ 570·78 or 11·5% $Na_2Cr_2O_7$ by weight. At 50°, 20·2%, and at 100°, 29·9% $Na_2Cr_2O_7$ would be required to give such a saturated solution. If the salts are mixed so as to produce more concentrated solutions at these temperatures there will be separation of potassium bichromate. The actual amount of potassium bichromate which will separate in any given case can be calculated as in the following example:—Suppose a mixture to be made up so that it contains 0·5 g.-equiv. KCl, 0·5 g.-equiv. $Na_2Cr_2O_7$, and 8·5 g.-mol. H_2O, *i.e.*, 37·28 g. KCl, 65·5 g. $Na_2Cr_2O_7$, 153 g. H_2O, or 14·6% KCl, 25·6% $Na_2Cr_2O_7$, 59·8% H_2O. This solution is supersaturated with regard to potassium bichromate and this salt will separate out, the composition of the remaining solution travelling along the line $K_2Cr_2O_7$—NaCl until it reaches a point where a solution of these two salts is in equilibrium with 8·5 mols. H_2O. This is the point "b," which has the composition 0·876NaCl, 0·124$K_2Cr_2O_7$, 8·5H_2O. The amount of potassium bichromate which is precipitated is given by the equation

$$0{\cdot}5K_2Cr_2O_7 + 0{\cdot}5NaCl = \underbrace{xK_2Cr_2O_7}_{\text{precipitate}} + \underbrace{y(0{\cdot}876NaCl + 0{\cdot}124K_2Cr_2O_7)}_{\text{solution "b"}}$$

Since the total quantities of each salt and of water remain unchanged and since no sodium chloride separates, $0{\cdot}876y = 0{\cdot}5$ or $y = 0{\cdot}571$, whence $x = 0{\cdot}429$. Thus from the original 0·5 equivalent of $K_2Cr_2O_7$, 0·429 equiv. has been obtained, or a yield of 85·8%.

Since the point "b" is very close to the boundary line between the fields $K_2Cr_2O_7$ and NaCl, it is apparent that a small increase in the concentration of the original mixture would cause this point to travel to "c" when potassium bichromate and sodium chloride would crystallise out together. The concentrations used in this example are thus about the maximum which could be employed in practice (working at 25°) if the risk of contamination with salt is to be avoided.

To remove the potassium bichromate still remaining in the mother liquor it is necessary to concentrate the solution. Suppose this is done at a temperature of 100°. It will be seen from the diagram that at this temperature the point "b" lies in the NaCl field and therefore, on concentration, salt will separate, the composition of the liquor passing along the line NaCl—$K_2Cr_2O_7$ towards the point "d." At "d" the solution becomes saturated with both sodium chloride and potassium bichromate, and if evaporation were further continued both would crystallise out together. Evaporation must therefore be stopped at this stage. Point "d" has the composition 0·609NaCl, 0·391$K_2Cr_2O_7$, 5·67H_2O. We therefore have the equation

$$0{\cdot}876NaCl + 0{\cdot}124K_2Cr_2O_7 + 8{\cdot}5H_2O = \underbrace{xH_2O}_{\text{water evaporated}} + \underbrace{yNaCl}_{\text{precipitate}} + z(0{\cdot}609NaCl + 0{\cdot}391K_2Cr_2O_7 + 5{\cdot}67H_2O)$$

Thus $8{\cdot}5 = x + 5{\cdot}67z$; $0{\cdot}876 = y + 0{\cdot}609z$; $0{\cdot}124 =$ $0{\cdot}391z$. Whence $x = 6{\cdot}7$; $y = 0{\cdot}683$; $z = 0{\cdot}317$. Thi[s] means that of every 8·5 mols. H_2O in the solutio[n] 6·7 mols. can be evaporated and that thereby sodiu[m] chloride is obtained to the amount of 0·683 ÷ 0·876 or 78% of the content of the original mother liquor.

On cooling the remaining solution to 25° agai[n] further potassium bichromate is precipitated, n[the] composition of the solution returning to the p[oint] "c." The equation governing the precipitation is

$$0{\cdot}609NaCl + 0{\cdot}391K_2Cr_2O_7 + 5{\cdot}67H_2O = xH_2O + yK_2Cr_2O_7 + z(0{\cdot}876NaCl + 0{\cdot}124K_2Cr_2O_7 + 8{\cdot}5H_2O)$$

whence $x = -0{\cdot}24$; $y = 0{\cdot}305$; $z = 0{\cdot}695$.

The negative value for H_2O shows that on coo[ling] such a solution crystallisation would not stop [on] reaching the point "c" and a precipitate [of] potassium bichromate contaminated with sod[ium] chloride would result. To prevent this it would [be] necessary either to add water to the extent [of] 0·24 mol. for each equivalent of total salts be[fore] cooling or to stop the evaporation at some [point] before the point "d" was reached. The am[ount] of potassium bichromate recovered by the a[bove] procedure would be 0·305 ÷ 0·391, or 78%. [The] total yield by the two crystallisations combin[ed is] therefore 85·8 + [78 × (100 − 85·8) ÷ 100] or 96·9[%].

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THE CONTRACTION OF ALCOHOL O[N] DILUTION.

BY HERBERT P. FORAN, M.SC.

It is well known that when water is adde[d to] alcohol there is a contraction in volume, and [the] final volume of the mixture is somewhat less than [the] sum of the volumes of alcohol and water u[sed]. This contraction may generally be ignored in [the] laboratory, where the quantities employed are [re]latively small, but it cannot so easily be neglecte[d in] industry where large amounts of alcohol are b[eing] reduced in strength. Even in the laboratory [in] certain cases where great exactness is require[d it] must be taken into account.

There are tables published giving the amoun[t of] contraction corresponding to various dilutions, [but] as it happened that in several instances the amount[s] given differed considerably from those obtained by experiment, it seemed to be useful to devise a method whereby the correct amount of contraction could be ascertained by means of a simple calculation. The present investigation was undertaken with that object in view.

When water is added to alcohol the volume increases, the percentage of alcohol decreases, and there is a contraction in the total volume; the first two may be easily calculated. In order to be generally applicable, these factors must be expressed as percentages.

In the analysis of alcohol and spirits, it is usual to report the volatile constituents other than ethyl alcohol in grams per hectolitre of alcohol at either 100% or 50%. Thus, as a preliminary to the analysis, strength of the distillate must be brought to % by volume, and accurate tables have been piled giving the amount of water which must added to effect the reduction, as well as the l volume obtained. In Table I. the data in the . three columns are taken from the tables of ird and Cuniasse,[1] and from these the figures he remaining columns have been calculated.

ı this table the first column gives the percentage volume of the alcohol to be reduced. Column 2 s the number of c.c. of water to be added to c.c. of this alcohol in order to reduce it to 50% volume. The final volume obtained in c c. is n in column 3.

he fourth column shows the percentage increase volume (V), which, since the original volume 100, is the same as the volume of water added. ımn 5 gives the percentage of reduction in strength which is obtained from the formula $100\ (p-p')/p$, re p is the percentage strength of the original hol and p' the percentage strength after reduction ich in this case is 50%).

TABLE I.

%	Vol. water	Final vol	% Increase vol. (V)	% Reduction in strength (P)	Contraction c c.	Contraction % (C)	V/P
00	107·44	200 0	107 44	50 00	7 44	3 58	2 14
95	95·87	189·9	95·87	47·36	5·97	3 04	2·02
90	84·76	179 9	84 76	44·44	4 86	2 63	1 91
85	73 86	169 9	73 85	41 17	3 95	2 27	1 79
80	63·07	159·9	63·07	37 50	3 17	1·94	1 68
75	52 38	149 0	52 38	33·33	2 18	1 62	1 57
70	41 78	139·9	41·78	28 57	1·88	1·32	1 46
65	31·23	129 9	31·23	23 07	1 33	1 01	1 36
60	20 76	119·9	20 76	16 66	0 86	0 71	1 25
55	10·37	109·9	10·37	10 71	0 54	0 48	1 11

'he figures in column 6 represent the amount contraction, and are obtained by subtracting the final volume (column 3) from 100 plus the volume of water added (column 2). The percentage contraction (C) is given in column 7, and is arrived at by dividing the amount of contraction by the sum of the volumes of alcohol and water and multiplying the result by 100. The values obtained in column 4 (V) are divided by those in column 5 (P), giving the values for V/P set down in column 8

Having these data in tabular form, various attempts were made to trace a mathematical connexion between V, P, and C. Plotting V against C and P against C resulted in smooth curves, resembling somewhat a logarithmic curve. In other words, C was shown to be a continuous function of both V and P. Combinations of V and P were then tried, and it was finally seen that when the quotient V/P was plotted against C the result was a straight line.

In Fig. 1 the values of V/P obtained in Table I are plotted as ordinates and the corresponding values of C as abscissæ. The result is the straight line A B, the equation of which will be of the form $y=mx+c$. From the figure it will be seen that c is 1·02 and the value of m may be taken as 0·33. So the expression $y=mx+c$ becomes $y=0{\cdot}33x+1{\cdot}02$, whence $x=(y-1{\cdot}02)\div0{\cdot}33$, or $x=3(y-1{\cdot}02)$. Substituting C for x and V/P for y we have

$$C=3\ (V/P-1{\cdot}02).$$

By taking different values of V/P as found in Table I., and applying this equation, values for C were obtained which corresponded very well with those given in the seventh column. The results are shown in the following table:

TABLE II.

		C from Table I.	C calculated		Difference.
1	..	3 58	3 36	.	−0·22
2	..	3·04	3·00	..	−0·04
3	..	2 63	2 67	.	+0·04
4	.	2 27	2·31		+0 04
5	..	1·94	1 98	.	+0·04
6	.	1 62	1 65	..	+0 03
7	.	1·32	1 32		—
8	..	1 01	1·02	..	+0·01
9	.	0 71	0 69	.	−0 02
10	..	0·42	0 36	.	−0 06

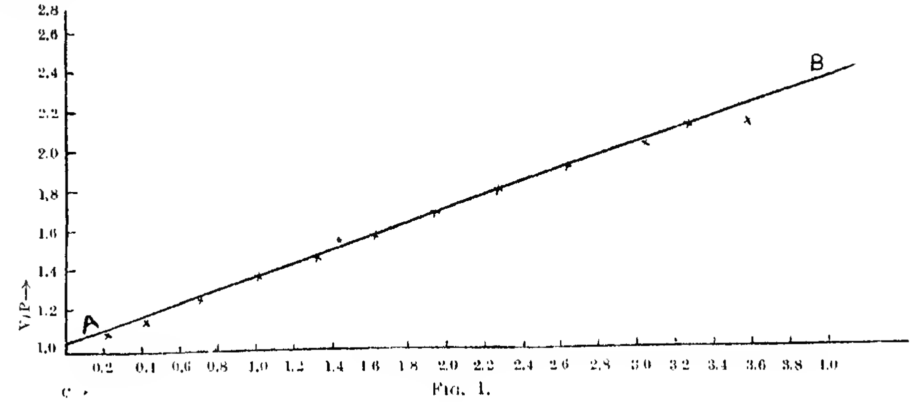

FIG. 1.

From these figures it will be seen that the values of C as calculated from the expression developed above do not vary from those calculated from experimental data by more than +0·06. The first line, where the reduction was from 100 to 50%, constitutes the only exception, the difference in this case being −0·22.

[1] C. Girard and L. Cuniasse, "Manual Pratique de l'Analyse des Alcools et des Spiriteux."

Thus far, however, the expression C =3 (V/P–1·02), has been applied only under the limited conditions governing the table of Girard and Cuniasse; that is to say, when the reduction was made from some higher percentage down to 50%. In order to ascertain whether it is equally applicable in the case of reductions to any strength, alcohol was diluted in various ways and the contraction observed. The results are given in Table III. The strength is here expressed in terms of fiscal proof spirit instead of % by volume.

TABLE III.

	Reduce from	Reduce to	Volume water added to 100 c.c.	Final vol.	% Incr. in vol. (V)	% Decr. in % (P)	Contraction c.c.	Contraction % (C)	V/P
1	65 O.P.	35 O.P.	22·22	121·5	22·22	18·18	0·72	0·59	1·22
2	65 O.P.	Proof	65·00	161·9	65·00	39·39	3·10	1·87	1·65
3	65 O.P.	15 U.P.	200·00	290·0	200·00	66·66	10·00	3·33	3·33
4	35 O.P.	20 U.P.	68·75	165·4	68·75	40·74	3·35	1·98	1·68
5	35 O.P.	30 U.P.	92·85	190·0	92·85	48·14	2·85	1·47	1·92
6	Proof	25 U.P.	33·33	132·0	33·33	25·00	1·33	0·99	1·33
7	40 O.P.	30 U.P.	100·00	195·0	100·00	50·00	5·00	2·50	2·00

The percentage contraction in each of these cases was then calculated from the expression C =3(V/P–1·02), and the calculated values were compared with those found experimentally, with the following results:

TABLE IV.

	C found	C calculated	Difference
1	0·59	0·60	+0·01
2	1·87	1·89	+0·02
3	3·33	6·93	+3·60
4	1·98	1·98	—
5	1·47	2·70	+1·23
6	0·99	0·93	–0·06
7	2·50	2·94	+0·44

It will be seen that in four cases (1, 2, 4, and 6) the agreement is reasonably good, the maximum difference being ± 0·06. In the other three instances (3, 5, and 7), the differences are so great as to make it apparent that in these cases, as well as in the one already cited (first line in Table II.), the method is unreliable.

When the values in Tables I. and III. of P, V, and V/P are tabulated together with the differences between the values of C as calculated and as found, the figures in Table V. are obtained:—

From this table it appears that the results are liable to be inaccurate when P is near or over 50%, when V is near or over 100%, and when V/P is near or over 2·00. It is suggested that the maximum limits of reliability be taken as 45% for P, 90% for V, and 1·90 for V/P.

TABLE V.

P	V	V/P	Difference
50·00	107·44	2·14	–0·22
47·37	95·87	2·02	–0·04
44·44	84·76	1·91	+0·04
41·17	73·85	1·79	+0·04
37·50	63·07	1·68	+0·04
33·33	52·38	1·57	+0·03
28·57	41·78	1·46	—
23·07	31·23	1·36	+0·01
16·66	20·76	1·25	–0·02
9·09	10·37	1·14	–0·06
18·18	22·22	1·22	+0·01
39·39	65·00	1·65	+0·02
66·66	200·00	3·33	+3·60
40·74	68·75	1·68	—
48·14	92·85	1·92	+1·23
25·00	33·33	1·33	–0·06
50·00	100·00	2·00	+0·44

The following example will serve to illustrate application of the method:—

It is desired to reduce 150 gallons of alcohol f 35 O.P. to 20 U.P. The volume of water to be ad to 100 c.c. of alcohol at 135% proof spirit to red it to 80% is given by the formula:—

$$135/80=(x+100)/100$$

whence x = 68·75 c.c.; hence the percentage incr in volume, V, is 68·75. The percentage decreas strength, P, is $[(135-80)/135]\times 100$, or 40·74. Th fore $V/P=68{\cdot}75/40{\cdot}74=1{\cdot}68$.

Applying the expression, $C=3(V/P-1{\cdot}02)$, we $C=3(1{\cdot}68-1{\cdot}02)=3\times 0{\cdot}66=1{\cdot}98$.

Since it is necessary to add 68·75 c.c. of wat 100 c.c. of alcohol, the amount to be added to gallons will be $68{\cdot}75\times 150\div 100=103{\cdot}125$ gal The percentage contraction is 1·98, and the sum the volumes of water and alcohol is 253·125; th fore, the contraction will be $253{\cdot}125\times 1{\cdot}98\div 1$0 5·011 gallons. As this is accurate to within ±0 the loss in volume due to contraction may be ta as 5 gallons. The final volume will therefore be

$$253\tfrac{1}{8}-5=248\tfrac{1}{8}\text{ gallons.}$$

Summary.

1. When alcohol is diluted with water, if the centage increase in volume is represented by V, percentage decrease in strength by P, and the centage contraction by C, then the latter may calculated from the formula:—

$$C=3\ (V/P-1{\cdot}02).$$

2. The values of C, calculated from this form are not reliable when P is over 45%, when V is 90%, or when the ratio V/P is more than 1·90.

When P, V, and V/P lie below these limits, h ever, the calculated values of C do not differ f those found experimentally by more than ±0·06.

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TRANSACTIONS

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LAMINE SALTS OF SOME SULPHONIC ACIDS OF THE BENZENE SERIES.
—BENZENEMONOSULPHONIC ACID.

BY C. M. KEYWORTH, M.Sc., A.I.C.

lamine salts of the naphthalene and anthra-ne series have been studied, notably by Perkin Sewell (J., 1923 27 T), Forster and Keyworth 24, 165 T, 299 T), and by Ambler (J. Ind. Eng. 1920, **12**, 1081) and Lynch (*ibid.*, 1922, **14**, 964). benzene series the arylamine salts have not studied, but alkylamine salts of benzene-luene-sulphonic acids have been prepared by and Westenhoff (Amer. Chem. J., **10**, 129). salts had low melting points and were charac-by their great solubility in water.

arylamine salts of benzenemonosulphonic acid owever, much less soluble in cold water, but the most part, easily soluble in hot water, hich they can be readily recrystallised They arp melting points with but few exceptions. ral they have higher solubilities and lower points than the corresponding arylamine naphthalenesulphonic acids.

erto these sulphonic acids have been identified nversion into the sulphochloride or sulphon-, or by fusing with caustic alkali and identify-e resulting phenol. Their identification can ried out more readily by means of a suitable ine salt. For example, the α- and β-naphthyl- salts of benzenemonosulphonic acid are formed and melt very sharply. Conversely quantities of amines may also be identified benzenemonosulphonic acid, in a similar way use of naphthalenemonosulphonic acids.

general the methods for the preparation of lts are similar to those used by Forster and orth for the preparation of the arylamine of naphthalenesulphonic acids (*loc. cit.*), but arium and calcium salts were mostly employed. ene was sulphonated with concentrated sulphuric at 80° and then allowed to stand 24 hours, the sulphonic acid was converted into the m or barium salt in the usual way. (By this od the amounts of disulphonic acids formed negligible.) Convenient quantities to use for ring salts are from 0·1 to 0·05 g.-mol, but a excess of the amine was found desirable. stallisation from water gave a pure product st cases.

The purity of the salts was checked, as with the lts previously described, by (1) melting point, 2) titration, and (3) solubility. The salts consist of 1 mol. of arylamine to 1 mol. of acid, except in he case of the diamines when they consist of 2 mols. of acid to 1 mol. diamine. The solubilities are expressed as parts per hundred (by weight) of salt dissolved in 100 parts of saturated solution All melting points are corrected.

Aniline benzenemonosulphonate To 24·5 g. of barium benzenesulphonate dissolved in 75 c.c. of hot water, 9·5 g. of aniline and 11 c.c. of concentrated hydrochloric acid were added. On cooling, fine needles were obtained which were easily recrystallised from a small quantity of hot water; m p. 240°. Solubility at 19°, 11·3/100; 0·5696 g required 20·3 c.c. of $N/10$ NaOH = 99·9% of theory.

o-Toluidine benzenemonosulphonate—This salt is very soluble in water and must be prepared in concentrated solutions, when long white needles are obtained, which can be conveniently recrystallised from alcohol: m.p. 176° Solubility 20/100 at 19°; 0·4662 g required 17·4 c.c. of $N/10$ NaOH = 100·2% of theory.

Norton and Westenhoff (*loc. cit.*) mention the aniline, *o*-toluidine, and α-naphthylamine salts of benzenemonosulphonic acid They give the m.p. of the *o*-toluidine salt 137°, and state that it is only sparingly soluble in water.

m - Toluidine benzenemonosulphonate — Beautiful long needles or elongated flat prisms, m p. 173°. Solubility 9·1/100 at 18°; 0·5356 g. required 20·3 c.c. of $N/10$ NaOH = 100·4% of theory.

p-Toluidine benzenemonosulphonate, white needles, m p. 205°, is easily prepared from the barium or calcium salt by the addition to the solution of sulphuric acid and *p*-toluidine. Solubility at 16°, 7·4/100; 0·7182 g. required 27·15 c c of $N/10$ NaOH = 100·2% of theory.

α-Naphthylamine benzenemonosulphonate. — Prepared from a freshly made solution of α-naphthylamine hydrochloride, this salt crystallises in fine white needles, m p. 234°, readily soluble in hot water. Solubility at 14°, 0·77/100; 0·7284 g. required 24·2 c c. of $N/10$ NaOH = 100·0% of theory.

β-Naphthylamine benzenemonosulphonate. — This salt is much less soluble in hot water than the α-naphthylamine salt, and a thick white precipitate is easily obtained on cooling a hot solution. Glistening white plates, m p. 248°. Solubility at 14° 0·59/100; 0·8112 g. required 26·95 c c. of $N/10$ NaOH = 100·0% of theory.

p - Nitro - o - toluidine benzenemonosulphonate.—Pale yellow needles, m.p. 222°. Solubility at 15° 1·84/100; 0·5110 g. required 16·55 c.c. of $N/10$ NaOH = 100·4% of theory.

m - Nitroaniline benzenemonosulphonate.—Yellowish plates, m.p. 236° (decomp.). Solubility at 15° 3·85/100; 0·3718 g. required 12·6 c.c. of $N/10$ NaOH = 100·3% of theory.

m - Xylidine benzenemonosulphonate was somewhat difficult to obtain in the pure state by recrystallisation from water, but it can also be recrystallised from alcohol, m.p. 233°. Solubility at 15° 1·46/100; 0·5832 g. required 20·8 c.c. of $N/10$ NaOH = 99·5% of theory.

Benzidine benzenemonosulphonate.—9 g. of barium benzenesulphonate dissolved in 50 c.c. of hot water were added to 3·7 g. of benzidine dissolved in 5 c.c. of hydrochloric acid and 100 c.c. of water. On cooling only slightly a precipitate was obtained which was recrystallised from 150 c.c. of water; m.p. above 330°. Solubility at 16° 0·59/100; 0·7348 g. required 29·25 c.c. of $N/10$ NaOH = 99·6 of theory (mol. wt. 560).

o - Tolidine benzenemonosulphonate. — Greyish-white plates, readily soluble in hot water, m.p. 310°. Solubility at 15° 1·45/100; 0·2788 g. required 10·55 c.c. of $N/10$ NaOH = 99·9% of theory (mol. wt. 528).

Dianisidine benzenemonosulphonate.—Grey needles, m.p. 277°, were obtained by recrystallising several times, using decolorising carbon (norit). Solubility at 18° 2·11/100; 0·5840 g. required 21·0 c.c. of $N/10$ NaOH = 100·7% of theory.

m-Phenylenediamine benzenemonosulphonate.—Very soluble in water, this salt is difficult to prepare and to recrystallise. Grey flat prisms, m.p. above 320°. Solubility at 17° 19/100.

p-Phenylenediamine benzenemonosulphonate. After decolorising the crude product, colourless glistening plates are readily obtained, which are much less soluble in water than the *m*-phenylenediamine salt, m.p. above 320°. Solubility at 10° 2·57/100; 0·5188 g. required 24·3 c.c. of $N/10$ NaOH = 99·3% of theor (mol. wt. 424).

p-Chloroaniline benzenemonosulphonate.—Readil prepared from aqueous solutions, this salt is easil recrystallised in the form of glistening white plat m.p. 235°. Solubility at 20° 2·51/100; 0·5320 g. re quired 18·55 c.c. of $N/10$ NaOH = 99·6% of theor

o-Chloroaniline benzenemonosulphonate, m.p. 204 is much more soluble in water than the *p*-chlor aniline salt.

ψ-Cumidine benzenemonosulphonate.—Easily re crystallised from water or alcohol, white needles, m. 217°. Solubility at 16° 2·03/100; 0·4944 g. requir 16·85 c.c. of $N/10$ NaOH = 99·9% of theory.

p-Anisidine benzenemonosulphonate.—12·3 g. *p*-anisidine, 17·7 g. of calcium benezenesulphonat 11 c.c. of hydrochloric acid, and 100 c.c. of water gav crystals on standing; on concentrating and r crystallising white needles were obtained, m.p. 182 Solubility at 16° 12·8/100; 0·9170 g. required 32 c.c. of $N/10$ NaOH = 99·8% of theory.

p-Phenetidine benzenemonosulphonate. — 9 g. calcium benzenesulphonate and 7 c.c. of *p*-phenet idine dissolved in 5 c.c. of hydrochloric acid an 40 c.c. of water gave beautiful clusters of needles o standing, which are extremely soluble in hot wate Recrystallised they melted at 171°. Solubility a 17°, 21/100; 0·6984 g. required 23·8 c.c. of $N/10$ NaOH = 100·5% of theory.

The N-substituted arylamines do not readily for salts with benzenemonosulphonic acid. Attempts t prepare the salts of *m*-nitro-*p*-toluidine and *β*-amin anthraquinone failed, whilst basic salts of th diamines could not be obtained in the pure state.

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TRANSACTIONS

Vol. XLIII., No. 49.] [December 5, 1924.

STUDIES IN THE ACENAPHTHENE SERIES. PART I.

4-AMINOACENAPHTHENE.

BY GILBERT T. MORGAN AND H. M. STANLEY.

Acenaphthene, one of the constituents of the higher fractions obtained in the distillation of coal tar, finds a useful application in the synthesis of vat dyes belonging to the Ciba Scarlet series.

A survey of the bibliography of this hydrocarbon shows, however, that comparatively few of its theoretically possible substitution products have so far been described. The mono-substituted derivatives are chiefly those containing substituents in (*para*) position 5, the predominance of this type arising from the orienting influence of the ethylenoid side chain.

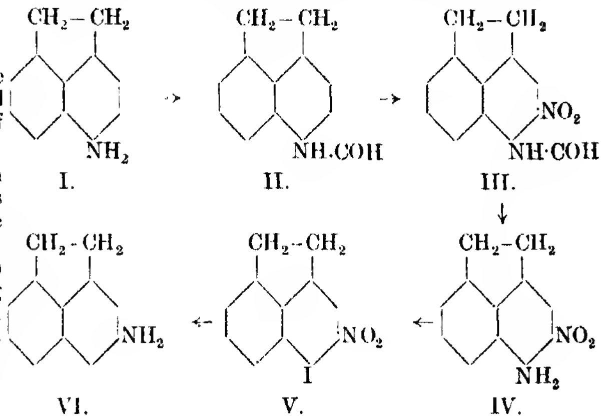
Nitration of the hydrocarbon as studied by Quincke (Ber., 1888, **21**, 1455) and by Graebe (Annalen, 1903, **327**, 77) led to 5-nitroacenaphthene, and reduction of this nitro compound furnished 5-aminoacenaphthene (Sachs and Mosebach, Ber., 1911, **44**, 2852; Fleischer and Schranz, *ibid.*, 1922, **55**, 3253).

Halogenation of acenaphthene follows a parallel course. 5-Bromoacenaphthene was first prepared by Blumenthal (Ber., 1874, **7**, 1095), whereas 5-chloro- and -iodo-acenaphthenes were described by Crompton, Cyriax, and Harrison (Chem. Soc. Proc., 1908, 41; 1910, **26**, 226). These three haloid derivatives were studied in greater detail by Crompton and Walker (Chem. Soc. Trans., 1912, **101**, 958), who established the identity of the chloro and bromo compounds with the corresponding substances obtained by Sachs and Mosebach from 5-aminoacenaphthene through the diazo reaction (Ber., 1910, **43**, 2474).

An important contribution to the chemistry of acenaphthene has recently been made by Dziewoński and Stolyhwo, who have amended earlier views on the constitution of acenaphthene monosulphonic acids (Ber., 1924, **57**, 1531). These investigators have shown that the sulphonic acid produced by the interaction of acenaphthene and chlorosulphonic acid in nitrobenzene is acenaphthene-3-sulphonic acid and not the 1-sulphonic acid as suggested in the patent literature in which this substance was first described (Kalle und Co., D.R.-P. 248,994; Friedländer, XI., 226). They also substantiate the constitution of acenaphthene-5-sulphonic acid, the product obtained in sulphonating with concentrated sulphuric acid by converting this product successively into 6-sulphonaphthalic acid and 6-hydroxynaphthalic acid.

* Read at a meeting of the Birmingham Section on November 11, 1924.

The present communication deals with the production of (*meta-*) *4-aminoacenaphthene* obtained by the operations summarised in the following diagram.



The acyl derivatives of 5-aminoacenaphthene (I.) nitrate in an ortho-position, as was demonstrated by Sachs and Mosebach (Ber., 1911, **44**, 2858), who hydrolysed 4-nitro-5-acetylaminoacenaphthene to 4-nitro-5-aminoacenaphthene and reduced the latter to the corresponding diaminoacenaphthene, which was shown to be an *o*-diamine by condensation with phenanthraquinone and diacetyl to give azino derivatives.

It has now been found that *5-formylaminoacenaphthene* (II.) nitrates smoothly to *4-nitro-5-formylaminoacenaphthene* (III.), which is hydrolysed readily to 4-nitro-5-aminoacenaphthene (IV.). The direct reduction of the diazonium salts of this nitro-amine to 4-nitroacenaphthene is not practicable and only ill-defined amorphous products are obtained.

The exchange of amino group for iodine is, however, readily effected through the diazo reaction, thus giving rise to *5-iodo-4-nitroacenaphthene* (V.). Drastic reduction of this product not only converts the nitro group into an amino radical, but also replaces the iodine by hydrogen, so that *4-aminoacenaphthene* (VI.) is obtained.

An attempt was made to produce 4-aminoacenaphthene by reducing the mononitro derivatives of 5-iodoacenaphthene, but this iodo compound nitrates in a very similar manner to 5-chloroacenaphthene (Farnell, Chem. Soc. Trans., 1923, **123**, 60), since in both cases the main product consists of a halogenated nitroacenaphthene containing the nitro group in the peri position with respect to the halogen. Accordingly drastic reduction of the less fusible *5-iodo-6-nitroacenaphthene* (m.p. 179°—180°) leads to 5-aminoacenaphthene.

The orientation of the nitro group in the more fusible 5-*iodonitroacenaphthene* (m.p. 151°—153°) has not yet been ascertained, although it is probably either in position 3 or 8; position 7 is less likely, as are also the positions 1 and 2 in the ethylenoid side chain.

EXPERIMENTAL.

5-*Aminoacenaphthene and acyl derivatives.*

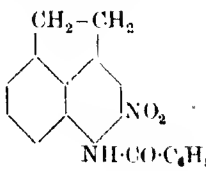
5-Nitroacenaphthene (Sachs and Mosebach, Ber., 1911, **44**, 2852) separated as a yellow crystalline mass on adding slowly 25 c.c. of nitric acid (*d* 1·42) to 25 g. of acenaphthene partially dissolved in 200 c.c. of glacial acetic acid, maintained at 10°. In this quantity of solvent the hydrocarbon dissolved on warming but separated on cooling and stirring as a fine crystalline magma which readily underwent nitration. After crystallisation from alcohol or petroleum the nitro compound melted at 106° (yield 84%).

5-Aminoacenaphthene (Fleischer and Schranz, Ber., 1922, **55**, 3253) was conveniently prepared by adding in two portions 50 g. of crystalline sodium hydrosulphite to 20 g. of 5-nitroacenaphthene dissolved in 200 c.c. of alcohol diluted with 100 c.c. of water, the mixture being boiled for 20 minutes until the yellow colour disappeared. After distilling off the alcohol, 100 c.c. of hot water and 100 c.c. of concentrated hydrochloric acid were added, the residue being boiled repeatedly with further addition of dilute hydrochloric acid. 5-Aminoacenaphthene, which separated on adding ammonia to the combined filtrates, was crystallised from light petroleum, m.p. 108° (yield 70%).

5-Acetylaminoacenaphthene (m p 192°, Sachs and Mosebach, *loc. cit.*) was nitrated to 4-nitro-5-acetylaminoacenaphthene (m.p. 251°) with nitric acid (*d* 1·42) in glacial acetic acid solution, but this product was not completely hydrolysed to 4-nitro-5-aminoacenaphthene even after 12 hours' boiling with alcoholic hydrochloric acid.

5-Benzoylaminoacenaphthene, which crystallised from glacial acetic acid in colourless plates (m p. 211°, Quincke, Ber., 1888, **21**, 1455), was prepared by the Schotten Baumann reaction and nitrated in glacial acetic acid to 4-*nitro-5-benzoylaminoacenaphthene* (VII., pale yellow needles from glacial acetic acid, m.p. 233°, yield 70%), but this product was not hydrolysable by hydrochloric acid even under pressure. The nitro group determined by titanous chloride gave NO_2=14·50; $C_{19}H_{14}O_3N_2$ requires NO_2=14·45%.

This nitrobenzoyl derivative was even more stable than the preceding nitroacetyl compound; it remained unchanged after heating with concentrated alcoholic hydrochloric acid.



VII.

5-*Formylaminoacenaphthene* (formula II.) was produced in almost quantitative yield (93%) by heating 5-aminoacenaphthene with 4 parts of formic acid (90% $H.CO_2H$) under reflux for one hour. After two crystallisations from dilute alcohol the product separated in colourless needles, m.p. 172°: found N=7·23; $C_{13}H_{11}ON$ requires N=7·11%.

4-*Nitro-5-formylaminoacenaphthene* (formula III. crystallised from glacial acetic acid in yellow needles m.p. 227°; it also dissolved in alcohol or chloroform It was prepared by adding 6·5 c.c. of nitric acid (*d* 1·42) to 5·0 g. of 5-formylaminoacenaphthene in 20 c.c. of glacial acetic acid at 10°. Considerable heat was generated and the yellow nitro product separated (yield 66%): found N=11·71 $C_{13}H_{10}O_3N_2$ requires N=11·57%.

4-Nitro-5-aminoacenaphthene (formula IV.) was obtained more readily from the preceding formyl compound than from its other acyl derivatives On heating under reflux 5·0 g. of 4-nitro-5-formylaminoacenaphthene in 75 c.c. of alcohol and 10 c.c of concentrated hydrochloric acid, the hydrolysis was completed in 30 minutes and the nitroamine separated in a state of purity from the dark red solution (yield 92%). 4-Nitro-5-aminoacenaphthene crystallised from alcohol or glacial acetic acid and melted at 219° (*cf.* Sachs and Mosebach, m.p. 222°—224°, *loc. cit.*): found N=13·16; $C_{12}H_{10}O_2N_2$ requires N=13·08%.

This nitro base was diazotised by adding 1·6 g to 8 c.c. of sulphuric acid (85% H_2SO_4) and to the suspension of amine sulphate were added 10 c.c. of glacial acetic acid, when a clear solution was obtained. To this solution cooled to 0°, solid sodium nitrite (0·75 g.) was added with stirring. Pieces of ice were introduced and the red diazo solution was poured into excess of absolute alcohol. On heating to boiling a flocculent red amorphous precipitate separated which did not melt below 270°.

5-*Iodo-4-nitroacenaphthene* (formula V.).—Six grams of 4-nitro-5-aminoacenaphthene suspended in 40 c.c. of 85% sulphuric acid were brought into solution by adding 50 c.c. of glacial acetic acid. After cooling to -5°, sodium nitrite (3·5 g.) and ice (200 g.) were added successively, followed by urea to destroy excess of nitrous acid and 6 g of potassium iodide in 15 c.c. of water. A brownish-grey precipitate separated and the mixture warmed to 70°: nitrogen was evolved and the coagulated solid extracted with boiling alcohol. On cooling, a crystalline product separated, a further amount being deposited on diluting with water (yield 45%).

5-*Iodo-4-nitroacenaphthene*, purified by successive crystallisation from alcohol and light petroleum (b.p. 80°—100°), separated in yellowish pink starlike clusters of needles, m.p. 148°. Insoluble in water sparingly soluble in glacial acetic acid, it dissolves readily in acetone, chloroform, ether or benzene found N=4·53, I=38·8; $C_{12}H_8O_2NI$ requires N=4·32, I=39·04%.

4-*Aminoacenaphthene* (formula VI.).—1. After unsuccessful attempts to reduce 5-iodo-4-nitroacenaphthene with sodium hydrosulphite and with hydrogen passed into alcoholic solution of the nitro compound in presence of finely divided palladium, the following

ocedure led to reduction of the nitro-group accom- nied by elimination of iodine.

Eight grams of 5-iodo-4-nitroacenaphthene, 10—15 g. granulated tin, 100 c.c. of concentrated hydro- loric acid and 100 c.c. of absolute alcohol were ated under reflux for half an hour when the solution came almost decolorised. After distilling off the cohol, the residual solution deposited the sparingly luble 4-aminoacenaphthene stannichloride, from hich ether and excess o. caustic soda removed the ee base.

Picric acid added to the ethereal extract preci- tated the yellow crystalline picrate (yield 60%).

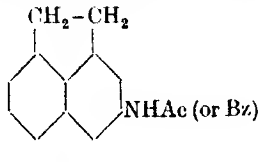
4-*Aminoacenaphthene picrate*, $C_{12}H_9{\cdot}NH_2,C_6H_2(NO_2)_3OH$, when recrystallised from alcohol or etone separated in yellow needles decomposing at 0°—200°. The picric acid content of this and other crates is readily determined by titration with andard sodium hydroxide using acetone as solvent d phenolphthalein as indicator, a small correction ing applied for the slight acidity of the acetone: und picric acid 57·7, C=53·62, H=4·25; $C_{18}H_{14}O_7N_4$ requires picric acid=57·54, C=54·27, =3·52%.

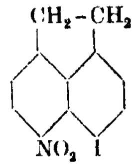
To isolate 4-aminoacenaphthene from its picrate, salt was added in small quantities to aqueous nonia warmed to 100°. After cooling to 0° the s was extracted with equal parts of ether and oleum (b.p. 80°—100°), the extract dried over um sulphate and distilled on the water bath; residual solution of base in petroleum was allowed vaporate until a mass of white crystals separated. product was recrystallised from hot water or alcohol, the former solvent yielding needles the latter giving prismatic needles, m.p. 87°. ninoacenaphthene is very soluble in the volatile nic solvents: found C=84·96, H=6·73, N=8·39; $_{11}$N requires C=85·21, H=6·51, N=8·28%.

dilute mineral acids, 4-aminoacenaphthene otised to an almost colourless diazo solution, by differing from 5-aminoacenaphthene, which liazotisation yields a blue coloration. The new differs also from its isomeride in not developing rations with ferric chloride. Acenaphthene-4- zonium chloride couples with alkaline β-naphthol with resorcinol to red and orange-red azo pigments espectively.

4-*Acetylaminoacenaphthene* (formula VIII.). Dry -aminoacenaphthene (0·8 g.) was heated under reflux with 10 c.c. of acetyl chloride for 15 minutes, the solution poured into water, and the precipitate rystallised repeatedly from dilute alcohol or glacial cetic acid when it separated in colourless prisms, m.p. 175°—176° (yield 60%). Insoluble in water, this derivative dissolves in chloroform or acetone: found N=6·71; $C_{14}H_{13}ON$ requires N=6·64%.

4-*Benzoylaminoacenaphthene* (formula VIII.). One gram of 4-aminoacenaphthene was subjected to the Schotten-Baumann method of benzoylation. The white residue insoluble in water crystallised from 90% acetic acid and separated in prismatic needles, m.p. 196°, and having a faint yellow colour: found N=5·27; $C_{19}H_{15}ON$ requires N=5·13%.


VIII.


IX.

Nitration of 5-iodoacenaphthene. A yield of 60% of 5-iodoacenaphthene was obtained by adding slowly 51 g. of iodine to 30 g. of acenaphthene dissolved in 200 c.c. of hot alcohol containing 45 g. of yellow mercuric oxide. After boiling for 30 minutes the filtered solution and alcoholic washings from mercuric iodide and oxide were combined and cooled, when the crude product separated as a yellow oil which was extracted with chloroform to separate the iodo compound from adherent mercuric iodide. On evaporating off the solvent 5-iodoacenaphthene remained as a brown oil which solidified on cooling and was purified through its crystalline orange-yellow picrate, m.p. 100°, this compound being subsequently decomposed by ammonia (Crompton and Walker, Chem. Soc. Trans., 1912, **101**, 958).

Three c.c. of fuming nitric acid (d=1·50) were added to 10 g. of 5-iodoacenaphthene dissolved in 100 c.c. of glacial acetic acid at 15°, when the solution reddened and yellow crystals began to separate. After three weeks the yield of crystalline crude nitro product was 68%. 25 g. of this material when crystallised fractionally from glacial acetic acid (200 c.c.), yielded 11 g. of nitro compound (A) melting at 174° and 6·8 g. of nitro compound (B) with m.p. 153°.

Product A. 5-*Iodo-6-nitroacenaphthene* (formula IX.) After three additional crystallisations from glacial acetic acid, 7·0 g. were obtained in pale yellow prismatic needles melting at 179°—180°. This isomeride is sparingly soluble in alcohol but dissolves readily in other volatile organic solvents: found N=4·75, I=39·08; $C_{12}H_8O_2NI$ requires N=4·32, I=39·04%.

The orientation of the nitro group in 5-iodo-6-nitro- acenaphthene (m.p. 180°) is demonstrated by the following reduction: The nitro product A (5·5 g.) was heated under reflux for three hours with 150 c.c. of concentrated hydrochloric acid, 180 c.c. of alcohol and 20 g. of granulated tin. After removing alcohol the filtrate was cooled, when a sparingly soluble stanni- chloride separated. This double salt was decomposed with ether and excess of aqueous caustic soda, the ethereal extract of the free amine being treated with picric acid to precipitate the following picrate (yield 80%).

5-*Aminoacenaphthene picrate*, $C_{12}H_9{\cdot}NH_2,C_6H_2(NO_2)_3OH$, which resembled its isomeride (*ante*), was crystallised from alcohol and separated in yellow needles decomposing at 190°—200°: found picric acid=57·3, 57·8, C=54·14, H=3·69; $C_{18}H_{14}O_7N_4$ requires picric acid=57·54, C=54·27, H=3·52%.

When decomposed with aqueous ammonia this picrate yielded 5-aminoacenaphthene, which after crystallisation from hot water melted at 105°—106° (mixed m.p. with standard specimen=106°). Moreover, this preparation of the amine gave the blue colorations on diazotising and on treatment with alcoholic ferric chloride.

Product B. *5-Iodo-?-nitroacenaphthene.* After repeated crystallisations from glacial acetic acid, the more soluble and more fusible product separated in pale yellow needles melting at 151°—153°: found N=4·34, I=39·19; $C_{12}H_8O_2NI$ requires N=4·32, I=39·04%.

The amount of recrystallised compound so far obtained was too small to establish its constitution by reduction. The mixture of the two isomeric nitro compounds A and B forms a two-component system yielding mixed crystals; there is no definite evidence of any eutectic mixture. Although the analytical data point to a mononitro compound, it is doubtful whether this isomeride (m.p. 151°—153°) has been isolated in a completely homogeneous condition; the product is still under examination.

Since nitrated 5-iodoacenaphthenes containing the nitro group in positions 4 and 6 are described above, it follows that the foregoing isomeride must contain its nitro substituent in position 3, 7, or 8, nitration in the saturated side chain being excluded as highly improbable.

The authors desire to express their thanks to the Advisory Council of the Department of Scientific and Industrial Research for a grant which has partly defrayed the expense of this investigation; and also to Messrs. Hardman and Holden, Miles Platting, Manchester, for a generous gift of acenaphthene.

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OBSERVATIONS ON THE HIGHER FATTY ACIDS.*

BY GILBERT T. MORGAN AND ARTHUR R. BOWEN.

I. The higher saturated fatty acids of cacao butter.

The object of this research was an investigation of the acids of cacao butter as a source of eicosanic acid. According to Traub (Arch. Pharm., 1883, **21**, 19—23) and Graf (*ibid.*, 1888, **26**, 830) cacao butter contains arachidic, stearic, palmitic, and lauric acids, but not theobromic acid, $C_{64}H_{128}O_2$, which had previously been reported by Kingzett (Chem. Soc. Trans., 1878, **33**, 38). Subsequently, Hehner and Mitchell (Analyst, 1896, **21**, 318) obtained pure stearic acid by repeated crystallisation in alcohol of the fatty acids from cacao butter. It has recently been shown by Ehrenstein and Stuewer (J. pr. Chem., 1923, (ii), **105**, 199) that arachidic acid derived from arachis oil is in all probability an *iso*docosanic acid, that is, a C_{22} acid having a branched chain, whilst the acid in rambutan tallow (from the seeds of *Nephelium lappaceum* J.) is the normal eicosanic acid (the C_{20} acid with unbranched chain).

Repeated crystallisation of the saturated cacao butter acids from 90% alcohol at 25° resulted in the isolation of pure stearic acid. This acid was also obtained by fractionation of the acids by Heintz's method.

For comparative purposes, pure eicosanic acid was prepared from erucic acid by potash fusion, and the mixed melting points with pure stearic acid were determined. Eicosanic acid was also obtained from rambutan tallow (Ceylon) and arachidic acid from arachis oil.

Saponification of cacao butter.—1 kg. of filtered cacao butter, 4 litres of absolute alcohol, and 500 g. of caustic potash in 2 litres of water were heated together under a reflux condenser in a copper vessel for four hours. After saponification, as much alcohol as possible was distilled off and the free acids were precipitated by the addition of a slight excess of 8*N*-sulphuric acid. At 50°—60° these acids separated as a pale yellow supernatant layer. The characteristic odour of cacao butter was retained after saponification. The free fatty acids were washed free from mineral acid, dried at 100°, and filtered.

Separation of saturated from unsaturated acids.—The saturated acids were separated from the unsaturated by means of the magnesium soap–alcohol method (Kerr, J. Ind. Eng. Chem., 1916, **8**, 904; Thomas and Yu, J. Amer. Chem. Soc., 1923, **45** (i), 113). Magnesium acetate (100 g.) was dissolved in 200 c.c. of boiling water, the solution filtered, coo[illegible] and mixed with three volumes of 95% alco[illegible]ate. One part of insoluble mixed fatty acids from c[illegible] butter was added to five parts (by volume) of [illegible] hot alcoholic magnesium acetate. The solu[illegible] was left overnight at room temperature, when [illegible] insoluble magnesium soaps were collected and wash[illegible] with cold absolute alcohol until free from magnesi[illegible] acetate. On decomposition with hydrochloric [illegible] these magnesium soaps yielded the fatty a[illegible] which after washing free from magnesium chlo[illegible] were dried at 100°.

Attempted separation of eicosanic acid from satur[illegible] cacao butter acids by recrystallisation from alc[illegible] at 25°. The saturated fatty acids from cacao but[illegible] (93 g.) recrystallised eight times from 90% alco[illegible] cooled to 25° gave 0·3 g. of acid, m.p. (Knap[illegible] method) 69·0°; mixed m.p. with stearic acid 69·0[illegible] Molecular weight by titration with *N*/10 alcohol[illegible] potash (1 c.c.= 0·006561 g. KOH): 0·0960 g. [illegible] acid required 2·90 c.c. of *N*/10 alcoholic potash: found M=282·6, $C_{18}H_{36}O_2$ requires M=284.

Fractionation of saturated cacao butter acids.

First fractionation.—The fatty acids of highest carbon content are the first to be separated by Heintz's method, which involves the fractional precipitation of their magnesium soaps by adding hot alcoholic magnesium acetate to an alcoholic solution of the fatty acids (J. pr. Chem., 1855, (i), **66**, 1). In this fractionation, 166 g. of saturated acids from cacao butter were dissolved in 500 c.c.

* Read at a meeting of the Birmingham Section on November 11, 1924.

f hot absolute alcohol and precipitated fractionally .y half the calculated amount of alcoholic magnesium ·etate. The precipitated magnesium soap was ›llected and the foregoing operation repeated five mes; the fatty acid thus obtained was thrice crys- ıllised from alcohol, when three grams of acid were ›tained melting at 69·0°. A mixed melting point ıth stearic acid was unchanged, whereas with cosanic acid the mixed melting point was 64°—67°.

Second fractionation.—In this fractionation, smaller ·antities (30 g.) of saturated fatty acids from cacao ·tter were used with 1½ litres of alcohol. Less ·oholic magnesium acetate was added than in the ·st fractionation, so that only about one-fifth of the ·ids were precipitated at each stage. The precipi- ·tion was carried out in duplicate and the small ·al fractions were combined; 0·3 g. of least soluble ·id was obtained from 60 g. of saturated acids. ·he melting point of this fraction was 68·5° and ·ixed melting point with stearic acid 68·5°, although ·e mixed melting point with eicosanic acid gave ·1 5°.

Preparation of n-*eicosanic acid.*

1. *From erucic acid* (Fitz, Ber., 1871, 4, 444).—›otassium erucate (40 g.) was fused with 114 g. f caustic potash and a little water at 310—320° ›r ¾-hour. The acid was separated as magnesium ılt; weight of crude acid, 26 g. After repeated ·ystallisation from petroleum (b.p. 80°—100°), ·e eicosanic acid (12 g.) melted at 75°; its methyl ·r melted at 46·5° and ethyl ester at 41·5°. Mole- · weight by titration gave M=311·3 · $C_{20}H_{40}O_2$ ·res M=312.

·*ced melting points of eicosanic acid stearic acid* ·*res.*—About 0·5 g. of the acids was melted, ·l, and allowed to solidify overnight in the ·cator. The melting points were then taken by ·p's method (J., 1915, 1121):—

·anic ·. ·$_{40}O_2$.	Stearic acid. $C_{18}H_{36}O_2$. %	m.p. °	Eicosanic acid. $C_{20}H_{40}O_2$. %	Stearic acid. $C_{18}H_{36}O_2$. %	m.p. °
	0	75·0	45	55	63·5
	20	70·5	40	60	63 3
	25	69·0	33·3	66 7	62·7
7	33 3	67·0	25	75	62·3
	40	64 5	20	80	63·5
5	47 5	63·5	9 8	90·2	66·7
	50	63 5	0	100	69 0

From rambutan tallow.—Rambutan tallow ·) was hydrolysed for four hours with 188 g. ›solute alcohol and 126 g. of 25% aqueous ·ic potash. The acids liberated with dilute ·lphuric acid were dried at 100°. The saturated ·cids were separated by the foregoing magnesium ·ap method; 42 g. of fatty acid were heated to ·iling with 250 c.c. of alcoholic magnesium acetate. ·he precipitated magnesium soap was decomposed ·th dilute hydrochloric acid, washed, and recrystal- ·ed from alcohol. This acid, which was still slightly ·llow, was decolorised by boiling with animal ·arcoal in petroleum (b.p. 80°—100°). The colour- ·s acid was recrystallised four times from light ·troleum: First crop, 0·7 g., m.p. 74·5°; second ·op, 6·0 g., m.p. 74°; third crop, 6·0 g., m.p. 68·5°. ·ethyl ester of acid from first crop, m.p. 45·5°.

Preparation of arachidic acid from arachis oil.—Arachis oil (50 g.) was worked up as in the case of cacao butter and rambutan tallow and the saturated fatty acids were separated as magnesium soaps. After four recrystallisations from light petroleum, the fatty acid (weight=1·5 g.) melted at 74°; mixed m.p. with n-eicosanic acid=67°—68°.

Summary.

The investigation was commenced in order to ascertain whether cacao butter could be used as a source of eicosanic acid, but fractional crystallisation of the free acids and fractional precipitation of their magnesium soaps did not lead to the isolation of any acid higher than stearic acid.

II. The existence of bimolecular complexes of the higher saturated fatty acids.

The melting points for the eicosanic acid–stearic acid mixtures were plotted against the percentage composition and the curve, Fig. 1, obtained. This type of curve indicates compound formation, in this case the bimolecular complex, 1 molecule eicosanic acid : 1 molecule stearic acid (composition =52·4% $C_{20}H_{40}O_2$, 47·6% $C_{18}H_{36}O_2$).

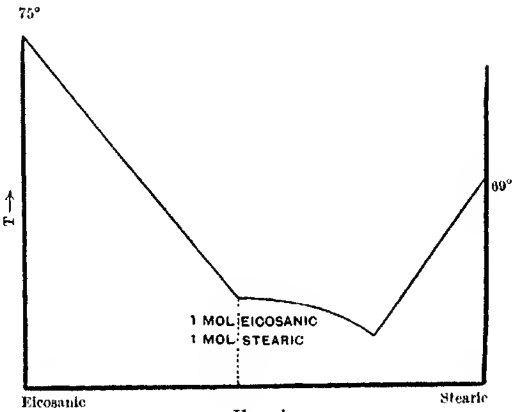

FIG. 1.
n-Eicosanic acid : stearic acid.

The corresponding stearic acid : palmitic acid curve was studied by de Visser (Rec. Trav. chim., 1898, 17, 182), who determined the melting points of mixtures of stearic and palmitic acids with a great degree of accuracy. Large quantities (50 g.) of the mixtures were used, and heated and cooled with stirring, the points of solidification giving the curve, Fig. 2. From this curve de Visser deduced that mixed crystals were formed in the vicinity of the 50% mixture. There is, however, no foundation for this conclusion, as the curve clearly shows compound formation (1 mol. stearic acid : 1 mol. palmitic acid). He also finds (*ibid.*, 346) that the composition of a mixture of the two acids in the proportion 47·5% stearic acid : 52·5% palmitic acid is unchanged on recrystallisation from alcohol and thus acts as a chemical entity.

Further determinations of melting points of fatty acid mixtures are given by Meyer, Brod, and Soyka

in their research on lignoceric acid (Monatsh, 1913, **34**, 1127) and by Meyer and Beer working on earth nut oil (*ibid*, 1202).

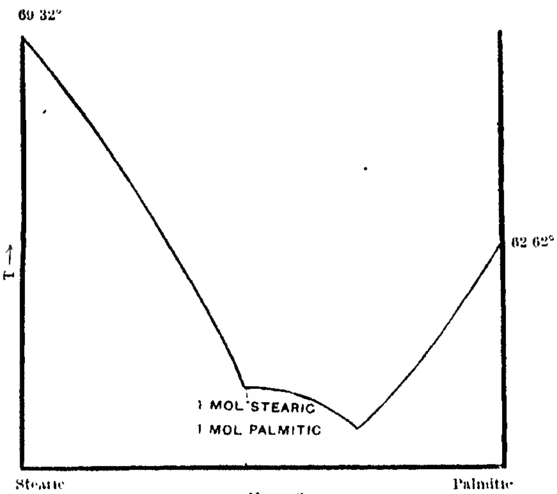

FIG. 2

Stearic acid: palmitic acid (De Visser).

Thus it will be seen that most of the examples of binary higher saturated fatty acid mixtures indicate marked evidence of compound formation usually of the type 1 mol. A : 1 mol. B, the amount of dissociation of these compounds at their melt points being considerable. It will, therefore, impossible to separate the 50% mixtures of su acids by fractional crystallisation, and the compour with their constant melting points and molecu weights will appear as chemical entities by t usual purity criteria. This is a point of gre importance in the identification of naturally-occurri higher fatty acids of both odd and even number carbon atoms. Holde (Ber., 1905, **38**, 1247) h shown that certain alleged instances of natura occurring heptadecylic acids are in reality mixtu of acids of even number of carbon atoms. In th connexion it is interesting to note that Müller a Shearer (Chem. Soc. Trans., 1923, **123**, 3156) ha also indicated that the higher fatty acids themselv are bimolecular, two chemical molecules constituti one crystal molecule. This result is confirmed the recent work of W. E. Garner and Randall on t heats of crystallisation of the normal monoba fatty acids (Chem. Soc. Trans., 1924, **125**, 881).

The authors desire to express their thanks to t Advisory Council of the Department of Scienti and Industrial Research for a grant which h partly defrayed the expense of this research; Messrs. Cadbury Brothers for a generous gift cacao butter; and to Mr. Petch, the Acting Direct of Agriculture, and Mr. Gadd, Peradeniya, Ceylo for the preparation of a sample of rambutan tallo

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NOTE ON "TEMPER" COLOURS.

BY R. C. GALE, A.C.G.I., A.I.C.

It is well known that when a piece of polished rdened steel is "tempered" by reheating, the heating is accompanied by the formation of a uence of coloured oxide films or "temper ours" on the surface of the metal. These colours y with the time of heating and with the tem- ature to which the metal is heated.

The observation of this phenomenon is a matter some antiquity; in the French translation[1] of inguccio's "De la Pirotechnia"[2] by Jacques ncent in 1556, the colours are described ". . . premiere desquelles a apparence blanche pour son dequoz il est appello argent. La seconde est jaune, est appelle d'aure. La tierce qui azuree, est nommee violet. Et la quatriesme de couleur cendree."

Robert Boyle[3] in 1680 writes: ". . . the Steel is hardened, will, if it be good, look somewhat hite, and must be made bright at the end, that change of Colours may be there conspicuous, l then holding it in the flame of a Candle . . . shall after a while see that clean end, which is contiguous to the flame, pass very nimbly ne Colour to another, as from a brighter , to a deeper or reddish Yellow, which arti- call a *sanguine*, and from that to a fainter nd then a deeper Blew." In a later chapter same work,[4] he observes ". . . touching the and Red and Yellow, that may be produc'd a piece of temper'd Steel: for these Colours h they be very Vivid, yet if you break the hey adorn, they will appear to be but Super- not only the innermost parts of the Metal, hose that are within a hair's breadth of the icies, having not any of these Colours, but ng that of the Steel itself."

ad[5] in 1900 showed that the colour of the film pendent on the nature of the substance, the perature of heating, and the time of heating, made use of these facts in differentiating between all areas of different constituents in pieces of lished metal, thus originating the method of heat tinting" now well known to metallographers.

Guillet and Portevin[6] in 1909 showed that for y given temperature, the colour developed tended become independent of time after a long period heating, further heating causing no change.

The possible explanations of the cause of colour the films are three:—

(1) Inherent colour of the oxide.
(2) Interference in the oxide film causing interference as in the case of Newton's rings and soap films.
(3) Diffraction of the incident light by the granular or laminated structure of the oxide film.

The first explanation is ruled out by the fact that the colour change does not take place at a definite temperature, and is not due to polymorphic change, *e.g.*, the mercurous iodide change red $\rightleftarrows$ yellow at 126°.

The two latter explanations have both been advanced in recent years.

Mallock[7] states that the colour cannot be due to interference, since it is not altered on reduction of thickness by polishing, this statement being quoted by Hinshelwood.[8]

This is contrary to the author's experience, who found that a dark blue film, purples and yellows were produced on polishing. It is not clear whether this is due to simple reduction of thickness, or to an irregular disturbance of the oxide film. Further work is in progress to clear up this point.

Hinshelwood[8] states that in the case of oxide films on copper, the colour is independent of the thickness of the film, and is probably due to diffraction of the incident light by the granular structure of the oxide.

Tammann[9] has investigated the rate of formation of coloured films produced by exposing metals to the action of air, nitrogen, halogens, etc., assuming that the thickness of the film of metallic compound formed is related to that of an air film of the same colour by the expression $T_A/T_M = \mu$, where T_A is thickness of the air film, T_M the thickness of the metallic compound film, and μ the refractive index of the metallic compound.

The apparently irreconcilable nature of the two latter explanations led the author to carry out the following preliminary experiments on the formation of temper colours on steel heated in air.

The primary object of the work was to determine the weight of the film formed by heating steel foil of known weight and area to a definite colour, and hence to deduce the thickness of the film and the ratio of its thickness to that of an oxide film of the same colour.

1. *Preparation of colour scale.*—A scale of colours was first prepared by heating mild steel discs $\frac{1}{4}$ in. by $\frac{3}{4}$ in. diameter, previously smoothed down to 0000 Hubert emery paper, in a molten tin bath for a period of one minute. The tin was contained in a steel tube $10 \times 1\frac{1}{2} \times \frac{1}{16}$ in. thick, sealed at the lower end, and immersed in a bath of stirred molten

[1] "De la Pirothecnie," Paris, 1556, p. 202.
[2] "De la Pirotechnia," Venice, 1540, p. 137.
[3] "Experiments and Considerations touching Colours," 1680, p. 6.
[4] *ibid.*, p. 23.
[5] J. Iron and Steel Inst., 1900, ii., 139.
[6] Rev. Mét., 1909, 6, 102.

[7] Proc. Roy. Soc., 1918, 94A, 561.
[8] *ibid.*, 102A, 318.
[9] Z. anorg. Chem., 1921, 111, 78; 1922, 123, 196; 124, 25. Rec. Trav. chim., 1923, 42, 547.

potassium and sodium nitrates in equal weights. This bath was well lagged with asbestos wool and board, and heated by a gas burner. The temperature was gradually raised from 240° to 360° (uncorr.) in steps of about 5°, a steel disc being half immersed in the molten tin at each 5° increase of temperature.

This gave a series of colours varying from the palest yellow, through brownish-yellow to reddish-yellow, purple, blue, pale blue, and grey, some of the adjacent discs not differing perceptibly in colour or shade.

A series was then selected in which the differences in colour or shade between adjacent discs was sufficiently well marked to be used as a scale for comparison purposes, the discs then being numbered in sequence (see Table V.).

2. *Determination of the increase in weight of steel due to the formation of temper colours.*

Series I.—The material used was cold-rolled steel strip 0·0102× 7·5 cm. This was smoothed down to grade 0000 Hubert emery paper, cut into strips about 2×7·5 cm., and coiled into spirals by wrapping round a thin glass rod. The spirals were then washed with dry ether over lime in a Soxhlet extractor for 4 hours, about 30 washes being given. They were dried in a water oven at 98° for 1 hour, and cooled over phosphoric oxide in a desiccator.

Weighings were made on an Oertling assay balance, the spiral being counterpoised by gilt and platinum weights on the right-hand pan, a centigram rider on the left-hand beam, and a milligram rider on the right-hand beam. The position of the zero point was then determined by swings, using the formula $L=\frac{1}{8}(l_1+3l_2+3l_3+l_4)$, where l_1, l_2, l_3, and l_4 are consecutive readings on the pointer scale. A large number of readings was taken (about 25 releases), the zero points plotted against time, and the zero point estimated by extrapolation to the vertical axis. This was necessary owing to the increase in weight taking place as weighing proceeded, possibly due to the absorption of moisture on the surface of the metal, this surface being large compared with that of the counterpoise weights.

The spiral was then heated in an electric oven to 220° until a colour developed, re-weighed as before, and the colour matched by comparison with the colour scale.

These operations were repeated for three different colours, the results being summarised in Table I.

Weight of spiral, 1·2762 g.; density, 7·84 g. per c.c.; thickness, 0·0102 cm.; area, 31·9 sq. cm.

TABLE I.

Zero point.	Difference.	Colour.	Increase in weight. g. per 31·9 sq. cm.	Increase in weight. mg. per sq. m.
40	—	—	—	—
35·7	4·3	2	0·000036	11·3
33·9	6·1	6	0·000051	16·1
29·8	10·2	10	0·000086	26·9

Sensitivity of balance: 1 division on scale = 0·0000084 g.

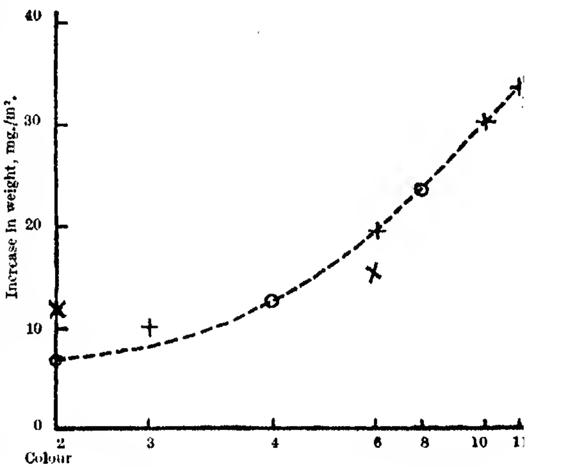
Series II.—A further series of weighings was made with the object of obtaining greater uniformity of weighings than in Series I. This was attained by taring two spirals and using one as a counterpoise throughout the series of weighings and heatings, the variations in weight during weighings being much less than in Series I. After heat-tinting one spira both were then heated *in vacuo* at 180° for 10 minute and cooled in a desiccator over phosphoric oxide fo half an hour before weighing.

Weight of spiral, 1·075 g.; density, 7·84 g. per c.c thickness, 0·0102 cm.; area, 26·9 sq. cm.

TABLE II.

Zero point.	Difference.	Colour.	Increase in weight. g. per 26·9 sq. cm.	Increase in weight. mg. per sq. m.
32·8	—	—	—	—
36·0	3·2	3	0·000027	10·0
39·0	6·2	6	0·000052	19·4
43·6	10·8	11	0·000091	33·7

Series III.—In this series of weighings steel stri 0·00254 cm. thick was used, prepared as in Series and II. The weighings were made on an Oertlin micro-analytical balance, equilibrium being obtaine by the use of riders as before. Owing to the greate increases in weight obtained, it was found possib to use the movement of the milligram rider on th right-hand beam as a means of approximating t equilibrium, the exact zero points then being dete mined by swings and plotted as before. An increa in the weight of the heated spiral during weig was observed.



Series.	Colour.	mg./m².
I.	2	11·3
× × ×	6	16·1
	10	26·9
II.	3	10·0
+ + +	6	19·4
	11	33·7
III.	2	6·6
• • •	4	12·5
	8	23·2

FIG. 1.

The spirals were heated *in vacuo* for half an ho at 150° before cooling and weighing.

Weight of spiral, 2·702 g.; density, 7·84 g. per c.c thickness, 0·00254 cm.; area, 271·4 sq. cm.

TABLE III.

Colour.	Increase in weight. g. per 271·4 sq. cm.	Increase in weight. mg. per sq. m.
2	0·00018	6·6
4	0·00034	12·5
8	0·00063	23·2

Sensitivity of balance: 1 division on scale = 0·000025 g.

On the basis of these weighings, a calculation of the ickness of the films was made, assuming that they nsist of ferric oxide of density=5·25 g. per c.c.

TABLE IV.

ncrease in weight lue to oxidation. per m.	g. per sq. cm. = W_1.	Weight of ferric oxide in g. per sq. cm. $W_1 \times \frac{159 \cdot 6}{48} = W_2$.	Thickness of film in cm. $= \frac{W_2}{5 \cdot 25}$	Colour no.	Series.
3	0·00000113	0·00000376	0·00000072	2	I.
6	0·00000066	0·000002[illegible]0	0·00000042	2	III.
0	0·00000100	0·000003[illegible]	0·00000063	3	II.
5	0·00000125	0·00000416	0·00000079	4	III.
1	0·00000161	0·00000536	0·00000102	6	I.
4	0·00000194	0·00000645	0·00000123	6	II.
2	0·00000232	0·00000772	0·00000147	8	III.
9	0·00000269	0·00000805	0·00000170	10	I.
7	0·00000337	0·00001120	0·00000213	11	II.

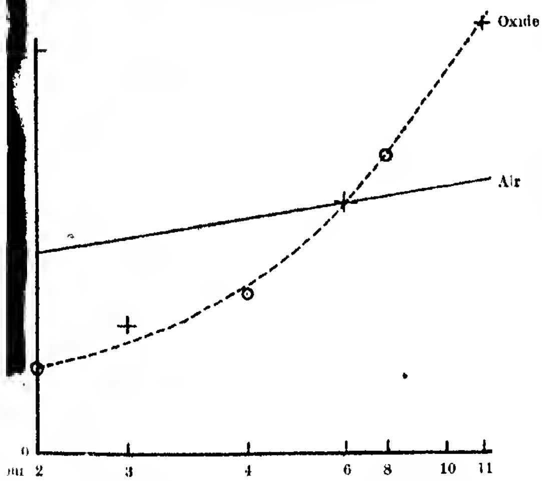
The thicknesses of air films of different colours are, cording to A. Rollett[10] :—

TABLE V.

Colour	Colour no.	Thickness in cm.
	1	—
Brownish-white	2	0·00000100
Bright brown	3	0·00000107
Dark brown	4	0·00000116
—	5	—
Red brown	6	0·00000124
—	7	—
—	8	0·00000127*
Dark purple	9	0·00000129
—	10	0·00000132*
Dark violet	11	0·00000135
Dark blue	12	0·00000140
Darker blue	12	0·00000164
Still darker blue	13	0·00000235
Pale blue green	14	0·00000245
—	15	—

* Interpolated.

e results of weighings are plotted in Fig. 1, points in Series I. corresponding to Colours 2 being neglected in subsequent curves.



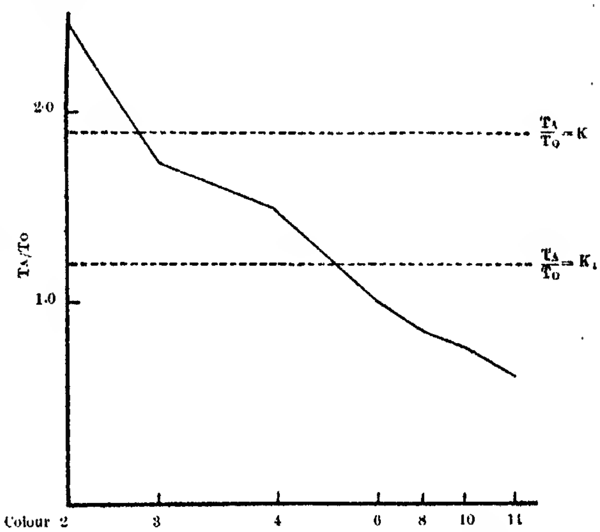
Oxide thickness, cm.	Colour	Air thickness, cm.
0·00000042	2	0·00000100
0·00000063	3	0·00000107
0·00000079	4	0·00000116
0·00000123	6	0·00000124
0·00000147	8	0·00000127*
0·00000170	10	0·00000132*
0·00000213	11	0·00000135

* Interpolated.

FIG. 2.

[10] Wien, Ber., 1878, 77 (3), 177 ; see also Landolt's "Tabellen," 3rd ed., 610.

Fig. 2 shows the relative thicknesses of the air and oxide films, the colour scale being spaced to correspond with equal increments of thickness of an air film.



Colour.	$\frac{T_{air}}{T_{oxide}}$	Colour.	$\frac{T_{air}}{T_{oxide}}$
2	2·38	8	0·86
3	1·70	10	0·78
4	1·47	11	0·63
6	1·01		

FIG. 3.

Fig. 3 shows the ratios of thickness of air films to the thickness of oxide films of the same colour.

Summary and conclusions.

1. The thicknesses of "temper" colour films on steel have been determined by direct weighing, assuming that the density of the film is 5·25 g. per c.c. These vary from $4 \cdot 2 \times 10^{-7}$ cm. for a pale straw colour to $21 \cdot 3 \times 10^{-7}$ cm. for a dark purple.

2. For temper colours on steel, the ratio $T_{air}/T_{oxide} = \mu$ is not a constant for all colours, as assumed in Tammann's experiments, and therefore cannot be used to express the thickness of oxide films in terms of the thickness of air films of the same colour.

3. If the temper colours on steel are due to interference, it is necessary to assume that the refractive index of the film varies from 2·53 in the case of a pale straw colour to 0·63 in the case of a dark violet colour.

4. The fact that a blue film may develop purples and yellows when polished does not prove that the colours are due to interference, and further experiments are in progress to clear up this point.

5. The heat-tinted spirals increase in weight more rapidly than the unheated counterpoises when weighed in moist air. This supports the view that the film is granular in structure and is not an interference film.

The thanks of the author are due to Sir T. K. Rose, of the Royal Mint, for the loan of the balance used for Series I. and II. weighings, to Messrs. Jessops, and Messrs. Kayser, Ellison, of Sheffield, for the supply of the steel foil used in the experiments, and to the Commandant, Artillery College, for permission to publish these results.

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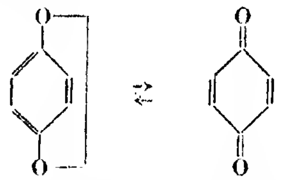
BACTERICIDAL ACTION OF QUINONES AND ALLIED COMPOUNDS.

BY GILBERT T. MORGAN AND E. ASHLEY COOPER.

In a previous paper (Biochem. J., 1921, **15**, 587), describing the bactericidal action of certain quinones, the authors suggested that the high germicidal power of benzoquinone was associated with the property of dynamic isomerism and due to the activity of the nascent peroxide molecules present in aqueous solutions.



Thus, although in the case of many groups of organic compounds, bactericidal power increases as the homologous series is ascended, the opposite was found to hold in the case of the quinones, *p*-benzoquinone being far more efficacious in this respect than the higher members of the series.

Further researches on this subject with A. W. Burtt and F. J. Corby are recorded in the present communication.

Influence of time on the relative germicidal power of the quinones.

The phenol coefficients of *p*-benzoquinone and toluquinone were first determined by the Chick–Martin method at 20°, with varying periods of disinfection :—

TABLE I.

Organism.	Substance.	Phenol coefficients. ½ hr.	1 hr.	3 hrs
B. typhosus	*p*-Benzoquinone	204	1400	>2750.
B. typhosus	Toluquinone	23	83	—
Staph. py. aur.	*p*-Benzoquinone	11	21	—

The results show that the bactericidal power of the quinones increases relatively to that of phenol when the period of disinfection is extended, coefficients of the unusual magnitude of 1000—3000 being obtained. It is thus of great importance to study the time-factor very carefully in these investigations.

Bactericidal power of various quinones and their derivatives.

The phenol coefficients were first determined with *B. coli communis* in absence of organic matter at 20°.

Bactericidal power was also determined another experimental method. It is well known t quinones react with proteoses and amino-ac and hence it was thought possible that suffici organic matter was carried over with a drop culture to affect the germicidal power of the quin solutions, as has been shown by Cooper, Woodhou and Forstner (unpublished work) in the case aldehydes, organic acids, and nitroso compounds.

The culture was therefore diluted with ste salt solution (0·85%) and a Chick–Martin t performed with this diluted culture. A gr difference in the results was obtained. With creasing dilution of the cultural organic mat there was a gradual increase in the germicidal pow of the quinone, until a certain limiting dilut had been reached, after which no further change the germicidal power was observed. To test whetl the consequent diminution in the number of orga isms present affected the results, the culture w diluted with sterile broth instead of with ster salt solution; the immediate effect was to low the germicidal power to its original value, showi that the disturbing factor was the organic mat present. The quinones to be compared were tested in this manner, and it was found that diluti of the culture 100 times was sufficient in each ca The main result of the observations is that t quinones retained approximately the same order regards germicidal power as when normal bro culture was employed, but the actual phenol c efficients were consistently much greater in magnitu A similar effect was observed when *B. pyocyane* was used in place of the *B. coli*, showing that t nature of the bacillus did not affect the change.

TABLE II.

Compound.	Coeff. at 20°, normal culture, ½-hour test.	Coeff. at 37°, culture dil. 100, 1-hour test. [With F. J. Corb
p-Benzoquinone	268	8650
Toluquinone	52	1710
Xyloquinone	< 20	296
Thymoquinone	< 20	356
m-Dichloroquinone	936	2620
Trichloroquinone	< 367	4130
Chloranilic acid	83·6	194·5
Sodium chloranilate	< 5·5	6·0
Bromanilic acid	—	216
α-Naphthaquinone	83	88·5
β-Naphthaquinone	104	663
Quinhydrone	—	517
Camphorquinone	Satd. soln. failed to disinfect.	1·6
Monochlorobenzoquinone	Satd. soln. failed to disinfect.	
p-Dichlorobenzoquinone	Satd. soln. failed to disinfect.	
p-Dibromobenzoquinone	Satd. soln. failed to disinfect.	

The following conclusions may be drawn fro the foregoing results :—

(1) Of all the quinones examined, *p*-benzoquinon is the most powerful.

(2) Camphorquinone, which is fully saturate and should not therefore exhibit the propert of dynamic isomerism, has a very low germ cidal power.

(3) The introduction of various substituents int the benzene ring results in a diminution i germicidal power (except in the case of *m*-d chloroquinone with ordinary culture).

With the phenols, however, bactericidal power i consistently increased by the substitution of haloge

hrlich and Bechhold, Z. physiol. Chem., 1906, 47, 3; Cooper and Woodhouse, Biochem. J., 1923, , 600), and in the case of phenols, alcohols, and nines also by the introduction of alkyl groups Iorgan and Cooper, 8th Int. Cong. Appl. Chem., 912, 19, 243). Again, 2.3-dihydroxynaphthalene is nsiderably more efficacious than pyrocatechol (*loc.* *t.*, 1912), whilst the naphthaquinones are less potent ian benzoquinone.

The effect of substitution in the case of *p*-benzo-uinone is thus in many cases quite anomalous, and he probable explanation is that its homologues nd other derivatives are less reactive and exhibit ynamic isomerism to a less degree (Kehrmann, er., 1888, 21, 3315; Stewart and Baly, Chem. oc. Trans., 1906, 89, 618).

(4) β-Naphthaquinone possesses a higher germicidal power than the isomeric α-compound.
(5) Bromanilic acid has a slightly greater activity than chloranilic acid.
(6) The germicidal power of chloranilic acid is greatly reduced by conversion into its sodium salt.
(7) The chloroquinones are more active as germicides than the alkyl derivatives (or homologues) of *p*-benzoquinone. As halogen substitution is known to be more effective than alkyl groups in diminishing the chemical reactivity of quinone, the abnormally high bactericidal power of the chloroquinones must be associated with a specific enhancement due to combined halogen, which easily counterbalances the depreciating effect of diminished tautomerism.

[With A. W. Burtt.] The exceptionally high ictericidal power of halogenated quinones is indi-ited by some further tests in which *B. pyocyaneus* s used. The coefficients obtained were as ws: benzoquinone, 15·6; toluquinone, <4·3; chloroquinone, 5·1. In this case the of halogen substitution is less marked, but with these results the halogen derivative is active than toluquinone, although halogen ituents reduce the chemical reactivity of nzoquinone to a greater extent than alkyl s. Further investigations with other organisms d be of interest. Incidentally, it may be observed t *B. pyocyaneus* resembles *Staphylococcus* in its ich greater resistance to the quinones than organ-ms of the coliform group (*cf.* Table I.).

Inhibitory power of the quinones.

Inhibitory power was determined with *B. coli communis* at 37° by the method described by the uthors (Biochem. J., 1923, 17, 30). The phenol coefficients of various compounds are tabulated below:—

TABLE III.

Phenol coefficients (48 hours' test).

p-Benzoquinone ..	35	*m*-Dichloroquinone ..	13
Toluquinone	27	Chloranilic acid ..	4·6
p-Xyloquinone ..	27	Benzoquinhydrone ..	97
Thymoquinone ..	11	α-Naphthaquinone ..	23
		β-Naphthaquinone ..	25

It is seen that the results obtained by the short-period disinfection test (Table II.) and the inhibitory method are entirely different, the compounds being consistently less active when tested by the inhibitory method. Whilst also the bactericidal power of benzoquinone is much greater than that of its homologues, the inhibitory powers approximate more closely. An extension of the period of disinfection, on the other hand, has already been shown to increase the difference in bactericidal action between *p*-benzoquinone and toluquinone, so that the relatively low inhibitory power of *p*-benzoquinone is probably due to its selective action on the constituents of the peptone broth.

Benzoquinhydrone is shown to be much more efficacious as an inhibitor than quinone itself. Probably the quinone is prevented from rapidly reacting with the peptone when in combination with quinol, and thus after adsorption is liberated within the bacterial cells in the active state available for disinfection. The quinhydrone may therefore be regarded as a quinone-carrier.

m-Dichloroquinone, although sometimes more active in the absence of organic matter than quinone itself, possesses a much smaller inhibitory power, and is unlikely to be of use for disinfecting purposes when organic matter is present.

Again, β-naphthaquinone is more efficacious as a germicide than the α-isomeride, but owing apparently to selective action of the β-compound upon the organic matter in the culture medium, the inhibitory powers of the two compounds are almost the same. This is confirmed by the results in Table II., which show that the α-compound is much less affected in germicidal power by dilution of cultural organic matter than the β-isomeride.

The inhibitory powers of *p*-benzoquinone and toluquinone have also been determined in other culture media as follows:—

TABLE IV.

Inhibitory phenol coefficients, *B. coli communis*.

	Benzoquinone.	Toluquinone.
Peptone broth	40	22
Peptone water (2%)	48	28
Urine	58	22
Ox-serum (heated 56°)	54	44
(Germicidal power, Chick–Martin test, in absence of organic matter)	6650	1710

In each case the coefficients are much lower than those obtained by the Chick–Martin test in absence of organic matter, indicating that the quinones are unlikely to be of service as internal disinfectants. There is also a relatively close similarity in the inhibitory powers of benzoquinone and toluquinone, especially in the case of serum, contrasting with the wider divergence in the germicidal power as determined by the Chick–Martin method.

The above observations suggest that there are substances present in the various media, either identical with or analogous to the vital cell constituents, with which the quinones react during the process of disinfection. These substances are present, principally in serum, and to a lesser degree in urine and peptone-broth. Further researches on these lines, employing for culture-media solutions of substances of known composition, should throw light on the

nature of the cell-constituents fundamental to vital phenomena.

[With A. W. Burtt and F. J. Corby.] *The action of quinones on proteins.*—The quinones, particularly *p*-benzoquinone, have been shown to react readily with proteins and allied substances, imparting a deep red colour to them (Cooper, Biochem. J., 1913, 7, 186). Gelatin when immersed in a solution of *p*-benzoquinone became permanently red and insoluble in water. The colour reaction diminished in intensity as the homologous series of quinones was ascended. Quinol was also found to be a product of the reaction, which supports the view that peroxide molecules of *p*-benzoquinone are especially involved in the chemical change.

Morgan and Cooper (1921) conducted further experiments with various proteins, and showed that *p*-benzoquinone was slowly removed from solution by proteins, a chemical action apparently taking place which proceeded continuously for several weeks.

Experiments to compare the rate of chemical action of *p*-benzoquinone and its homologues with gelatin have since been carried out, and the results are now described. The method employed consisted in submitting equal weights of gelatin to the action of equimolecular concentrations of the quinones, and determining the amounts taken up at the end of given periods. Other proteins, *e.g.*, caseinogen and albumin, have also been used. Full experimental details are given in the previous paper (*loc. cit.*, 1921).

The general outcome of these experiments is that benzoquinone reacts with gelatin to a slightly greater extent than toluquinone, but the difference in the rates of the reactions is only about 20%. It is evident, therefore, that the influence of dynamic isomerism so well brought out by the bacteriological results, is not revealed to the same extent in the protein experiments. Results of the same order were obtained in the case of *p*-xyloquinone; although benzoquinone is at least twenty times more active as a germicide than xyloquinone, yet its reaction with gelatin is at the most only twice as rapid as that of the higher homologue.

Different results were obtained when the colour reactions were further studied. Thus, solutions of benzoquinone cause gelatin to become intensely red, and in less than 24 hours to be insoluble in hot water. On the other hand, gelatin exposed to toluquinone solutions, although turning red, is not rendered insoluble until a week has elapsed, whilst xyloquinone has no effect on gelatin even after eight months.

The effect of tautomerism evident in the bacteriological results is thus also disclosed by the colour reactions of the quinones, but is not apparent in the foregoing experiments on velocity of reaction. It would appear that some definite chemical change associated with the tautomeric properties of the quinones underlies their bactericidal and colour-inducing activities, and that other reactions of lesser importance accompany this fundamental process, and thus obscure the significance of the quantitative data.

The qualitative colour tests are therefore of some interest, and further observations have been made.

The differences in the bactericidal powers of α- ar β-naphthaquinones were found to be reflected in the colour reactions with proteins, the α-quinone produ ing a light reddish-brown colour with gelatin an albumin, whilst the β-isomeride yielded a dark brow colour. Chloranilic and bromanilic acids behav differently from quinones towards proteins, on producing a reversible red coloration with gelati Being phenols, they also caused precipitation of th protein as an opaque mass. Monochloro-, *m*-dichlor and trichloro-quinones gave red colorations wit gelatin and albumin, whilst *p*-dichloro-, *p*-dibromo and camphor-quinones had no action.

The observations as a whole point to a correspon dence between germicidal powers and colour-inducin properties.

Summary.

1. The germicidal power of the quinones diminishe as the homologous series is ascended. Th naphthaquinones and camphorquinone are als less active than *p*-benzoquinone.
2. The results as a whole support the view that th high bactericidal power of *p*-benzoquinone i associated with its property of dynamic isomer ism, nascent reactive molecules being liberate in its aqueous solutions.
3. Certain halogenated quinones, however, are mor efficacious as germicides than the alkyl deriva tives, although they exhibit tautomerism to lesser degree. This exceptional behaviour i probably due to an enhancement in bactericida power resulting from the combined halogen atom present in the molecules.
4. The bactericidal power of the quinones is greatl reduced by the presence of organic matter, *e.g.* peptone, serum, urine.
5. Proteins give red colorations with solutions many quinones. These colour changes are ally irreversible and correspond in intensity the bactericidal power of the quinones.
6. Proteins react chemically with quinones. velocity of reaction does not appear, how to be determined entirely by the propert dynamic isomerism, and side-reactions of biological significance probably complicate results.
7. The comparatively high concentrations of the quinones necessary for disinfection in the presence of organic matter would seem to preclude the possibility of applying these substances a internal germicides in man.

The authors desire to express their best thanks to Prof. Ling, of the Department of Biochemistry of Fermentation, for his generous gift of halogenated quinones, and to the Advisory Council of the Department of Scientific and Industrial Research for grants which have helped to defray the expenses of this investigation.

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CRITICAL STUDY OF THE PUBLISHED RESULTS OF TESTS OF WATER-GAS PLANT.*

BY M. W. TRAVERS, D.SC., F.R.S.

In working out a process for the complete gasifica-
n of coal, an account of which was recently pub-
hed in the *Gas Journal* by Mr. F. W. Clark and
author,[1] use was made of the published results of
perimental researches on the water-gas process
rried out by H.M. Fuel Board,[2] and by the Research
mmittee of the Institution of Gas Engineers.[3]
e results of these investigations were not at the
e considered in any way critically. Since this
per was published, it has been considered advis-
le to examine the published data relating to
ter-gas manufacture critically, particularly with
view to determine the influence of various factors
the efficiency of gas production. The study
s carried out entirely for our own information,
l with a view to improve our process for the
mplete gasification of coal, and not with a view to
blication. Least of all was it intended to criticise
se workers to whom we owe such quantitative
owledge of the water-gas process as now exists.
wever, it would be doing no service either to
m or to the gas industry to admit that experi-
ntal research has done more than lay a founda-
n on which knowledge of the water-gas process
1 be built up. A great deal of work, both in the
oratory and in the plant, remains to be carried
t, and in the meantime studies such as the following
y be of assistance to those who are planning
her experiments.

In the two reports referred to above, chemical
ermal balance sheets are used to show how the
y and material involved are utilised. Thus
ve :—

Credits	Debits
ble heat of coke	Sensible heat of water gas
nt heat of coke	Latent heat of water gas
ble heat of steam	Sensible heat of blow gas
ble heat of air	Latent heat of blow gas
	Sensible heat of waste, ashes, etc.
	Latent heat of waste, ashes, etc.

mething more than this is really required,
ticularly as such balance sheets have always
n based upon the assumption that the carbon
ccounted for as water-gas and waste in the
es left the plant as blow gas. What we really
nt is a statement of account which will really
w the relationship between the three sub-processes
which the water-gas process may be analysed,
l which are usually referred to as :—

(*a*) The blow process
(*b*) The run process
(*c*) The clinkering process

We will not include the "blow-run," an American device which would raise the CO_2-content to an extent inadmissible in English practice.

3. These three sub-processes can be considered as being conducted quite independently, and a statement can be prepared showing the debits and credits under each head of account, as below :—

	I. Blow	II. Run	III. Clinkering
Heat of reaction ..	..(+)A	(−)A′	(+)A″
Sensible heat of gas ..	(−)B	(−)B′	(−)B″
Sensible heat of air	..(+)C		(+)C″
Sensible heat of steam ..		(+)D′	
Sensible heat of coke	..(+)E	(+)E′	(+)E″
Sensible heat of ashes ..	(−)F	(−)F′	(−)F″
Radiation and conduction	(−)G	(−)G′	(−)G″

The capital letters refer to quantities of heat in any convenient units. The positive and negative signs, in brackets, indicate that so far as we are concerned at the moment, the numerical values of the symbols are positive or negative. The indices ′ ″ show whether the quantity refers to the blow, run, or clinkering process. If the relationship between the quantities is such that they represent the balance in the water-gas process, then

$$(A - A' + A'' + B + B' + B'' + C + \&c. \ldots) = 0.$$

4. The statement that the three sub-processes may be regarded as taking place independently may require a little explanation. In the blow process air is blown into the coke, and a quantity of heat represented by the algebraic sum of the quantities in column I. is rendered available, as sensible heat in the plant and its contents, for the conduct of the second operation. In practice we find that there is a limit to the period of the blow, and this is actually when the numerical value of negative quantities approaches the numerical value of the positive quantities. However, we are not at the moment in any way concerned with the mechanism of the process, or how the energy is stored up during the blow process. All we have to consider is that when a certain quantity of coke is gasified in the blow process, a certain amount of heat is rendered available for the run process, and this quantity, which will be denoted by the symbol P, is the algebraic sum of :—

A, which increases with the value of the ratio CO_2/CO in the blow-gas, since the heat of formation of CO_2 is greater than the heat of formation of CO;

B, which for any quantity of carbon gasified as blow-gas increases both with the CO_2-content of the blow-gas, and with the temperature at which the gas leaves the fuel bed;

C, which increases with the temperature of the air, and with the quantity consumed, but is an unimportant factor;

E, which depends upon the temperature of the coke;

F, which depends upon the temperature of the ashes removed from the plant, and the quantity of waste, a share of which is allocated to each part of the process;

* Read at a meeting of the Institution of Chemical Engineers on November 5, 1924.

[1] *Gas Journal*, October 3 and 10, 1923.

[2] *Fuel Board Technical Paper No. 7.*

[3] *Reports VI. and X.*

G, which depends upon the insulation of the plant, and the duration of the blow, relative to the duration of the run period.

5. Similarly the energy utilised during the blow, which we will denote by the symbol Q, is the algebraic sum of the quantities under column II. However, it is not necessary to go into details at this stage, except to point out that we shall simplify the problem by assuming that we are considering what may be called standard practice, in which a water-gas of a composition varying only between narrow limits, is produced (§10). In this case, for any definite quantity of carbon gasified as water-gas, A has a constant value, and the numerical value of B increases only with increase of the temperature at which the water-gas leaves the fuel bed of the plant.

6. We have supposed that the ashes removed in the clinkering process are debited to the blow and run processes in proportion to the quantity of carbon consumed in each, so as to allow us to deal with these processes independently. In the operation of water-gas plant in actual practice, we have, however, to take into account certain changes, some of which appear generally to be lost sight of. Published chemical balance sheets invariably show the amount of carbon removed from the plant during the clinker. This quantity, when subtracted from the total carbon supplied to the generator, is generally supposed to yield a measure of the total carbon gasified. The carbon gasified as water-gas is calculated from the measured volume and composition of the water-gas; and the difference between the total carbon gasified (assumed value) and the quantity of carbon in the water-gas is taken to be the carbon in the blow-gas.

Careful analysis of published results shows that quite a considerable loss may be incurred in the clinkering process through the combustion and loss of carbon which is not accounted for. Comparing the results of experiments recorded by the Research Committee of the Institution of Gas Engineers (§32), we find that, while the yield of water-gas in the test Report X, D, was much higher than in the mean of the tests Report VI., every factor upon which the efficiency of water-gas production depends, with certain minor exceptions, should have led to a higher production in the second case than in the first. However, in Test VI. the clinkering period was 14·2% of the whole test period, while in Text X, D, it was only 6·1%. This leads to an explanation of the fact that the total carbon gasified (run and blow) per 100 cub. ft. of water-gas made was recorded as 33·3 lb. in Test VI., and only 29·2 lb. in Test X, D. The difference is probably due to loss while clinkering which has been debited to the blow process.

7. The total loss of carbon must obviously include two quantities, the actual carbon removed from the plant, and the quantity consumed during the clinkering process. The latter is mainly converted into carbon monoxide by the draught of air entering the clinkering doors, the waste gases escaping through the stack valve. It will be noted that as the air current is a slow one, and as CO is therefore main product, and therefore,

(i) the loss of carbon is large relatively to quantity of air passing through the plant,

(ii) the heat developed in the process is relativ small, and a heat balance is rapidly attained betw the factors in column III.

It is probable therefore that we can neglect algebraic sum of the factors under column III., consider the carbon burned off while clinkering merely removed from the system. We will assu that we can do so to simplify treatment of the subje

8. If we take a ton of dry coke as the unit experiment, and suppose that this quantity conta M lb. of carbon, the carbon gasified as water-gas blow gas may be represented by (M—N) lb., wh N lb. is the quantity of carbon removed from plant as waste, and burned during the clinker process. For the purpose of obtaining numeri estimates we will at first suppose that the c contains 85% of carbon, and that about (7·03) of it is removed and lost during clinkeri The value of (M—N) is then 1800 lb. Neglect the small heat change (A″+B″, etc.) taking place the clinkering process, we can assume that a is arrived at in the water-gas process wh molecules of carbon are gasified as water-ore (150—x) lb.-molecules of carbon are gasva- blow-gas. If we write o a

$$p = a - b + e + e - f - g$$
$$-q = -a' - b' + d' + e' - f' - g'$$

where p, a, −b, are the numerical value of the syn used in paragraphs 3—5 when the same quan of carbon is gasified in the run and blow pro say, 10 lb.-molecules; then balance could be att when, $(150 - x)p = -x \times q$, or $x = 150\ p/(p$ We will now consider the blow and run proc separately, taking the run process first.

10. *The run.*—British water-gas practice, w we do not propose to criticise or to justify, ai the manufacture of water-gas approximating t following composition:—CO_2 5·5, CO 39·0, H_2 CH_4 0.5, N_2 6·0%.

The value of −q for 10 molecules of carbon gasif as water gas, must of course depend upon the position of the gas produced, but it will not, under or nary circumstances, vary very materially within small range over which the composition of water gas departs from the analysis given abo We can therefore eliminate one of the variables wh affect the efficiency of water-gas production, at expense, in a small degree, of completeness of analysis, but with the advantage of simplifying treatment of the subject enormously. As engine think of water-gas in terms of thousands of cub. at 60° F. (15·55° C.) and 30 in. of mercury, saturat we shall use these units throughout.

11. Taking the gas of the composition given ab as standard and assuming that 1000 cub. ft., 60° and 30 in., saturated is equivalent to 2·596 lb. ft. mo cular volumes, we have for each 1000 cub. ft. of g

	Lb.-mols. constituent	Lb.-mols. carbon
CO_2	0·14278 ..	0·14278
CO	1·01244 ..	1·01244
H_2	1·27204 ..	—
CH_4	0·01298 ..	0·01298
N_2	0·15576 ..	—
Total	2·59600 ..	1·16820

12. Since the basis of calculation is 10 lb.-mols. f carbon, this quantity is equivalent to 8560 cub. t. of water-gas at 60° F. etc., and contains :—CO_2 2222, CO 8·6666, H_2 10·8887, CH_4 0·1111, N_2 1·3333 .-mols.

13. If 85% of the steam supplied to tho generator decomposed we have from the abovo (per 10 lb.-ols.) :—Steam to generator, 13·0712; steam decomposed, 11·1109; steam with gas, 1·9603 lb.-mols.

14. The sensible heat of steam to generator (d′) = 0,950 C.H.U.

15. The heat of formation of water-gas (a′) can e calculated from the CO_2, CO, and CH_4 content f the gas, above, and the equations :—

$$C+2H_2O=2H_2+CO_2-20900 \text{ C.H.U.*}$$
$$C+H_2O=H_2+CO-31000$$
$$C+2H_2O=CH_4 \quad +20350$$

17. The evaluation of the minor factors e′, f′, and G′ will be dealt with later.

18. *The blow process.*—We will again take 10 lb.-molecules of carbon as our unit, but to avoid a vast amount of arithmetic, we will first suppose that the plant is blown with dry air, treating the effect of moist air separately (§ 26). We have now to consider the fact that the heat of formation of the blow gas, for any definite quantity of carbon gasified, varies very materially with the nature of the product, whether rich in carbon monoxide or rich in carbon dioxide. We have, therefore, to consider the heat of formation (a) to be a variable, and the best we can do towards simplifying the problem is to find a convenient way of connecting the value of a with the composition of the blow-gas. This can best be done by representing the molecular composition of the blow gas by $CO_2/CO=(10-n)/n$, where n lb.-molecules of carbon monoxide are produced for each 10 lb.-molecules of carbon gasified. This system has the advantage of giving us linear relationships. We will then calculate the values of a, b, and c, for values of the CO_2/CO ratio between 1/9 and 9/1. The data will be found in the following table :—

	CO_2/CO ..	1/9 ..	3/7 ..	5/5 ..	7/3 ..	9/1
position (lb.-molecules)	CO_2 ..	1·00 ..	3·00 ..	5·00 ..	7·00 ..	9·00
	CO ..	9·00 ..	7·00 ..	5·00 ..	3·00 ..	1·00
	N_2 ..	20·69 ..	24·45 ..	28·21 ..	31·98 ..	35·74
position (%) ..	CO_2 ..	3·26 ..	8·71 ..	13·09 ..	16·67 ..	19·67
	CO ..	29·32 ..	20·32 ..	13·09 ..	7·12 ..	2·19
	N_2 ..	67·42 ..	70·79 ..	73·82 ..	76·21 ..	78·14
equivalent (lb.-mols.)	.. ..	26·19 ..	30·95 ..	35·71 ..	40·78 ..	45·24
ble heat of blow-gas (b)	600° ..	—129200 ..	—149100 ..	—169000 ..	—198950 ..	—208850
	800° ..	—175150 ..	—202250 ..	—229950 ..	—257400 ..	—284900
	1000° ..	—222450 ..	—257650 ..	—292800 ..	—328000 ..	—361150
of formation (a) ..	.. ..	336250 ..	472100 ..	607950 ..	743800 ..	875650
ble heat of air 20° C.	.. ..	4200 ..	4950 ..	5800 ..	6550 ..	7250

at of formation of water-gas (−a′) = −291,950 U.

. The sensible heat of the water-gas leaving the depends upon the efficiency of the heat interge between the water-gas and the coke in the r layers of the fuel bed. It is a variable quantity ry material importance. It can be calculated the data given above in the manner indicated r previous paper (*loc. cit.*, p. 1). The following the values between 400° and 1000° C. :—

Temperature. ° C.		Sensible heat of water-gas. (−b′)
400	..	— 68700 C.H.U.
600	..	—104900
800	..	—142350
1000	..	—181100

*Coke carbon is assumed to be a form of carbon approaching graphite. amorphous carbon were used in the water-gas process one might write or the main reactions :—

(i) H_2O (steam) $= H_2O$ (water) $+(10725-10t°)$
(ii) $2H_2+O_2 = 2H_2O$ (steam) $+57785$
C (graph.) $+O_2 = CO_2 +94270$
(iii) $2CO+O_2 = 2CO_2 +67935$
(iv) C (graph.) $+H_2O = CO+H_2 -31450$
(v) C (amorph.) $= C$ (graph.) $+h$

h has a maximum value about 2350 for material like sugar charcoal, but as the change represented by equation (v) is independent of the reaction taking place between the gases and the coke, increases in velocity at high temperature, and is catalysed by ash, it is quite possible that, if the material used is amorphous carbon, more than an equivalent of the free energy of reaction (v) becomes available during the blow, and less than an equivalent set free during the run. This is a complication which has not yet been considered. The following values for the main reaction have been used : $C+O_2=CO_2+94750$; $C+H_2O=CO+H_2-31000$.

19. *Minor gains and losses.* The sensible heat of the coke at 20° C. equivalent to 10 lb.-molecules of carbon is given by :—

$$e \text{ or } e'=10\times12\times0{\cdot}195\times20/0{\cdot}85=550 \text{ C.H.U.}$$

assuming that the coke contains 85% of carbon. Assuming that it contains 12% of ash the sensible heat of the ashes at 300° is given approximately by :—

$$-f \text{ or } -f'=-10\times12\times12\times0{\cdot}2\times300/85=\text{say, } -1000 \text{ C.H.U.}$$

The radiation and conduction loss is taken as 2% on the calorific value of the fuel, distributed 1/3 to the blow process and 2/3 to the run process, as the loss depends upon the time of operation. We have then,

$$-g=-12000 \text{ C.H.U.}; \ -g'=-24000 \text{ C.H.U.}$$

20. Assuming that the composition of the water-gas corresponds to the analysis in § 13, and that p and −q represent each 10 lb.-molecules of carbon gasified in the blow and run processes respectively, we can calculate their values when the following facts are known :—The temperature at which the blow-gas leaves the fuel bed; the temperature at which the water-gas leaves the fuel bed; the ratio CO_2/CO in the blow-gas. The results are given in the following table :—

21.

Temperature. °C.	$-q = a' - b' + d' + e' - f' - g'$
400	−374150
600	−410350
800	−447800
1000	−486550

22.

CO_2/CO	1/9	3/7	5/5	7/3	9/1
Temperature. °C		$p = a - b + c + e - f - g$.			
600	198800	315500	432300	548950	661400
800	152750	262350	371350	480500	585350
1000	105450	206950	308500	409900	507100

23. If the coke contains M lb. of carbon per ton, of which N lb. are lost, then $(M-N)/12$ lb.-molecules of carbon are gasified as blow-gas and water-gas (§ 11), and the quantity of carbon gasified as water-gas is given by :—

$$x = (M-N)\ p/12(p+q).$$

In standard water-gas practice, 1000 cub. ft. of gas at 60° F. etc. have been assumed to contain 1·1682 lb.-molecules of carbon (§ 14), so that if $(M-N)$ is 1800 lb., or 150 lb.-molecules.

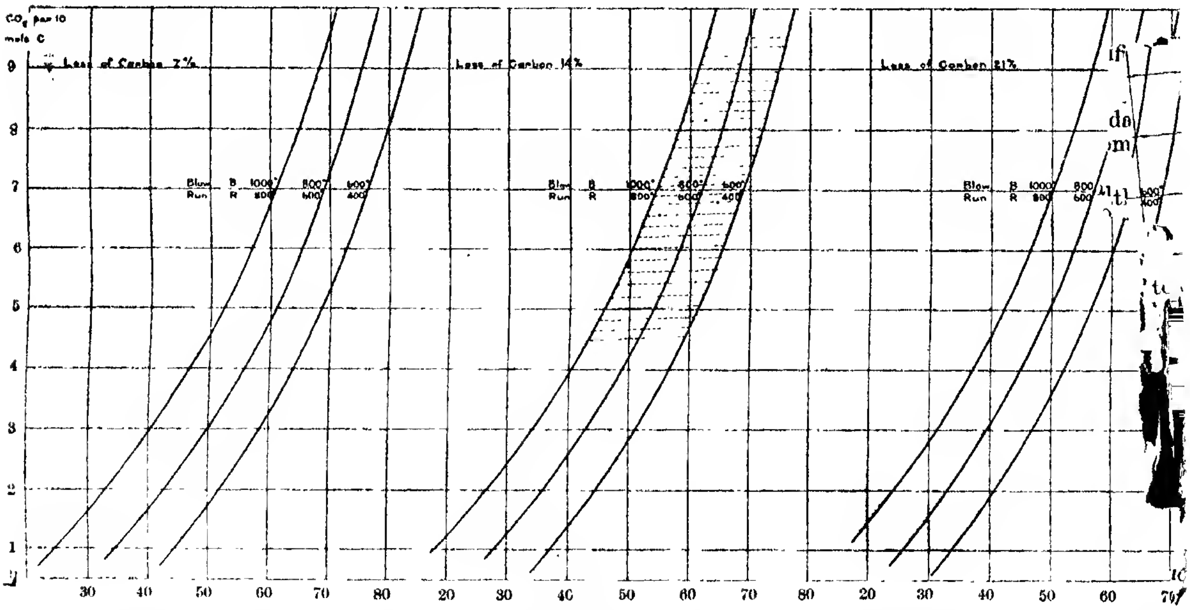
$$\text{volume of water-gas per ton of coke} = 150 \times 1000\ p/1{\cdot}1682\ (p+q) = 12840\ p/(p+q)$$

24. In order to show how the variation in the composition of the blow-gas and the temperature at which gases leave the fuel bed should affect the production of water-gas we have used the formula at which we have just arrived to calculate the volume of water-gas produced, when, as seems to be usually the case, the blow-gas leaves the fuel bed 200° hotter than the water-gas, the latter in the three series being at 400°, at 600°, and at 800° respectively. Calculations have been made for the five values of the ratio CO_2/CO which we have already dealt with. The results are set down in the following table.

CO_2/CO in blow-gas		1/9	3/7	5/5	7/3	9/1
Blow-gas	Water-gas	Volumes water-gas				
600°	400°	44550	58750	68800	76350	82850
800°	600°	34850	50050	61050	69250	75500
1000°	800°	24450	40600	52400	61350	68200

The figures relate to the case in which the loss of carbon is reckoned at 7% of the whole. Similar calculations have been made for the cases in which the loss of carbon is 14% and 21%, and the results of these three sets of calculations are shown in Fig. I. The shaded portion of the curves corresponding to a loss of 14% probably represents the range and limits of practical working.

25. That the output of water-gas per ton of coke should increase with increase in the value of the CO_2/CO ratio for the blow-gas and should decrease with increase in the temperatures at which the gases leave the fuel bed, is a conclusion which can be arrived at from the general consideration of the changes involved in the process. These facts are now demonstrated quantitatively. From our general knowledge of the process of the gasification of carbon by air it might also have been predicted that the CO_2/CO ratio for the blow-gas would increase with the velocity of the blast into the fuel bed, and might also decrease with increase in the depth of the fuel. However, in none of the experiments of which the results have been published have the depth of fuel and the blast velocity been varied independently. For instance, in the experiments described in Technical Paper No. 6 of the Fuel Research Board, the following data are given or can be deduced from the recorded facts.



	Depth of fuel bed ft.	Air per min. cub. ft.
Test 3	4	4740
Test 4	7	3310

The reduction in the velocity of flow is a onsequence of increasing the resistance of the fuel ed.

26. The effect of moisture in the air on the efficiency f the water-gas process cannot actually be neglected, hough the application of the necessary correction ould have involved a vast amount of arithmetic. he following calculation based upon the case in hich the air was half saturated (54%) at 6·5° C. indicates the magnitude of the effect proуced. In this case the air contains :—

	Lb.-molecules
Oxygen	0·001112
Water	0·0000275

27. We can suppose that the water is decomposed ompletely, yielding 0·0000275 lb.-molecule each f hydrogen and carbon monoxide. We can then ork out by the laborious process of trial and error e quantity of carbon monoxide and carbon dioxide roduced by the oxygen in the mixture. We will ke the case in which the ratio of the total CO_2 to e total CO is 5/5. We have then :—

	CO	CO_2	H_2
rom 0·0000275 H_2O ..	0·0000275	—	0·0000275
rom 0·001112 O_2 ..	0·0007225	0·0007498	—
Total	0·0007500	0·0007498	0·0000275

For 10 lb. molecules of carbon

eat of formation of H_2 and CO from water
$-666/7 \times 0·0000275 \times 31000 = -5700$

eat of formation of CO from oxygen
$666/7 \times 0·0007225 \times 26830 = 129200$

eat of formation of CO_2 from oxygen
$6667 \times 0·0007498 \times 94760 = 473700$

Total 597200

Where the air is supposed to be dry (§ 22), the eat of formation of the blow-gas for the CO_2/CO tio 5/5 was found to be 607950.

. To demonstrate the effect of moisture in air we will take the particular case in which the peratures of the blow-gas and water gas were and 600° respectively. We have now :—

	Air 54 % saturated	Air dry
p	360600 ..	371350
q	410350 .	410350
(p + q)	770950 .	781700
Volume water-gas ..	60050 ..	61050

The difference amounts to 1000 cub. ft. per ton of coke.

29. This calculation shows how important it is o avoid condensing moisture in the plant. Leakage of steam into the generator during the blow may also reduce the efficiency of gas production very considerably.

30. It is obvious that preheating the steam used in the run process must increase the efficiency of gas production, and on the other hand, that wet steam must have the opposite effect. In order to investigate the effect of preheating and of saturation we will take cases between the extremes of preheating to 700° C. and 10% saturation. Thus, for 10 lb.-molecules of carbon gasified we have for sensible heat of steam to generator (§§ 16, 17) :—

	C.H.U.
1. Steam preheated to 700° C.	78400
2. „ „ „ 300° C.	32650
3. „ dry at 100°	10950
4. „ 5% saturated	3650
5. „ 10% „ ..	—3650

31. If we take as an example the case in which the ratio CO_2/CO is 5/5, and the blow-gas and water-gas leave the fuel bed at 800° and 600° respectively, we have :—

	1	2	3	4	5
p.(800°)CO_2/CO=5/5)	371350	371350	371350	371350	371350
q.(600°)	342900	388650	410350	417650	425050
p+q	714250	760000	781700	789000	796400
Volume of water gas	66750	62750	61000	60450	59850

32. There are three very weak points in all investigations on water-gas production, the results of which have not as yet been published. These are due to :—

(i) failure to measure the amount of air entering the plant,

(ii) lack of means of recording loss of carbon,

(iii) inaccurate estimation of the sensible heat of the gases leaving the plant.

If the volume of air entering the plant were measured it would then be possible to check the

	X.D.	VI (mean)
1. Period of test	47·73 hr.	47·75 hr.
2. Duration of clinkering ..	3·33 hr. 6·1%	6·77 hr. 14·2%
3. Gas per ton of dry coke .	57690 cub. ft.	51280 cub. ft.
4. Gas per hour of gas making	27520 cub. ft.	27400 cub. ft.
5. Calorific value	296 B.Th.U.	301 B.Th.U.
6. Gas in therms per ton ..	170·8	154·5
7. Steam to generator, lb. per 1000 cub. ft. ..	34·6	33·6
8. Carbon in 1000 cub. ft. water-gas	14·29	14·52
9. Carbon in equivalent blow-gas (?)	15·63	18·80
10. CO_2/CO in blow-gas ..	4·67/5·33	4·88/5 12
11. Temperature of water-gas at exit	520	365
12. Temperature of blow-gas at exit	600	330
13. Depth of fuel bed ..	5 ft.	6 ft.
14. Composition of water-gas .. CO_2 .	4·5	4·2
CO ..	40·7	41·4
CH_4 ..	0·6	0·8
H_2 ..	49·2	49 2
N_2 ..	4·9	4·3
O_2 ..	0·1	0·1
15. Composition of blow-gas .. CO_2 ..	12·1	12·2
CO ..	13·8	12·8
CH_4 ..	0·3	0·5
H_2 ..	2·4	3·0
N_2 ..	71·3	71·3
O_2 ..	0·1	0·2

quantity of carbon gasified in the blow, which has hitherto only been arrived at as a difference. There is no doubt that the loss of carbon in clinkering, and otherwise, may be large; and with a view to illustrating this point we will again refer to the experiments mentioned in § 6. Some of the more

important data relating to these experiments are tabulated on p. 359 T.

33. In these two tests the rate of production of water-gas was almost identical—viz., 27520 and 27400 cub. ft. per hour of gas making, the difference being hardly outside the possible error of measurement. The difference between the compositions of the water-gas and blow-gas was very small, and every factor influencing the efficiency of gas production points to a higher efficiency in the Test VI. Yet the output of water-gas in this test was very considerably lower than in Test X, D. Careful analysis of the results gives no explanation of the apparent discrepancy, which appears to be in some way connected with the fact that in Test X, D, clinkering occupied only 6·1% of the total period of the test, whilst in Test VI. it occupied 14·2% of the period. A water-gas generator cannot be kept open for long periods without the combustion of a considerable quantity of fuel taking place in it. This may in some measure account for the difference in the yield of water-gas, which has certainly nothing to do with the change in the depth of the fuel bed.

34. With a view to ascertain the cause of the apparent discrepancies we have worked out balance sheets for the two tests on the lines which we have indicated. The facts recorded in the Reports Nos. VI. and X. have been accepted as published, and it has only been necessary to make an independent estimate of the loss by radiation and conduction, which is taken as 2% of the calorific value of the fuel. This is twice the allowance usually made in gas-producer practice. The total loss by radiation has been allocated to the blow and run process in the proportion 1/4, the ratio of the blow and run periods. The balance sheets refer to a ton of dry coke. This was to be expected.

X.D.

		Blow.		Run.	
Heat of reaction A		4315950	—	—	–2011350
Sensible heat of:					
Gas	B		–1106650	—	–702350
Air	C	27150	—	—	—
Steam	D	—	—	145950	—
Coke	E	4600	—	4150	—
Ashes	F	...	–33550	—	–30550
Radiation etc.	G	—	–60000	..	–240000
		4317700	–1200200	150100	–2984250

P = 3147500 Q = –2834150

P+Q = 313350

VI (mean)

		Blow		Run	
Heat of reaction	A	4802700			–1802500
Sensible heat of:					
Gas	B		– 954250		– 421200
Air	C	29500			
Steam	D			120350	
Coke	E	4950		3800	
Ashes	F		– 41800		– 32100
Radiation etc.	G		– 60000		– 240000
		4837150	–1056050	124150	–2495800

P = 3781100 Q = –2371650

P+Q = 1409450

35. The difference between the algebraical sum of the quantities under the headings Blow and Run for Test X.D. is relatively small, and of the sign which would have been anticipated, since errors in the temperature measurements, and loss of carbon, would tend to make the algebraic sum positive. The error is of the order of 10%, and with a view to ascertain the cause of it we first adjusted the results on the basis that the temperature measurements were 100° too low both for the run and blow processes. We then obtained the following result:—

	C.H
Sensible heat of blow-gas 700°	130
,, ,, ,, water-gas 620°	84

Introducing these quantities into the balance we obtain the result:—

	C.H
Total of quantities under blow (P) ..	294
,, ,, ,, ,, run (Q) ..	297

We have now run past the balance point. assume that about 5 per cent. of the carbon is assumed to be gasified as blow-gas is real and that the gases really leave the fuel be temperature about 50° hotter than is re by the pyrometers, we shall arrive at balance.

36. For the series VI. (mean) the value of is very large, a circumstance which is probably connected with the long clinkering period and the consequent loss of carbon, which is set down as carbon gasified in the blow process. This makes the calculated value of the heat of formation of the blow gas too high, whilst the fact that the temperature observations are probably too low makes the apparent numerical values of the sensible heat of the gases too small. It must be remembered th the investigation described in the Sixth Re of the Institution of Gas Engineers was carried on a public utility plant, without interfereing the operating routine, and the authors have n regarded it as covering much more than a gen test of the efficiency of the process.

37. Finally, since the water-gas produced Test X.D. approaches in composition to what have considered to be the standard (10), we apply the formula which we developed in the earl part of the paper to recalculate the water-gas output in this test. The result is as follows:—

1.	Water-gas per ton of coke, dry	57690 cu. ft.
2.	Carbon gasified per ton of coke	1726 lb.
3.	Water gas per 1800 lb. carbon	60130 cu. ft.
4.	Temperature blow-gas + 100°	700° C.
5.	,, water-gas + 100°	620° C.
6.	P, from table in § 28	383200 C.H.U.
7.	Q, from table in § 28	417850 C.H.U.
8.	Volume of water-gas from formula § 28 ..	61420 cu. ft.

The agreement between items 3 and 8 is as close as can be expected.

38. We can now deal with the experiments of which the results are published in Technical Paper 6 of the Fuel Research Board. These were carried out

vith a view of contrasting the Dellwik-Fleischer ystem of operation, in which a high blast velocity nd a shallow fuel bed are used, with the usual method f operating a Humphries and Glasgow plant, in which the fuel bed is of the order of 6 ft. to 7 ft. s has already been pointed out, more certain nformation would have been gained if the depth of uel bed and the blast velocity had been varied ndependently.

39. It may be pointed out that in tests 1 and 2 plant was really being tuned for the final low fuel test 3, and that test 4 corresponds to normal ice. We will only discuss the results of the last tests.

two tests.	1	2.	3.	4.
d of test, hour ..	62·0	36·5	51·0	48·0
d of gas making ..	60·4	30·6	40·9	34·6
per hour of gas king, cub. ft. ..	10150	11400	11350	21850
or ton of dry coke ..	63950	62900	65600	59050
val. gross	276·5	284·0	282·6	296·2
ms per ton of dry ke	178	179	185	175
bed depth, ft. ..	3·5	3·5	4	7
nary air per minute ring blow	4795	4980	4740	3310
m per minute during n, lb.	10·51	8·22	7·70	18·85
er-gas CO_2	8·30	5·30	6·00	4·50
O_2	0·15	0·10	0·10	0·10
CO	35·55	39·60	39·00	41·60
H_2	50·55	48·60	49·20	50·44
CH_4	0·20	0·30	0·10	0·25
N_2	5·30	6·10	5·60	3·15
w-gas CO_2	19·5	19·3	19·06	14·55
O_2	0·1	0·8	0·33	0·10
CO	2·2	2·68	2·84	9·29
H_2	0·8	0·24	0·51	3·71
CH_4 ..	0·6	0·67	0·48	0·77
N_2	76·8	77·30	76·78	71·58
.. ..	9/1	8·75/1·25	8·70/1·3	6·22/3·78
minutes	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{3}$	1
minutes	6	6	6	4
rature, blow-gas	—	—	860°	745°
rature, water-gas	—	·	650°	640°

It must be admitted that the measurement temperatures of the gases leaving the generator matter of no little difficulty, particularly in the of the blow-gas, when the blast velocity is high, blast period short, and the temperature of the ow-gas consequently high. Under these circum- ances the drop in temperature of the gas as it aves the generator must be very rapid, and error likely to arise through radiation from the thermo- nction, if it is not shielded, lag in the heat inter- ange between the gas and the thermojunction, and g in the heating of the thermojunction to a uniform mperature. All circumstances combine to increase he difference between the true and observed tem- peratures. Although the temperatures in the table bove really represent the maxima recorded, t is possible that they are still actually below he true temperature of the gases. The measure- ment of temperatures under the conditions which we are considering would repay further study. The quantity of primary air consumed per minute during the blow is in no case the result of direct observation, and there is no evidence which would enable us to differentiate between the carbon gasified as blow-gas, and the carbon consumed during clinkering.

It is therefore hardly worth making the laborious calculations involved in the compilation of a balance sheet. However, as the composition of the water-gas in both tests approaches to that of our standard we may use the formula to calculate the quantity of water-gas which the experiments should yield, supposing that the data tabulated are correct, and also supposing that allowances have to be made for incorrect temperature measurement, and for loss of carbon, reckoned as percentage loss on the carbon gasified as blow-gas. The following are the results of the calculations:—

TEST 3

Temperature of blow-gas	No loss	5% loss	10% loss
860° ..	72560 ..	70810 ..	69220
960° ..	67260 ..	65930 ..	64190

TEST 4

Temperature of blow-gas	No loss	5% loss	10% loss
745° ..	66680 ..	64880 ..	63150
845° ..	62770 ..	61130 ..	59400

Comparing these figures with item 5 in the previous table, it will be clear that the results of these tests would require considerable correction to make them balance. However, as they are strictly comparable they show quite clearly that the high CO_2/CO ratio in the blow-gas is a factor which makes for efficiency. While the conditions arrived at in Test 3 make for the higher gasification efficiency, they necessitate the slowing down of output, a matter which we are not now considering.

41. It has been shown that in studying the results of tests carried out on water-gas plants, balance sheets should be compiled showing, not merely that the total energy of the fuel is utilised, but also the relationship between the run and blow processes. If a balance is not then obtained it is clear that the experimental results are at fault. Study of the published results of experiments shows that they are subject to error partly owing to errors in estimating the sensible heats of the gases leaving the generator and partly to the fact that, as no allowance is made for loss of carbon, otherwise than as ash, clinker, etc., the amount of carbon supposed to be gasified as blow gas appears always to be too high. In order to extend our knowledge of the subject experiments should be carried out in which one factor only is varied at a time. Thus, by keeping a constant depth of fuel bed and changing the velocity of the blast, by maintaining a constant blast velocity and varying the depth of fuel bed, and by varying the size and quality of the coke when the other two factors were kept constant, we should obtain definite and valuable information as to the exact influence of these important factors. Measurement of the amount of primary air entering the plant would also serve as a valuable check on the consumption of carbon in the blow process.

THE POLYMERISATION OF DRYING OILS.

BY R. S. MORRELL, M.A., PH.D., F.I.C.

In a communication entitled "Ueber die sogenannte Polymerisation der trockenen Oele" (Z. angew. Chem., 1924, **37**, 729; B., 1924, 916), H. Wolff states that drying oils which have been thickened by heat, and the acids obtained therefrom are unimolecular in camphor solutions (Rast, Ber., 1923, **55**, 1051), and that the previous determinations in the case of the oils have given too high results, owing to the associating character of the solvents employed. I have been unable to find in Wolff's paper details of results obtained in the case of the thickened oils, although a table is given, showing that the acids obtained from the thickened oils are essentially unimolecular. The value of Wolff's conclusions rests entirely on the production of data obtained directly from the oils and not from the acids, and judgment must be reserved until these results are forthcoming. In the meantime it is advisable to point out that the results relating to the acids are not new. In 1915, after careful determination of the physical and chemical properties of thickened linseed oil (its acids and methyl esters) it was pointed out that the molecular weight of the two components of thickened linseed oil separated by means of acetone were 1788—2517 (oil insoluble in acetone) and 904—975 (oil soluble in acetone). The molecular weights were determined in benzol solution, and it is surprising that one part of the mixed glycerides (50%) should show great association, and the other part only very little, if benzol were considered as acting solely as a strongly associating solvent. Similar results were obtained with thickened poppy seed oil and China wood oil (J., 1915, 105).

Although the accuracy of the method using benzol as solvent for determining the degree of polymerisation has been criticised (J. Oil and Col. Chem. Ass., 1924, **7**, 153), it must be admitted that some form of polymerisation is indicated. In an earlier paper (1915) I pointed out the anomalous results that are obtained with the fatty acids, using benzol as solvent, and in the later communication (1924) I compared the results obtained by using glacial acetic acid with the stearic acid solvent method of M. Y. Seaton and G. B. Sawyer (J. Ind. Eng. Chem., 1916, **6**, 490; Biltz, Z. physikal. Chem., **19**, 385). Wolff's communication respecting the molecular weights of the acids from the thickened oils is not new. Both the acids and the methyl esters obtained from thickened linseed oil and China wood oil show only slight increases over the unimolecular state (J., 1918, 181 T), but on distillation *in vacuo* they give unimolecular distillates and multimolecular non-volatile residues (J., 1918, **37**, 181 T). It was shown that the polymerisation was not intra-molecular from the examination of the methyl esters obtained from thickened China wood oil. In my last communication (1924) the peculiar nature of the change is discussed in the light of evidence from the iodine values. It was pointed out that owing to the values obtained with varying times of contact with the Wijs reagent it was inadvisable to construct graphs representing the degree of polymerisation. The methyl esters from thickened China wood oil (insoluble in acetone) with a molecular weight in benzol of 393 showed iodine values rising from 138 ($1\frac{1}{2}$ hours' contact) to 168 (6 days' contact); China wood oil, heated for three hours at 205°, and insoluble in acetone, from 76·5 (1 hr. contact), rising to 150·8 (18 hours' contact); linseed oil, thickened at 260°, showed iodine values varying from 121 ($1\frac{1}{2}$ hours' contact) to 136 (20 hours' contact). Mention must be made of the increase in the molecular weight of oxidised α-elæostearic acid (in glacial acetic acid) and the ready gelation of oxidised linseed or China wood oil compared with the corresponding oxidised ethyl esters (Chem. Soc. Trans., 1918, **113**, 124; J. Oil and Colour Chem. Assoc., 1924, **7**, 159).

Until more is known of the process of gelation it is inadvisable to dismiss the conclusion that some form of molecular polymerisation occurs.

The composition of the oils plays an important part in their coagulation, either by heat or oxidation; moreover, the presence of the glyceryl group favours the setting of the oxidation product and the increase in viscosity when heat is applied. The setting is sensitive to the presence of small quantities of apparently inactive substances, which may or may not affect the rate of oxidation of the oil. An explanation from a colloid standpoint is always attractive, but it is not always satisfactory from a strictly chemical point of view. The influence of composition on the coagulation of oil systems does not admit an interpretation from a mere consideration of variable degrees of dispersion or sizes of aggregates. It is possible that the so-called polymerised oils are instances of special molecular complexes of dispersed material permeated by the dispersion medium which is of the same chemical composition (R. Zsigmondy, Z. physikal. Chem., 1921, **98**, 14). The thickening of drying oils, especially China wood oil, from experimental evidence appears to be a border case, whilst in linseed oil changes in the arrangement of the ethenoid linkages must not be overlooked.

The experiment described by Wolff (*loc. cit.*, p. 73) in connexion with changes in a China wood oil film illustrates "syneresis" or a possible lattice structure of linoxyn enclosing unoxidised oil. This occurs in most drying oil films in which the oxidation has been superficial. It has been shown by the present author that a surface of an oxidised China wood oil film is active and this activity is manifested long after the film is hardened.

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AMINATION OF THE BANDED CON-ITUENTS OF A DERBYSHIRE COAL.

BY H. D. GREENWOOD, M.SC., A.I.C.

nomenclature originally introduced by Stopes Wheeler to distinguish between the constituents banded coal has been generally adopted, and the racteristics of the four ingredients—fusain, durain, rain, and vitrain—are well known. The proper- of these bands from a number of coals have been estigated by several workers.

ideswell and Wheeler (Chem. Soc. Trans., 1919, , 619) made a detailed analysis of a New Ham- d coal, together with a distillation *in vacuo* at °; Lessing (*ibid.*, 1920, 117, 247—256) extended se investigations to laboratory distillation tests 00° and 900°, and also to analyses of the ash from different bands. Analyses of the bands from the p Hard Seam, E. Kirby Colliery, are given by ranov and Francis (Fuel, 1922, 1, 219).

impression gathered from a survey of these ilts is that there is a general gradation of certain perties of the four constituents in the order, rain, clarain, durain, and fusain.

he ultimate analyses show a gradual rise in carbon l fall in oxygen content, and the above order ears to hold also for the other properties investi- ed.

e results given by Tideswell and Wheeler may d as an example :—

	Vitrain	Clarain	Durain	Fusain	
	%	%	%	%	
l.. .	12·6	10·2	6·5	3·9	
h- and c-free)	38·6	40·8	39·7	22·6	
. ..	78·5	79·1	80·8	84·7	
..	13·0	13 4	11·8	9·7	
per g. ..	184 c.c.	206 c.c.	194 c.c.	—	(Lessing)

vestigators agree in finding differences in the properties. The vitrain and clarain give ollen-coke, whereas the durain undergoes ly no change in volume, and fusain is entirely of coking properties.

he following paper are recorded the results of mination of the banded constituents of a Derby- coal from Flockton and Parkgate seams of ngton Colliery. The examination is divided two sections :—

Analyses and distillation in small silica retort.

., Examination of the resulting cokes.

Experimental.

The coal samples were obtained by picking lumps coal from truck deliveries from the colliery, these ng selected so as to show their banding clearly, l the bands then separated by hand.

The durain and clarain, which formed well-defined nds, were easily distinguished and separated, hough care was necessary that no thin laminæ of durain were present in the clarain bands, and *vice versa*. The detection and separation of the vitrain presented greater difficulty.

On casual examination the clarain and vitrain were very similar, but the latter had a more brilliant surface lustre which was not banded as in the clarain. The vitrain, which was almost vitreous in texture, when broken into small fragments showed a distinct conchoidal fracture, whilst the clarain split into parallel laminæ.

As the vitrain only occurred to a small extent in the coal and in very thin bands, its separation from the matrix was difficult, and it was only after the examination of many samples that the vitrain was found in bands sufficiently large to allow of its separation.

The samples thus obtained were ground to pass a sieve of 60 meshes to the inch, and stored in air-tight bottles.

Proximate analyses of each were carried out according to the methods of the American Chemical Society.

Distillation tests.—The distillation at 900° was carried out in a small silica retort, heated by a specially designed gas furnace. The furnace was so constructed that the front 4 inches of the retort could be raised to the distillation temperature before heating the rear portion containing the coal, providing a region where the volatile matter evolved during the early stages of the distillation might be superheated and thus give some approximation to the conditions prevalent in a horizontal retort in practice.

Ten grams of coal were placed in the rear portion of the retort in order that the volume of free space immediately above the coal might be the same in each experiment. The liquid products were collected in a water-cooled U-tube, and the gas passed, *via* an acid bubbler, to a gasholder, which was filled with water and glycerin. The pressure in the apparatus was maintained uniform throughout the distillation by the constant-level device described in the Fuel Research Board Report, No. 1.

The retort and condenser were weighed before and after the experiment to determine the yield of coke and liquid products. The tar was dissolved in chloroform and the liquor separated and measured; the tar adhering to the side tube of the retort was burnt off and the loss in weight recorded and added to the bulk of the tar. The gas analyses were carried out in a modified Orsat apparatus and the nitrogen was determined by direct combustion over copper oxide.

Discussion of results.—The proximate analyses (Table I.) of the clarain and vitrain were very similar, and the low ash content of all except the fusain was noteworthy. The gradation of properties which has been observed with other coals (*loc. cit.*) is not so well marked in the present instance.

The moisture content follows the order observed with other coals, but the durain has a considerably higher volatile content than the other bands, and the ash is practically the same for each band, excluding the fusain.

TABLE I.

	Fusain.	Durain.	Clarain.	Vitrain.	Eckington coal.
Density . .	1·4·4	1·310	1·317	1·312	
Proximate analysis—					
Moisture	1·60%	2·61%	2·80%	3·30%	2·5%
Volatile (ash- and moisture-free).	21·3	39·2	36·2	35·3	34·6
Fixed carbon .	78·7	60·8	63·7	64·6	59·1
Ash . . .	10·08	2·1	2·1	2·0	7·1

The above figures are not the results of an isolated test, similar results having been obtained with many samples.

The fusain must be considered in a class apart, since its properties differed greatly from those of the other bands. It is marked by a high ash and low moisture and volatile content, in which respect it is in agreement with the analyses of other observers on different coals.

The deliveries of this coal sampled from wagons in the ordinary way contain from 9 to 13% of ash, showing the large proportion of adventitious matter.

Results of distillation tests.—The three coking bands yielded similar results on distillation at 900°, as might be anticipated from the proximate analyses.

The yield of gas was greatest with the vitrain and least with the durain, but for the tar yields this order was reversed.

In each case the total volatile matter evolved was less than in the crucible test (proximate analysis), due probably to the secondary decomposition of the tar etc., with the formation of carbon on the walls of the retort.

The composition of the gas was similar for the three coking bands and calls for no comment.

With the fusain, the tar and gas yields were much lower and the gas was poorer in quality, containing 16·5% of methane and 60·6% of hydrogen, compared with 28·5% and 49% respectively in the gas from the clarain (see Table V.).

TABLE II.

Results of distillation tests.

	Coal as sampled.					Ash- and moisture-free coal.				
Coal.	Coke, %	Tar, %	Liquor, %	Gas c.c. 10 g.	Total volatile.	Coke, %	Tar, %	Liquor, %	Gas c.c./10 g	Total volatile.
Vitrain .	65·7	7·7	8·0	3465	34·3	67·3	8·1	4·9	3660	35·2
Clarain .	65·4	8·0	7·5	3390	34·6	66·5	10·3	5·3	3560	33·4
Durain .	62·3	12·1	5·9	3280	37·1	62·8	12·7	3·4	3440	36·3
Fusain	80·3	3·6	4·8	2400	19·7	79·5	4·1	3·6	2710	21·3
Eckington (av. sample) . .	66·8	8·9	7·5	3100	33·3	64·6	10·2	5·7	3450	34·6

In Table II. are also recorded the results of an average test of Eckington coal as sampled in the ordinary way; the relatively high tar and low gas yields will be noted.

Examination of the cokes.

The cokes, after cooling and weighing, were extracted from the retort and the real and apparent specific gravities determined by the methods described by Greenwood and Cobb (J., 1922, 181—183 T).

In order that the free space available for expan above the coal might be the same in each test, was taken that the coal occupied the same portio the retort in each experiment.

The specific gravities of the original coal and cokes are collected in Table III., and in Table IV calculated the changes in volume which take plac the coking process starting with 100 g. of coal.

TABLE III.

Physical properties of cokes.

	Fusain.	Durain.	Clarain.	Vit
Real specific gravity	1·980	1·877	1·880	1·
Apparent specific gravity . .	1·980	0·980	0·600	0·
Percentage porosity	Nil.	49·8%	68·0%	70·

TABLE IV.

Changes in volume on coking in silica retort.

	Weight, g.	Volume of coal c.c. A	Total Volume of coke c.c. B	Change in volume c.c. (A B)	Volume of coke material c.c. C	Dec in vo from c. (A-
Fusain—						
Original coal .	100·0	68·8	40·2	−28·6	40·2	−2
After coking at 900°	79·5			=−41·5%		=−4
Durain—						
Original coal . .	100·0	71·4	61·2	−10·2	32·0	−3
After coking at 900°	60·0			=−14·2%		=−5
Clarain—						
Original coal . .	100·0	77·0	104·5	+27·5	33·3	−4
After coking at 900°	62·7			=+35·7%		=−5
Vitrain—						
Original coal . .	100·0	76·1	115·0	+38·9	33·8	−4
After coking at 900°	63·6			=+51·1%		=−5

As is usual, the fusain was entirely devoid coking properties, and the residue consisted of greyish, non-porous powder with a relatively h specific gravity, as the coal contracted 48·5% of original volume on carbonisation.

The durain, which may be regarded as int mediate in its properties between the str coking clarain and non-coking fusain, po sufficient agglomerant to bind the particles t and form a dense, hard coke; the decr volume was only 14·2%, as compared with with the fusain, the difference constituting th space in the durain coke. The material reta original shape to a large extent, and showed n of inter-fusion of the particles. This prop clearly demonstrated by coking a small cube coal, when a similar cube of coke is formed with tically no change in volume.

Both the clarain and vitrain gave highly sw cokes, especially the vitrain, which showed a te dency to "mushroom" formation. To the ey these cokes appeared very similar, but from Table I it will be seen that the vitrain expanded 51·5% its original volume, compared with 35·7% for th clarain. These cokes were completely fused an covered with a film of bright retort carbon

The low specific gravity of these cokes em phasises the expansion which has taken place, th figure 0·981 for the durain being comparable with th average figures for gas and oven coke. The decrea in volume of the coke material by loss of volati matter was similar for the three coking bands, an in marked contrast to the differences in volume o the coke material together with the pore spaces.

The centre of both the clarain and vitrain cokes
s composed of relatively large, and the periphery
small, cells, showing that the expansion had
ust the coal against the sides of the retort, where
pressure of the expanding material prevented
formation of large cells.

TABLE V.

Gas analysis.

	H_2S & CO_2	O_2	C_nH_m	CO	H_2	CH_4	N_2
ngton coal	2·7	1·2	3·8	7·0	49·0	27·7	8·6
ain	2·6	1·2	2·9	8·2	60·6	16·5	8·0
ain	1·9	1·4	3·9	6·8	47·7	26·3	9·0
ain	2·0	1·3	4·0	6·4	49·0	28·5	8·8
ain	1·9	1·3	3·9	6·3	49·5	29·0	8·1
On air-free basis.							
ngton coal	2·0	--	4·0	7·4	53·1	29·4	2·0
ain	2·7	—	3·1	8·9	64·2	17·4	3·5
ain	2·03	--	4·3	7·5	54·3	28·1	3·77
ain	2·10	--	4·2	7·2	52·2	30·3	3·94
ain	2·0	--	4·1	7·06	52·7	30·9	3·24

When coal is carbonised in small samples and
ler conditions which allow free expansion, the
parent specific gravity of the resulting coke is
siderably less than when the coal is coked in bulk,
superincumbent weight of the charge and the
raining influence of the retort walls then prevent-
excessive expansion.

Considering these results from the standpoint of
bonisation practice, it may be anticipated that
ls containing a large proportion of clarain and
rain will show a considerable expansion on coking,
being tempered by the durain present.

Where coals are carbonised in the rough, as in
id-stoked horizontal retorts, the different expan-
s of the bands should result in a want of uni-
nity and a consequently weaker coke.

The greater the degree of subdivision of the coal
more uniform should be the resulting coke, and
derable scope is thus offered for the blending of
ontaining different proportions of banded
ents.

Summary.

he banded constituents, durain, clarain,
and fusain, of a Derbyshire coal (Eckington
) have been separated and subjected to
te analyses and distillation tests on a labora-
le. The porosity and specific gravity of the
rom these tests have also been determined.

The fusain may be considered in a class apart
is characterised by low volatile and high ash
; it was further entirely devoid of coking
ies.

The durain, clarain, and vitrain showed much
ty in certain properties, but the gradation
above order which has been recorded for other
oc. cit.) was hardly appreciable.

The vitrain and clarain gave highly swollen
but the durain showed very little change in
, and even a slight decrease in volume on
king.

(5) The real specific gravity was practically identi-
in all the three cokes, but owing to the different
gree of expansion on coking the apparent specific
vity was greatest with the vitrain and least with
durain.

The author wishes to express his thanks to Mr. F. G. Shaw, Engineer and Manager of the Burton Corporation Gas Dept., for permission to publish these results.

NOTES ON ALLOY METALS USED IN ALLOY STEELS.*

BY JULIUS L. F. VOGEL.

For the purpose of this paper steel will be regarded as iron containing small percentages of carbon and silicon as essential constituents, whilst alloy steels will be regarded as containing in addition definitely predetermined quantities of one or more other metals.

It should be borne in mind in connexion with steel of every kind that the manufacturers and consumers are interested solely in its physical qualities. For them chemical analysis is merely a means of insuring uniformity in successive heats and freedom from excess of impurities which are known in practice to affect the physical qualities adversely.

To realise the part played by the different alloy metals it is necessary to visualise to some extent the structure of alloy steels, and for this purpose a study of a recent paper by M. Grossmann and E. Bain† is useful, as it summarises the accumulated knowledge of many workers in this branch of metallurgy. The paper deals with an investigation into the nature of high-speed steel which contains tungsten, chromium, and vanadium in addition to iron, carbon, and silicon. Its properties are great tensile strength to withstand the enormous strain of heavy and fast cutting without breakage or distortion, together with great hardness, which is maintained even at high temperatures. The cutting edge of a tool made from such steel will not be softened and become blunt, even when it is heated to a visible red by the friction and strain of taking heavy cuts at high speed.

The conclusions arrived at in this and other papers are, briefly :—

1. That a carbon steel is a definite crystalline structure in which the size, chemical composition and disposition of the crystals are regulated by the quantity of carbon, the work under the hammer and rolls, and the heat treatment.
2. That in high-speed steel certain of the additional metals form true alloys with the iron and carbon, and thereby produce a matrix of greater tensile strength than carbon steel, and that other of the alloy metals for the most part form carbides which are very hard and refractory.
3. That by suitable preparation, mechanical and heat treatment, the finished steel can be produced so as to consist of the matrix through which the carbide crystals are evenly distributed.
4. That a further use of some of the added metals is to combine with oxygen or nitrogen in the molten steel and carry these elements into the slag.

* Read at a meeting of the Liverpool Section on Nov. 21, 1924.
† Iron and Steel Institute, September, 1924.

With this conception of the structure of an alloy steel it is interesting next to study a list of the metals which are thus utilised, and at the same time to compare them with others which, if present in excessive quantities, are found to be deleterious.

A very great number of elements may be detected by a complete analysis of alloy steels, but attention is only drawn to those which are added or avoided intentionally. Further, it must be borne in mind that scientific investigation is in progress in many laboratories and factories where alloy steels of every kind are under examination. In consequence, certain of the elements tabulated are still only under observation and not in commercial use to any extent, but these are included for the purpose of comparing their properties with those of elements of already proved utility.

The tables are arranged in the order of the chemical groups, but no evidence can be deduced from the classification, as the same groups are found to include both useful and deleterious elements, as, for instance, chromium and sulphur.

Table of the elements employed in the manufacture of alloy steels.

	Sp. gr.	m. p.
A. *Useful Elements.*		
Titanium	4·87	2500°
Zirconium	6·40	1800°
Carbon	2·3	4000°
"	3·5	—
Silicon	2·3	1200°
Vanadium	5·5	1680°
Chromium	6·92	1550°
Molybdenum	9·01	2110°
Tungsten	18·7	2800°
Uranium	18·7	1800°
Manganese	8·0	1240°
Iron	7·86	1520°
Cobalt	8·8	1490°
Nickel	8·8	1452°
B. *Employed as a reagent.*		
Aluminium	2·56	654°
C. *Considered deleterious or at the best of no value to alloy steels.*		
Copper*	8·95	1084°
Tin	7·3	232°
Antimony	6·8	630°
Bismuth	9·7	270°
Phosphorus	1·83	44°
Arsenic†	5·73	—
Sulphur	2·07	115°

* Copper is said to be utilised in some steels, but generally it is specified as deleterious in ferro alloys for steel making.

† Volatilises without fusing.

A study of this table does not convey much information.

The most noticeable point in the useful alloy metals is their high melting point. Manganese alone melts substantially below iron. Of the others, cobalt, nickel, and chromium have melting points approximating to that of iron, whilst the others have very high melting points.

Now manganese, cobalt, nickel, and chromium very largely enter into the steel as a true alloy, and impart to it definite physical characteristics, whilst the metals of high melting point tend more to appear in the finished steel as complex carbides held in the matrix.

These are generalised statements and only to be applied cautiously, but they may indicate to some extent the effects of different elements on the steel.

Aluminium occupies a peculiar position. At the temperature of molten steel it is readily oxidised, and if added to a melt containing ferrous oxide effectively deoxidises the bath. Hence it is used "doctor" over-oxidised or boiling metal, ingots fro which would be filled with gas bubbles. The al minium oxide is light and passes readily to the sl floating on the surface. Over-treatment with alu minium, which results in some of the metal remainir unoxidised and in admixture with the steel, is foun to be bad for certain classes of steel. Hence cautic is desirable in adding what is, for its legitima purpose, a useful reagent.

Turning to the deleterious impurities, phosphoru arsenic, and sulphur are all well known to affe carbon steel adversely, and equally so alloy stee The proportion of these must in consequence be ke very low in ferro alloys or metals used in making all steel.

Tin is objected to and also copper, for reasons wh are not specifically stated. The importance restriction of these metals lies in the fact that wolfra the raw material for making tungsten, is alwa associated with tin ore, and copper is often pres in molybdenite and must be watched for in a minium used for thermit reduction.

Thus, the problem facing makers of ferro allo and alloy metals for steel makers may be brie summarised by saying that the products they supp must contain the desired metals within comparativel narrow limits, and that they must be free fro any deleterious or even doubtful impurities. Fur ther, the maker of the ferro alloys must be conten to realise that his product will be judged more by th physical properties of the steel produced than by th assay of the ferro alloys themselves. The only sa course is to keep the products as free as possible fro the impurities he wishes to avoid. In the first plac therefore, he buys the ores he uses as raw mat on very strict specifications. It is not, of always possible to obtain all necessary supp the highest quality, but prices are redu direct ratio to impurities. Broadly speakin ferro alloys such as ferrotungsten, ferrochron ferromolybdenum, which are reduced directl the ores by electric furnace or by thermit pro call for the purest raw materials, since the poss of eliminating impurities in the course of manuf is very limited.

The pure metals such as nickel, cobalt, tun or chromium made by isolating the oxides, ca produced from considerably less pure raw mate since the impurities can be eliminated in proce manufacture whether by wet or dry methods.

It is obvious from a study of the table that number of elements which definitely modify physical qualities of steel is very great. Since vary quantities of each element have marked effects, three, four, or more may be utilised in different rat to one another, it is obvious that the number combinations is almost infinite.

The purely commercial problem facing makers of alloy steels, viz., that of complying with certa physical tests, is in itself complicated. Alloy ste to comply with the specification physically may be obtainable by several different mixtures, and the c st

raw materials is an important consideration. For tance, if 5s. worth of tungsten gives the same ults as 10s. worth of molybdenum in a high-speed el, it is obvious which metal will be used commer- lly. Thus, it is a problem to which there may many solutions, and fluctuation in price of raw aterials may vary the answer from time to time hen costs are considered.

The demand for a special alloy metal which is are will, as a rule, create a supply sooner or later, llowed generally by reduced cost. For instance, fore the war the ores of tungsten were compara- ely scarce, but the enormous war demand resulted the discovery of entirely fresh sources of supply d consequent reduced prices.

No attempt will be made here to deal in detail with manufacture or origin of the various metals under cussion, but a few words on these subjects may be ful.

itanium.—This metal is used in alloy steels, for most part as a scavenger to deoxidise finally the al before teeming, and for this purpose it is added he ladle. The quantity employed is only sufficient this purpose, and none of the metal is to be found the finished steel.

Numerous claims have been made for its efficacy an ingredient of steel, and it can be classed as er investigation rather than as a metal employed mercially by steel makers. To the extent that s used, it is rather in castings than in steel for ing or forging. The ferrotitanium is prepared electric furnace or thermit methods from rutile, ineral which is by no means rare.

irconium is still in the experimental stage, and e is no commercial demand in this country. Many l makers who have experimented with it have d that the metal cannot be traced in the steel, t it appears to have gone entirely into the slag. very high melting point, and strong affinity en, together with a low specific gravity, so y no means improbable.

supplies of zirconium ores could be obtained, oxide is in some demand as a refractory, separation from silica presents a somewhat un problem commercially, and restricts its igh cost.

fractory purposes high zirconium and low necessary, and these points are those chiefly tched in examining the ore.

and *silicon* need not be discussed as they the same sense alloy elements, their presence eing fundamental and the subject of adjust- her than of addition.

ium is an alloy metal that has come largely during the last twenty years. It is one of interesting of the series. Its effects on the properties of steel are very marked and so as an addition to steel containing other metals.

he chief sources of vanadium are the sulphide of Peru and the lead vanadate mined in Central ca. Vanadium is also found in association with nium and in ashes from Peruvian bituminous coal.

The problem of smelting vanadium for use by steel makers is not altogether simple. In the first place the actual product they require is ferrovanadium, containing limited percentages of silicon and carbon and 35—50% of vanadium. A higher vanadium content gives an alloy too low in specific gravity and not sufficiently fusible.

Rich sulphide ores containing 20—30% as sulphide can be roasted to oxide and reduced in admixture with iron oxide by aluminium. This process was the one chiefly in use for some years when the Peruvian mines were producing large quantities of rich sulphide. The cost of production in this way was comparatively low and the product satisfactory, although somewhat higher in silicon than now specified by many consumers.

The reduction by aluminium is subject to sub- stantial loss in the alumina slag, and over a period this amounts to a very considerable stock. B. D. Saklatwalla worked out the recovery of the vanadium from these slags in electric furnaces, and supplied large quantities during the war, but the quality is considerably lower than the original aluminothermic product.

The recovery of vanadium from lead vanadates in- volves quite different methods. The minerals contain 10—20% V_2O_5 and varying quantities of lead, zinc, and copper. In many cases there is a very substan- tial quantity of phosphorus, which must be eliminated. Vanadium oxides, as is well known, are almost equally soluble in mineral acid and alkaline reagents. Further, in wet methods of extraction vanadic oxide precipi- tated by careful neutralisation brings down with it oxides of other metals, generally as slimy, unfilterable precipitates.

In practice, therefore, it is found that the different ores of vanadium, although very similar in composi tion, require special treatment for the production of vanadic oxide and ferrovanadium, and that each ore must be studied as a separate problem. For sale and purchase of vanadium ores a complete analysis is desirable and almost essential. Special attention must be paid to accurate determination of the phos- phorus.

Chromium is very largely used for alloying with steel. It increases the tensile strength and hardness, and it is employed to a considerable extent as a third or fourth ingredient in alloy steels containing a number of alloy metals. Ferrochrome is sold in various grades, according to the carbon contents, which vary between commercially carbon-free (under 0·1%) and 8—10%, and prices rise rapidly as the carbon contents fall.

Practically the whole production is made in electric furnaces smelting chromite ores containing 48—52% Cr_2O_3, together with iron oxide, magnesia, and silica. Impurities such as sulphur and phosphorus are not usually present in large proportions in the ores, which are mainly produced in Rhodesia, New Cale- donia, South-East Europe, and America, though there are sources of supply in many countries.

Chromium is specially interesting to-day as an alloy metal, since it is the main constituent, other than iron, of stainless steel and iron, which contain 10—20%

Cr. The reason for the high resistance of these alloys to corrosion is not yet satisfactorily explained, but generally speaking they seem to have in an exaggerated form the well-known properties of iron in a passive state. For ferrochrome production silica is frequently specified within certain limits, and in consequence the assay of the minerals must be watched for this as well as for magnesia, iron, sulphur, phosphorus, and arsenic. The use of chromite ore without treatment as a refractory is, of course, well known, and in this case experience is largely a guide to the relative values of minerals of different origin.

Molybdenum has very pronounced effects on the physical qualities of steel. It shares with tungsten the property of imparting red-hardness, or hardness at abnormally high temperatures, and for this purpose can be used as a constituent of high-speed tool steels. Its effects in this direction are more pronounced than those of tungsten, and the percentage required is only about one-fourth to one-third of the tungsten used in making high-speed tungsten steels. Its disadvantages are first cost, which is more than proportionally higher than that of tungsten, and the volatile nature of molybdic oxide which tends to reduce the amount of the metal alloyed with the steel, and in particular makes it difficult to insure uniformity of molybdenum contents in successive heats.

On the other hand, molybdenum is utilised to a considerable extent for other classes of steel to increase hardness and strength, and it is required in some specifications for armour plate.

The mineral used for the most part is molybdenite, which is mined in several places, notably Canada, Norway, and Australia. It is not a simple mining proposition, as the values are generally very patchy and concentration is difficult, but has been solved to a considerable extent by flotation. Lump ore is very difficult to grind and water concentration involves prohibitive losses in float mineral.

Ferromolybdenum is produced directly from the sulphide in an electric furnace, or by thermit methods from the calcined ore. There are two recognised grades containing respectively 1% of carbon and upwards, and carbon-free, the molybdenum varying between 60 and 80%. Copper is frequently present in the ore, and a maximum of 0·25—0·75% Cu is often specified in the alloy. This, therefore, must be watched for carefully in assays of the mineral, as also phosphorus, since large quantities of molybdic acid are used for the rapid determination of phosphorus in steel.

Tungsten has been used for half a century or more to impart red-hardness to tool steel. Starting with 3—4% introduced by adding pure tungsten ore into the steel crucible, it has gradually risen to nearly 20% in the most efficient tungsten-chromium-vanadium high-speed steel. It is also used for permanent magnet steel in small quantities (2—4%).

The use of tungsten for incandescence electric lamp filaments and for terminals in electro-magneto coils is well known, but absorbs only a comparatively small tonnage.

The main use is for tool steel, and for this pur[illegible] it is employed either in the form of powder (98—[illegible] W) or ferrotungsten (80—85% W). Powde[illegible] prepared by isolating tungsten trioxide by an alka[illegible] melt, lixiviation, precipitation by mineral acid, [illegible] reduction of the trioxide thus obtained. Fe[illegible] tungsten is made by direct smelting of the min[illegible] either electrically or by thermit methods.

The ores, mainly iron tungstate (wolfram) [illegible] scheelite (calcium tungstate), are very widely [illegible] tributed and generally associated with tin. Chi[illegible] Burma, Malaya, Australia, and the United States [illegible] the chief producers, but supplies collected during [illegible] war and remaining as unconsumed stocks have co[illegible] pletely upset the mining of tungsten ores, and for [illegible] most part there is little or no production at prese[illegible] except in conjunction with tin. Standard wolfr[illegible] contains 65% WO_3 and upwards and less th[illegible] 1—1½% Sn, but consumers when they can pick [illegible] choose, reject ores containing much sulphur, arse[illegible] and copper. Further, for direct smelting the relat[illegible] percentages of iron and manganese in wolfram [illegible] important, as ferrotungsten is generally specified [illegible] contain a certain maximum of manganese.

Uranium is one of the metals on probation as [illegible] alloy in steel. Up to the present it has only be[illegible] tried experimentally, and the results claimed h[illegible] not led to any general commercial use.

It has been produced as a by-product in reco[illegible] radium from pitchblende. The oxide is isolat[illegible] the reduction to metal or ferro alloy involve[illegible] siderable difficulties, since great heat as w[illegible] thermit reagents are required. It is done, the[illegible] in an electric furnace with aluminium, and in [illegible] ducing or neutral atmosphere.

The ore, formerly mined to some extent in [illegible] rado, Portugal, Austria, Cornwall, and else[illegible] now comes almost entirely from the Be[illegible]an [illegible] where large and cheaply worked deposits hav[illegible] discovered.

Manganese is an indispensable alloy meta[illegible] in small quantities, but special steel co[illegible] 14—16% of manganese is utilised for many pu[illegible] where a very hard and tough metal is required. [illegible] alloy is generally cast and ground, as it is di[illegible] to machine. Rolls, jaws for stone crushers, tra[illegible] points and crossings, and many other useful pr[illegible] are made from it. The ore is found in many p[illegible] and is the subject of a great deal of literature, so tha[illegible] even a brief reference to the metallurgy and assay [illegible] unnecessary.

Cobalt is now utilised to a considerable extent [illegible] steel for permanent magnets and other uses. It i[illegible] bought as pure metal reduced from the oxide int[illegible] cubes or shot. The bulk supply comes from Canada where large bodies of ore are mined, primarily fo[illegible] their high silver contents. The metallurgy follows orthodox lines of solution, purification of solutions, and precipitation of cobalt oxide. There is, too, a steady consumption of cobalt oxide in the ceramic industry.

Nickel has been employed for a long time as a[illegible] alloy metal in steel. Its utilisation can be traced in

allel with the battle between defensive armour armour-piercing projectiles. Nickel steel and ome-nickel steel are standard products for use re high tensile qualities are required. The chief ducing countries are Canada and New Caledonia, ough many other deposits are known.

he metallurgy is complicated and interesting, as volves two very different principles. The Mond ess of volatilising nickel carbonyl and decom- ing it at a higher temperature is opposed to elec- ytic purification of crude smelted metal. These esses and many others are described in technical lications and need no further reference.

t is not claimed that these notes have dealt austively with the elements of use in or detri- ntal to alloy steels. Their main object is to cate the vast field that has been opened up in industry, which by its very nature calls for the operation of chemists at every stage. The steel- ks laboratory can no longer concern itself only h carbon determinations and tests for phosphorus. here are still many blank pages in the chemical ly of alloy steels, and not the least of these is the estigation of rapid and accurate methods for the ermination of different elements in admixture h others.

he steel-maker's verdict is based eventually on sical tests, and the chemist and alloy maker are called upon to account for troubles which may e within their province. Nevertheless, for n production to meet physical tests, uniform al composition is essential, and those deal- th the assay of ores and ferro alloys, and kers of those special metals, must exercise ing care if they are to avoid introducing al troubles into the manufacture of alloy To this end rapid and accurate methods of s are essential, especially when they can be dised for use by buyer and seller.

oved methods of preparing the alloy metals o alloys, and the exact influence of impurities physical qualities of steel, are also subjects ich chemical investigation can materially the production of alloy steels.

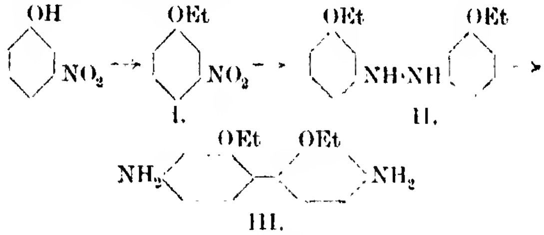
PARATION OF ISODIPHENETIDINE.

OHN REGINALD HARVEY WHISTON, M.A., B.SC.

During the course of another investigation it came necessary to prepare *m*-nitrophenetole, and was thought to be of interest to convert this bstance into the corresponding diphenetidine, as e latter does not appear to be described in the erature. It is also of interest in order to test the neral rule that only homologues of benzidine ntaining substituents in the ortho position to the nino groups yield azo dyestuffs substantive to otton. *iso*Diphenetidine is no exception to this rule, on tetrazotising and coupling it only yields dye- uffs substantive to cotton when coupled with such ds as S-acid (8-amino-α-naphthol-5-sulphonic acid) hich themselves appear to confer the property of rming substantive dyestuffs for cotton.

Experimental.

The reaction scheme evolved for the preparation of *iso*diphenetidine was:—



Preparation of m-*nitrophenetole* (I.).—A solution of 139 g. of *m*-nitrophenol (prepared by diazotising *m*-nitroaniline in sulphuric acid solution and decomposing the diazo compound by boiling) in 250 c.c. of 20% sodium hydroxide solution was heated to gentle boiling under reflux, and 215 g. of ethyl *p*-toluenesulphonate (recrystallised from methylated spirit) added in quantities of about 50 g. at a time at 10—15 minute intervals. When all had been added the reaction mixture was refluxed 6—7 hours, a further 40 c.c. of 20% sodium hydroxide solution added, and the nitrophenetol distilled off in steam. Yield 150 g. (90% of theory); m.p. 33°.

Preparation of mm'-*diethoxyhydrazobenzene* (II.). 33·4 g. of *m*-nitrophenetole were added to a solution of 25 c.c. of alcohol (92%), 50 g. of sodium hydroxide, and 150 c.c. of water contained in a flask fitted with a stirrer and reflux condenser. With vigorous stirring, 60 g. of zinc dust (90%) were added in small portions at a time so that the reaction mixture kept gently boiling. It was necessary to heat the flask on the water bath during the addition of the last 10—15 g. of zinc dust. 100 c.c. of water were then added, and the reaction mixture was left overnight. The pale yellow solid which had formed on the top was separated from the zinc residues by pouring on to a sieve (40-mesh) and washing with water. It was then ground up with dilute hydrochloric acid, filtered, washed with water, and air-dried. After recrystallisation from light petroleum (b.p. 40°—60°) the hydrazo compound was obtained in almost pure white crystals in yield of about 75% of theory; m.p. 86°. (Found N = 10·2%: $C_{16}H_{20}O_2N_2$ requires N = 10·3%.)

Conversion of mm'-*diethoxyhydrazobenzene into* iso-*diphenetidine* (III.).—This conversion does not proceed so smoothly as the conversion of the simple hydrazobenzene into benzidine. The following method was found to give the best results: 34 g. of the hydrazo compound were ground with 100 c.c. of cold hydrochloric acid (33%), the mixture was heated for 15 minutes on the water bath, and finally boiled gently for 15 minutes. On adding hot water (350 c.c.) almost complete solution took place. After filtering hot, the filtrate was made alkaline by the addition of dilute sodium hydroxide solution, and the free base, which separated as an oil, extracted with benzene. The benzene extract was boiled with charcoal and filtered, and the benzene distilled off under diminished pressure. The residue set to a somewhat sticky, crystalline mass, and the pure *iso*-

diphenetidine was obtained from this by two recrystallisations from dilute alcohol, the final yield being 12·5 g. (37% of theory); m.p. 109°. (Found C = 70·6%, H = 7·2%, N = 10·2%; $C_{16}H_{20}O_2N_2$ requires C = 70·6%, H = 7·3%, N = 10·3%.)

Summary.

*iso*Diphenetidine (m.p. 109°) has been prepared from *m*-nitrophenol. It does not yield azo dyestuffs which are substantive to cotton.

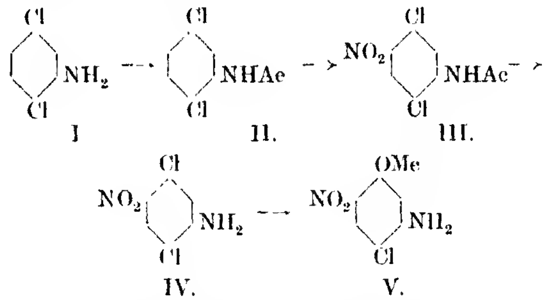
The bulk of the above work was carried out in the Dyson Perrins Laboratory, Oxford, and the author owes his thanks to Prof. W. H. Perkin for the kindly interest he took in the work, to Mr. F. Hall for making the necessary analyses, and to The British Dyestuffs Corporation and the Commandant, Artillery College, for permission to publish these results.

Artillery College,
Woolwich.

THE PREPARATION OF 4-CHLORO-6-NITRO-*m*-ANISIDINE.

BY JOHN REGINALD HARVEY WHISTON, M.A., B.SC.

This compound is mentioned in G.P. 216,417 (Friedländer, IX., 419), but no details as to its preparation or properties are given. As it was required in connexion with some other work, its preparation was attempted from 2.5-dichloroaniline (I.) by the following reaction scheme:—



The preparation of 2.5-dichloro-*p*-nitroaniline (IV.) is mentioned by Noelting and Kopp (Ber., 38, 3514), but their method has been considerably modified, and very good overall yields of 4-chloro-6-nitro-*m*-anisidine have been obtained.

Experimental.

To 20·4 g. of 2.5-dichloroacetanilide (II.) (prepared from 2.5-dichloroaniline by the usual method of treatment with acetic anhydride) dissolved at 45° in 80 c.c. of sulphuric acid (96%) and cooled to 5°, a mixture of 12 g. of nitric acid (66%) and 60 g. of sulphuric acid (96%) was slowly added, with stirring, the temperature rising to 10°. The mixture was allowed to stand for 15 minutes at room temperature, poured on ice, the precipitated nitro compound filtered off, washed with water, and pressed. Without drying, it was heated for 2 hours on the water bath with 150 c.c. of sodium hydroxide solution (8%). After cooling and adding water, the yellow dichloronitroaniline (IV.) was filtered off, well washed with water, and dried. Yield 19·5 g. (94% of theory); 152°—153°.

Preparation of 4-chloro-6-nitro-m-anisidine (V 10·4 g. of 2.5-dichloro-*p*-nitroaniline were refl for 8 hours on the water bath with 50 c.c. of me alcohol and 4 g. of sodium hydroxide. After coo the reddish-yellow product was filtered off, wa with water, and dried. Yield 8·7 g. (85% of theo m.p. 154°—155°. On recrystallisation from ben it forms pale yellow, needle-shaped crystals of 156°. (Found C = 41·3%, H = 3·5%; $C_7H_7O_3$ requires C = 41·5%, H = 3·5%.)

Summary.

4-Chloro-6-nitro-*m*-anisidine has been prep from 2.5-dichloroaniline. It forms pale yel needle-shaped crystals, m.p. 156°.

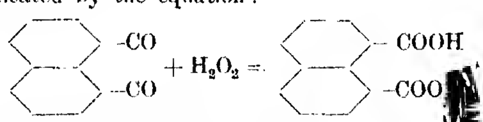
The author wishes to thank Prof. R. Robinson his interest in this investigation, and also The Br Dyestuffs Corporation and the Commandant, Arti College, for permission to publish the results.

Artillery College, Woolwich.

THE PREPARATION OF NAPHTHALIC A BY OXIDATION OF ACENAPHTHAQUINONE.

BY JOHN REGINALD HARVEY WHISTON, M.A., B

Although naphthalic acid is usually obtained a by-product in the preparation of acenaphthaquinc it was thought to be of interest to determine whet it was possible to convert acenaphthaquinone naphthalic acid by means of hydrogen peroxide indicated by the equation:—



This reaction has been found to proceed very sm an almost quantitative yield of the acid bei tained.

Experimental.

192 g. of a paste of acenaphthaquinone (25% stirred to a smooth suspension with 100 c.c. of hydroxide solution (25%) and 200 c.c. of After heating to 40°, a solution of hydrogen pe containing about 15% excess of hydrogen pe was slowly added, the temperature being raise boiling during the addition. The acenaphthaquinc was rapidly converted into naphthalic acid, wh passed into solution as its sodium salt. After boili for 10 minutes, the solution was filtered hot, the sm amount of residue being washed with hot water un the washings were clear. The naphthalic acid w then precipitated from the filtrate by the additi of hydrochloric acid, filtered off, washed, and drie Yield 55 g. (95·5% of theory).

The author wishes to express his thanks to Pr R. Robinson for suggesting this investigation, a to The British Dyestuffs Corporation and the Co mandant, Artillery College, for permission to pub the results.

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CHEMISTRY & INDUSTRY

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The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

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EDITORIAL

A FEW weeks ago there was a singular and distressing outbreak of cases of poisoning by lead tetraethyl in the United States. This compound was discovered in 1854, but achieved no commercial importance until comparatively recently. Mr. T. Midgley found that it could be mixed with petrol and that the mixture was more efficacious for driving motor-cars and was less liable to knock than ordinary petrol. One part of lead tetraethyl was mixed with about a thousand parts of petrol. The lead tetraethyl was made by the E. I. du Pont de Nemours Company at Wilmington, and also made and mixed with petrol by the Standard Oil Company at Elizabeth, New Jersey. Lead tetraethyl is a particularly poisonous compound and may cause delirium, insanity and death. Five deaths from this form of poisoning recently occurred at the Standard Oil Company's works at Elizabeth, and eight or nine people are alleged to have been killed by it at the du Pont works at Wilmington. The Board of Health of New York has prohibited the use of petrol containing lead tetraethyl and the New Jersey State Department of Health has made a similar order. The Standard Oil Company has discontinued the manufacture and sale of the mixture and a careful investigation of the methods of manufacture and use of lead tetraethyl is now being conducted.

* * *

It was pointed out by Sir Robert Hadfield, Mr. C. A. Klein and others, at the meeting of the London Section last Monday, that there are many methods of protecting surfaces from corrosion or weathering. If a body is to be subjected to so much friction that the surface is constantly being worn away, it is obviously useless to coat this with a covering of no greater power of resistance than the original body. A knife blade, if in constant use, is always losing its surface; it is useless to electroplate it, the only cure is to alloy the steel with sufficient chromium to keep it rustless. A knife that is to be used at rare intervals might with advantage be plated with nickel or chromium to prevent its corrosion in the long intervals between its use. The protection of wood varies with its use and other circumstances. Sometimes you must impregnate it with oil or creosote, sometimes you must paint it; your paint will not necessarily be the same for wood in your drawing room as for your greenhouse roof. Varnishes, polishes, cellulose dopes, oils and waxes all have their own special powers of resistance; we think the distinction drawn between protection of a body from wear and protection of a body from weather is sound. A boy who climbs every wall in the vicinity requires protection for his clothes differing from the protection his mother provides for her fur cloak when she puts it away because the cold and wet weather has set in. The protection of stone is singularly difficult in the air of a great city. Stone is so compact that it cannot easily be impregnated, but it is so porous that water and various solutions can penetrate in places so deep that great damage is done when the water freezes or the solution crystallises. Some day the chemist will show us how to convert an inferior sandstone into a superior granite: it may not be so easy to convert chalk or limestone into a really durable material.

* * *

The joint meeting of the Oil and Colour Chemists' Association with the London Section of the Society of Chemical Industry, which was held at Burlington House last Monday provided many subjects for reflection. The meeting was fortunate in having Sir Robert Hadfield to open the discussion, on "Protective Paint Coatings," and although, as Sir Robert said, his contribution, dealing with the production of alloys resistant to corrosion, was not directly concerned with protective coatings, yet it did show how far the metallurgical chemist, approaching the subject from a different standpoint, had proceeded in the endeavour to do without paint altogether. How difficult the chemistry of paint is was amply shown by the various speakers, a serious difficulty being the necessity for practical exposure

tests, involving considerable expense and a long delay. As the chairman, Dr. Bernard Dyer, said, there must be very few chemists who, at some period in their career, do not have to face some problem connected with paint, and Dr. Fox showed how harassed the chemist can be when such problems are presented. It was of singular value to consider the subject from the industrial as well as the user's standpoint, and the discussion must have impressed everyone in the large audience with the need for more chemists and more chemistry in the paint and varnish industry. Had we more chemists of the type of Dr. Morrell to devise ingenious apparatus and methods such as those which he described for testing the permeability of varnish films; were there more chemists like Dr. Fox to talk to us confidentially and show the limitations of chemical analysis, with a Mr. Klein or two to hold the balance on the practical side, progress would be rapid. The meeting on Monday showed some of the gaps in our knowledge and provided a stimulating atmosphere in which to discuss them. Excellent as are the products of the paint and varnish manufacturer—the London bus, with its gay colours, is a convincing witness—who could be so bold as to say that improvement is impossible? Discussion lights up the path along which advance is profitable. That this path may be distinctly thorny was shown by the summing up by Dr. H. Houlston Morgan, the president of the Oil and Colour Chemists' Association. One point was very striking: the presence of a water-soluble constituent in paint was declared by one speaker to be sufficient cause for rejection of the paint, but another speaker disagreed entirely. This seems a fruitful subject for discussion and we shall hope for enlightenment.

* * *

The Society of Chemical Industry, with its far-flung membership, comprising such a variety of interests centred on chemistry, holds a unique position. This wide scope of the Society and the liberal interpretation which must be given to the word chemistry confer unusual qualities on its *Journal*, qualities that carry with them many problems, as the editorial staff knows full well. One of the most striking features, and one which constantly comes to our notice, is the way in which information given in the *Journal* percolates to sources that are not immediately obvious considering the membership. An article which provokes no comment when it is published may lead to a succession of letters weeks or even months afterwards. A five-line note on some current topic results in a request for further information which arrives the day after publication, and letters relating to the same note may still reach us a couple of years after publication. One kind of letter—that containing an article—always brings a gleam of hope to the editorial eye. Perhaps it is that much desired article on that industrial topic about which no one will write. Perhaps the author is not restricted by the possession of confidential information; perhaps——. Too often it is "alas," not "a visage of joy," but we still hope.

ECONOMY IN STEAM RAISING. II

By CHAS. F. WADE, A.M.I.Mech.E., A.M.I.E.E.

BOILER FURNACES. FIREGRATES. AREAS. [illegible] SUPPLY ARRANGEMENTS. DRAUGHT CONTR[illegible] MECHANICAL STOKERS.

The standard firegrate supplied with a Lancash[illegible] boiler is usually 6 ft. in length, and will vary [illegible] width with the size of the boiler and with vary[illegible] practice of different makers. This 6-ft. grate see[illegible] to be a legacy of past times when the principles [illegible] heat transfer were but little understood and boil[illegible] were only supplied for certain rated outputs [illegible] steam per hour, irrespective of the amount of co[illegible] burned to obtain the required duty or special loc[illegible] conditions of the plant.

Before mentioning practical details of boiler fu[illegible]naces, it is as well to understand thoroughly the tw[illegible] principal ways in which heat is transmitted in [illegible] boiler. These are by direct radiation or the tran[illegible]formation of heat-energy into radiant energy, an[illegible] back again to heat energy on absorption by a[illegible] opaque surface; and secondly by direct conductio[illegible] of heat energy by contact of the comparatively coo[illegible] heating surface with the high temperature gases[illegible] The former method of transfer plays the most im[illegible]portant part in any boiler, being responsible for abou[illegible] 75 per cent. of the heat transferred. The explanation[illegible] of this is that radiation is not interrupted by trans[illegible]parent layers of gases in contact with the heating[illegible] surfaces, while, to conduction, such gas films offer [illegible] very considerable resistance. The most effective way of increasing the heat transfer by conduction is to maintain the velocity of the hot gases as high as possible, so that the inert gas film is reduced to its minimum possible thickness.

The principal object to aim at in any boiler furnace is to maintain as high a temperature as possible with a corresponding maximum radiation activity: this is obtained when the firebed is of the greatest thickness compatible with complete combustion. This thickness will vary according to the amount of air supply available, for it cannot be too well or too often emphasised that the atmospheric oxygen is as much the fuel as the coal or other material usually known by that name, so that, above a certain point, the more air there is used the more wasteful is the operation of the plant. The importance of high furnace temperature will be realised on reference to the laws of transference of heat by radiation as evolved by Stefan and Boltzman, wherein it is given that the amount of heat radiating from an incandescent black body varies in proportion to the fourth power of the absolute temperature. Rankine has laid it down that the total heat transference in a boiler, due both to radiation and conduction, varies as the square of the temperature difference, but the exact variation is very difficult to determine. In any case, it is obvious that the furnace temperature has a very marked effect upon the efficiency of the boiler. If the furnace temperature is low the temperature gradient through the boiler will be reduced as compared with high furnace temperature, or, in other words, the exit tem-

perature of the waste gases will not vary directly with that of the furnace.

The grate area of a Lancashire boiler to give the highest efficiency can only be found by actual experiment, by reducing the area step by step and increasing the combustion rate per sq. ft. of heating surface until a point is reached, determined by local conditions, where the steaming capacity of the boiler commences to fall or the fire thickness is too great for complete combustion. Under average conditions a 4-ft. length of grate is usually found to approximate closely to the best combustion conditions.

The next most important point to consider is the design of the firebars. These should be so designed that the maximum air space is available between the bars consistently with mechanical strength. An ample depth is also necessary in order to present a good surface to the incoming air to cool the bars and incidentally to preheat the air slightly. Numerous thin firebars both distribute the combustion air more evenly throughout the firebed, and are less liable to burn away rapidly, than a smaller number of thicker bars.

The firebridge in cylindrical boilers should always be built as low as possible, and must only be considered as a check against coal being thrown too far beyond the grate. A high firebridge acts as a fixed damper in the path of the gases, and leads to incomplete combustion and trouble from smoke emission.

With hand firing special attention is called for in the regulation of the air supply, both through the firebed and over the fires. The main air control from the individual boiler dampers must always be easily workable and worked from the firing position, while the secondary air supply over the fires should be regulated by means of proper air shutters on the fire doors, and the ashpits should be provided with a damper so as to divert the air from the ashpit to the combustion space until the large volume of volatile matter at first driven off at firing has been largely consumed. Air introduction at the firebridges is not an effective method of consuming the volatile hydrocarbons, but more often arrests combustion and merely dilutes the gases with comparatively cold air. There are many patented devices on the market embodying various forms of hollow firebridges for secondary air supply, but in practice none of these are very satisfactory. By closing the ashpit damper and allowing a larger volume of air to pass over the fires through the firedoor grids, the generation of unmanageably large volumes of gases is retarded by the reduced temperature in the bottom of the firebed, and a larger supply of air is available to mix with the gases above the fires. It may be mentioned here that air in passing beneath the firegrate to a hollow firebridge or other form of secondary air supply at the back end of the grate does not become appreciably preheated, as is sometimes claimed, as the air is only exposed to radiation and not conduction, and is therefore not heated up, owing to its transparency. What little heating may take place is that from the lower surface of the ashpit, and in cooling the water at this point will do more harm than good in reducing the water temperature and reducing circulation, just where it is most required.

Considerable attention is now being given to the use of various low grade fuels such as fine slack coal and coke dust, and, so long as a specially designed furnace is employed, these materials will give perfectly satisfactory results. As a rule the percentage of ash in the class of fuels mentioned is rather high while the calorific value is low. The requirement for a furnace to burn low grade slacks is that it shall have a sufficiently powerful draught to maintain a high rate of combustion and at the same time the formation of large masses of clinker must be reduced as far as possible. Fine slack coals and coke dust pack closely together on the firegrate so that a high draught pressure is necessary in order to overcome the resistance to the passage of air through the firebed and at the same time to maintain a sufficiently rapid combustion rate to obtain a reasonable duty from the boiler. There are several excellent makes of forced draught furnaces available which will burn high ash fuel efficiently with but little combustible matter removed with the ashes. All these furnaces employ an arrangement of steam jets to maintain sufficient pressure in the ashpit, and the effect of the steam on the firebars prevents the formation of masses of clinker, which remains in a granular form and can be raked out rapidly when cleaning fires.

When burning coke or other low volatile fuel forced draught is always necessary in order to keep the whole of the mass of fuel at incandescence, if anything approaching high efficiency is to be obtained. The reason for this is that with low rates of combustion the secondary, reducing action of the carbon in the upper layers of fuel on the grate reduces the surface temperature by its endothermic effect and the carbon monoxide resulting burns with a flame which is deficient in radiant energy, so that heat transference is mainly dependent upon conduction instead of radiation.

When speaking of the "furnace" of a boiler the combustion engineer includes in that description the whole of the boiler furnace proper and the flues around the boiler. The requirements as to high velocity of gases in order to effect the maximum conduction transmission are, in cylindrical boilers, greatly restricted owing to the necessity for sufficient space for access purposes. The utility of such devices as firebrick obstructions in the flue tubes is limited by the amount of draught power available, for although the velocity of the gases may be accelerated by the insertion of, say, a firebrick cylinder, yet the air supply to the fires may be so reduced thereby as to result in a diminution of combustion rate that will more than offset the advantage obtained by the increased velocity of the gases.

In water-tube boilers attempts to increase the velocity of the gases by the addition of baffling so that the path of the gases is lengthened and narrowed have mostly resulted in increased final temperatures for the gases instead of the expected reduction, although the furnace temperature has been lowered. This result is explained in the same way as that given above. Another result of adding

baffling to vertical water-tube boilers which also reduces efficiency is that caused by the actual covering up of appreciable portions of the tube surfaces by the extra baffles, this taking place usually where, in the absence of the extra baffles, the hot gases would directly impinge. By altering the actual system of tubing so as to maintain or increase the velocity of the gases as their volume decreases with the temperature, the difficulties referred to above are overcome, as in the present writer's recently patented system of tubing. In this arrangement each successive bank of tubes is of the same aggregate heating surface, but composed of smaller tubes grouped more closely together so that the area of the gas passage occupied decreases proportionately to reduction of the gas volume, thus maintaining the velocity.

The water-tube boiler has a great advantage over the internally-fired boiler in that there is but little limitation of combustion space and a very large combustion chamber may be provided for thorough combustion of large quantities of fuel before partially burned gaseous products reach the comparatively cool heating surfaces. In older water-tube boilers, set low over the fires, high combustion and evaporation rates were prevented because the hydrocarbons reached the tube surfaces before combustion was complete and were thus arrested, with the formation of more or less black smoke. In more recent installations the boiler is set some feet above the firegrate surface so that combustion is perfect before contact is made with the heating surfaces, while the direct exposure of the latter to radiation from the firebed is not interrupted.

In order to provide more combustion space in Lancashire and similar boilers experiments have been made with various forms of external furnace, but none of these has met with any large measure of success owing to the fire surface being screened from the heating surface and practically the whole heat transmission having to be effected by conduction. The provision of an inverted arch for a few feet within the mouth of the flue tube would be very effective in providing an incandescent radiating surface to project the heat on to the heating surface.

Mechanically fired furnaces have their widest field of application in conjunction with water-tube boilers, while there are only a few types which are satisfactory with internally-fired boilers. The principal drawback in the latter case is the difficulty of seeing how the fuel is distributed over the firegrates so that the necessary adjustments can be properly carried out. The construction of water-tube boilers, on the other hand, lends itself to the provision of ample sight holes in the sides of the furnace so that the state of every portion of the fires can be observed readily. The limited space available in a furnace tube also prevents the adoption of anything approaching a travelling grate arrangement, so that the feeding of the coal down the grate of a Lancashire boiler is never so definite as with the travelling grate stoker of a water-tube boiler.

The sprinkling type of stoker greatly outnumbers all others for firing Lancashire boilers and this class of machine will deal very satisfactorily with low-grade fuels of most descriptions. The air is usually supplied under pressure from steam jets and the firebar arrangements approximate very closely to those employed for the hand-fired furnaces already mentioned.

In the absence of steam storage, mechanical firing is at a disadvantage compared with hand method when the demand to be met is subject to heavy and rapid fluctuations as is very widely the case in the chemical industries. Where the forced draught is supplied by means of steam jets and there is an appreciable fall of steam pressure due to a sudden heavy demand for steam, it is a frequent occurrence that the reduced steam pressure prevents anything approaching a heavy fire being worked up owing to the decreased effect of the jets. This means that a good reserve of boiler capacity must always be available in order to avoid trouble from fall of steam pressure.

The efficient operation of mechanical stokers calls for quite as much intelligence as hand firing although the need for physical effort is greatly reduced in the former case, and it is a fact that, until some device for automatic regulation of the fire speed and thickness by the composition of the waste gases is evolved, coupled with damper regulation in the same way, the necessity for scientific and intelligent human control will not be reduced.

Some mention may be made of methods of automatic draught control. These all derive their initial means of operation from the variations of steam pressure, and if control of the stoker feed is not combined with the damper control there are circumstances under which such devices will be quite the reverse of economical. A fall of steam pressure may be caused through holes in the fire or thin patches, so that on the damper opening under this influence more cold air than before will be drawn through the boiler, resulting in further lowering of steam pressure and more uneconomical furnace conditions. Closing of the damper under the influence of a rise of steam pressure will probably result in a deficiency of air for the fuel on the grate so that incomplete combustion results with the presence of carbon monoxide and probably black smoke.

The best method of hand control of fires is by means of the differential draught gauge in conjunction with a steam flow meter, either combined in one instrument, as in the Bailey boiler meter, or by the use of two separate instruments.

A simple calculation will show that the amount of oxygen or air required to produce a given number of heat units is very nearly constant over a range of solid fuels ranging from semi-anthracite to low-grade semi-lignites. Also in a given boiler, when all other things are equal, the rate of steam generation is a measure of the amount of heat being generated, and the fall of draught pressure from the boiler side of damper to the combustion space over the fires provides a measure of the relative air-flow. Thus, with the boiler working at its best efficiency there will be an approximately constant relation between the reading of a differential draught gauge, connected at the points mentioned, and that of a steam flow meter, connected in the boiler steam branch. Initial calibration of such a

combination is made by careful adjustment of the air and fuel supply, with the assistance of an Orsat apparatus, so that the best combustion conditions are obtained and then marking the dial of the differential draught gauge with the corresponding steam meter reading. This operation is repeated for different values of steam flow and the fireman will then have a direct guide to the correct damper or fan adjustment for the particular rate of steaming obtaining at any time.

In the Bailey boiler meter, a single circular recording chart is employed. Two mechanisms record on the same chart, one being a steam flow recorder and the other a differential draught recorder. The instrument is so adjusted that when the correct relation between the two factors exists the line traced by each pen is superimposed. If there is too much air for the amount of fuel on the grate or the steam flow rate, the draught line will be above the steam line. If at any time it is found impossible to make these lines correspond it is a direct indication that there is some defect in the boiler which calls for rectification. Thus, a dirty boiler will render it impossible to get the air line down to the steam line even though the air is in correct proportion to the fuel being used, the apparent discrepancy being caused by the reduction in the amount of steam being generated for the amount of fuel being used.

ON THE HISTORY OF POTABLE GOLD

In the *Chemiker Zeitung* (112, 653 and 678), Dr. Ernst Darmstaedter—who will be remembered for his recent book "Die Alchemie des Geber"—has an interesting article entitled "Zur Geschichte des 'Aurum Potabile.'" Darmstaedter first of all considers the question of how the metals originally came to be used in medicine, and brings forward evidence from the Atharvaveda, Yajurveda and other ancient Sanskrit literature in support of his suggestion that the supposed relationship between the sun and moon and gold and silver respectively may have led men to drink a suspension of gold in water in order to acquire the vitality of the solar god. In the Indian ritual gold was closely connected with Agni, the fire-god. The Susruta medicine describes the preparation of a "gold drink" by beating out gold into thin leaves, heating it strongly six or seven times, and then dissolving it in various liquids. The drink so obtained was used as an aphrodisiac, etc.

In this connexion it may be noted that the ancient Egyptians regarded gold (as well as malachite and other substances) as essentially a *giver of life*, and according to the Elliot Smith and Perry school of archæologists, it was their industrious search for sources of these givers of life which led the Egyptians to construct sea-going ships and thus to spread the archaic civilisation all over the world.

Darmstaedter next considers the use of honey in medicine. Honey is often mentioned in Vedic literature, and its golden yellow colour may explain why it was frequently used, like gold, in the preparation of elixirs of life.

Greek medicine apparently made no use of gold and silver for healing purposes. Such application is, however, found in the Pharmacology of the Persian Abu Mansur Muwaffak, in the tenth century. Abu Mansur Muwaffak has, incidentally, another claim to distinction: he was the first to mention the use of plaster of Paris in surgery.

Similarly Ibn Sina (Avicenna, died 1036), in his Qānūn or Canon of Medicine, recommends the addition of gold to medicines used in case of melancholia, and says that, as a collyrium, it strengthens the eyes.

In medieval European medical practice potable gold found extensive application. It is mentioned by Arnaldus de Villanova, Vincent de Beauvais, Albertus Magnus, Thomas de Cantimpré, Konrad von Megenberg, and other well-known writers. It seems to have been a solution of gold chloride or occasionally colloidal solutions of gold. Ulstadius, Gesner and Paracelsus all extol the virtues of *aurum potabile*, and although at first the idea was quite independent of alchemy, the two soon became, and remained, closely connected.

Darmstaedter appears to attribute the discovery of fulminating gold to "Basil Valentine" (or Johann Thölde), in the "Letzten Testament," Strasburg, 1651. It was, however, well known to Jean Béguin half a century earlier, and is fully described by Christopher Glaser, who was the teacher of Lemery and acquired an unenviable reputation by getting himself mixed up with the notorious *Affaire Brinvilliers*.

Darmstaedter also mentions the well-known bactericidal powers of colloidal gold and suggests that the ancient praises of potable gold have something at least to be said for them. He sums up his conclusions by saying that we can get some idea of why gold was used as a healing and strengthening agent by a consideration of the following facts:—

(1) Magical, mystical and religious ideas.
(2) Alchemical theories.
(3) Practical observations of the action of metals and metallic preparations.
(4) The customs of folk-medicine.
(5) For later times, scientific, pharmacological and medical observations.

SODIUM CARBONATE IN CANADA

In the vicinity of Meadow Lake, 50 miles north of Clinton, British Columbia, the Lillooet Soda Company is operating at a hydrous sodium carbonate lake and shipping the product to Vancouver, over the Pacific Great Eastern railway. This material is being disposed of at the present time to soap manufacturers on the Pacific coast, but plans are under way for the erection of a drying plant to handle the material at the lake and to further increase the output. This Company also owns several other lakes of the same material which they propose to operate at some future date.

FORTHCOMING EVENTS

Dec. 8. BIOCHEMICAL SOCIETY, Imperial College of Science and Technology, South Kensington, at 5 p.m. (1) "The Magnesium of Human Serum," by E. Watchorn. (2) "The Oxidation of Amino Acids by Fungus Tyrosinase," by M. E. Robinson and R. A. McCance. (3) "The Isolation of a Hydrolysis Product of the Proteins hitherto Undescribed," by H. W. Buston, H. N. Mukherjee and S. B. Schryver. (4) "Some Transformations of Casein," by H. Martin and S. B. Schryver. (5) "The Separation of the Proteins of Egg-White in an Electrical Field," by D. Griffiths and S. B. Schryver.

Dec. 8. INSTITUTE OF BREWING, *London Section*, Engineers' Club, 39, Coventry Street, London, W. "Removal of Nitrogen from Wort by Yeast during Brewery Fermentation," by H. F. E. Hulton and J. L. Baker.

Dec. 8. CERAMIC SOCIETY, Central School of Science and Technology, Stoke-on-Trent, at 7.30 p.m. "Notes on Crushing and Grinding Mills," by F. Lane.

Dec. 8. ROYAL SCOTTISH SOCIETY OF ARTS, 117, George Street, Edinburgh, at 8 p.m. "Stone Decay and Preservation of Buildings," by Principal A. P. Laurie.

Dec. 8. ROYAL SOCIETY OF ARTS, John Street, Adelphi, London, W.C. 2, at 8 p.m., *Cantor Lecture*. "Modern Colour Problems," by Dr. L. C. Martin (Lecture 3).

Dec. 9. SOCIETY OF CHEMICAL INDUSTRY, *Birmingham and Midland Section*, the University Buildings, Edmund Street, Birmingham, at 7.15 p.m. "The Role of Silica in Plant Growth: its Assimilation, and Physiological Relation to Phosphoric Acid," by D. R. Nanji and W. S. Shaw.

Dec. 9. FARADAY SOCIETY, Rooms of Chemical Society, Burlington House, Piccadilly, London, W. 1, at 4.30–7.30 p.m. "Base Exchange in Soils," by Dr. D. J. Hissink; "Role of the Electronegative Ions in the Reaction between Soils and Electrolytes," by N. M. Comber; "Studies on Base Exchange in Rothamsted Soils," by H. J. Page and W. Williams; "Base Exchange in Relation to Soil Activity," by G. W. Robinson and R. Williams; "Relation between the p_H Value, the Lime Requirement and the Thiocyanate Colour of Soils," by S. J. Saint; "Some Secondary Aspects of Base Exchange in Soils," by E. A. Fisher.

Dec. 9. SOCIETY OF CHEMICAL INDUSTRY, *Glasgow Section*, The Ramsay Chemical Dinner, at the Ca'doro Restaurant, Glasgow.

Dec. 9. SOCIETY OF DYERS AND COLOURISTS, *Leeds Junior Branch*. "The Tinctorial and Antiseptic Properties of Certain Types of Quinoline Dyestuffs," by P. G. Marshall.

Dec. 9. ROYAL PHOTOGRAPHIC SOCIETY, *Scientific and Technical Group*, 35, Russell Square, London, W.C. 1, at 6 p.m. Discussions will take place on (1) "The Light Source, Primary and Secondary," opened by J. W. T. Walsh. (2) "The Exposure Mechanism," opened by S. O. Rawling. (3) "Development," opened by W. Clark.

Dec. 10. INSTITUTION OF CHEMICAL ENGINEERS. The meeting arranged for this date has been cancelled.

Dec. 10. UNIVERSITY OF LONDON, University College, Gower Street, W.C. 1, at 5.30 p.m. "Technical and Scientific Libraries," by A. Gomme.

Dec. 10. INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND, *Manchester Section*, The Engineers' Club, Albert Square, Manchester, Concert at 7 p.m.

Dec. 11. INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, Joint Meeting, the Pharmaceutical Hall, 36, York Place, Edinburgh, at 7.30 p.m. "Fumigation with Hydrogen Cyanide," by Lieut. Col. W. Glen Liston.

Dec. 11. INSTITUTE OF METALS, *London Section*, 85-88, The Minories, Tower Hill, E. 1, at 7.30 p.m. "Present Problems and Developments in Engineering Bronze Foundry Practice," by F. W. Rowe.

Dec. 12. IMPERIAL COLLEGE CHEMICAL SOCIETY, Royal College of Science, South Kensington, S.W. 7, at 5 p.m. "Some Knots in the Organic Chemical Tangle," by Prof. A. Lapworth.

Dec. 12. INSTITUTE OF BREWING, *Midland Counties Section*, Annual Meeting and Dinner at the Queen's Hotel, Birmingham.

Dec. 12. INSTITUTE OF METALS, *Swansea Section*, University College, Singleton Park, Swansea, at 7.15 p.m. Discussion on "The Design of Furnaces for Annealing and Heat Treatment."

Dec. 12. SOCIETY OF DYERS AND COLOURISTS, *Manchester Section*, "Recent Experiments on the Behaviour of Aluminium Hydroxide towards Dyestuffs and Salts," by J. K. Wood and A. Wooller. "On Alkali Cellulose," by Prof. E. Knecht and J. H. Platt.

Dec. 13. SOCIETY OF CHEMICAL INDUSTRY and INSTITUTE OF CHEMISTRY, *Birmingham and Midland Sections*, The Annual Dinner, Queen's Hotel, Birmingham at 6.45 for 7 p.m.

Dec. 15 to 20. UNIVERSITY OF LEEDS. Jubilee of the Yorkshire College of Science, and Coming of Age of the University.

Dec. 16. WEST OF SCOTLAND IRON AND STEEL INSTITUTE. "The Application of Producer and Coke Oven Gas to the Metallurgical Industry," by Prof. R. V. Wheeler.

Dec. 17. INSTITUTE OF CHEMISTRY, *London Section*, 30, Russell Square, London, W.C. 1.

Dec. 18. INSTITUTE OF CHEMISTRY, *Belfast and District Section*, Queen's University, Belfast, at 7.30 p.m. "The Rutherford-Bohr Atom from a Chemical and Physical Standpoint," by Dr. R. C. Johnson.

Dec. 18. SOCIETY OF DYERS AND COLOURISTS, *West Riding Section*, "The Blending of Materials in the Woollen Trade with Relation to Dyeing," by J. W. Radcliffe.

Dec. 19. SOCIETY OF DYERS AND COLOURISTS, *Scottish Section*, "Celatine Colours and their Application," by J. W. Wilson.

Dec. 19. SOCIETY OF DYERS AND COLOURISTS, *Midlands Section*, "Destruction of Wool by the Action of the Atmosphere," by S. R. Trotman and R. W. Sutton.

Alteration.—The January meeting of the Manchester Section of the Society of Chemical Industry which had been arranged for January 2 is now arranged for January 9. In this meeting it is hoped that in addition to the paper by Messrs. Simpkin and Sinnatt, the Section will have the honour of welcoming and hearing a paper by Prof. Hugh S. Taylor of Princeton University, U.S.A., the title of his address to be "The Properties of a Catalytic Surface."

SOCIETY OF CHEMICAL INDUSTRY

SUSPENSION OF ENTRANCE FEE

As an inducement to Chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Society in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 4, June 13 and 27, July 4 and 25, September 19, or October 3 and 17, 1924, that they are willing to dispose of to the Society.

BIRMINGHAM SECTION

At the meeting held on November 11 (*cf. Chemistry and Industry*, Nov. 21, 1924) the following paper was also read:—

Dr. Wardlaw, in presenting a paper on researches on molybdenum salts which were being carried out at the University of Birmingham in conjunction with Messrs. F. H. Nicholls and R. L. Wormell, pointed out that only one molybdenum salt now found extensive use, namely, ammonium molybdate, in which molybdenum had a valency of six. Nevertheless many well-defined salts existed with valencies of five, four, three and two. The present research work dealt with tervalent salts which were of interest from the point of view of chemical theory in that molybdenum from its position in the periodic system should show interesting analogies in its tervalent derivatives with the well known chromium salts. Furthermore, such substances should have powerful reducing properties and uses as mordants.

By electrolytic reduction of molybdenum trioxide dissolved in hydrochloric and sulphuric acids solutions had been obtained from which tervalent sulphates and chlorides had been isolated. The new substances had powerful reducing properties, and in the case of the chlorine derivative comparative stability. From the theoretical standpoint there were also interesting possibilities in this field of inorganic isomerism.

EDINBURGH AND EAST OF SCOTLAND SECTION

The second ordinary meeting was held jointly with the local section of the Institute of Chemistry at Edinburgh on November 19, Dr. Alexander Lauder presiding.

Prof. G. G. Henderson, F.R.S., president of the Institute of Chemistry, delivered an address on "The Profession of Chemistry." He recalled the time when the man in the street only thought of a chemist in connexion with drugs and medicines. This conception was to a very great extent widened during the war, when the work of the chemist was brought more prominently before the public eye. A second factor in the appreciation of the true work of tho chemist was undoubtedly to be found in Wembley, where very many visitors had examined the exhibits, asked many questions, and come away with a better idea of the world work of the chemist. Over and above these two factors, the Institute of Chemistry for fifty years had been labouring to educate the public and to consolidate the profession. The extent of their success could be measured by the attitude of the Government Departments, who now frequently sought information and assistance from the Institute. However, the end had not yet been attained, and would not be attained until the profession ranked in public appreciation at least equal to any other in importance. It was unnecessary to tell an audience of trained chemists the extent to which chemistry entered into everyday work. What was necessary, however, was to convince their fellow-citizens of the vital importance of their profession to the health and prosperity of the country. To do this efficiently closer co-operation must be brought about between the various chemical societies, so that it would be possible for the whole profession to speak with one voice.

GLASGOW SECTION

A meeting was held on November 26, in the Institute of Engineers and Shipbuilders, Glasgow, when an address on "The Future Prospects of a Clean Atmosphere" was given by ex-Bailie W. Brownhill Smith, the chair being taken by Mr. Douglas A. MacCallum.

Bailie Smith said that a pure atmosphere had a very beneficial effect upon the public health and upon national economy. In Britain, the air of the large cities was very impure when compared with that of American and Continental towns. The returns for 1923, for example, showed that, at Blythswood Square, Glasgow, 370 tons of solid impurities had fallen per square mile. The domestic open grate, burning raw coal, was the chief agent by which the air was polluted. An examination made in Glasgow had shown that the smoke produced per second by burning coal in an open grate contained sixteen million particles of soot. This explained why the greatest quantity of soot fell on Blythswood Square, as it was surrounded with great blocks of office premises, in each room of which there was an open fireplace.

The particles of soot, coated with a layer of oily hydrocarbons, formed the nuclei for the condensation of moisture and absorbed much of the acid produced during the combustion of the raw coal. The presence of these impurities in the air produced dense fogs during frosty and calm weather. During the winter of 1909, when fog was very prevalent in Glasgow, the death-rate rose rapidly, and a high percentage of the deaths were due to diseases of the respiratory system. In the same period, in seven other large towns in Scotland, where no fog occurred, there was little change in the normal death-rate. Another result of the impure atmosphere was the serious damage to buildings caused by acid corrosion. The periodical repair of this damage was a heavy charge on the public funds.

Many suggestions had been made for rendering the air purer, and more extensive use of gas and electricity for heating and cooking would materially help;

but the preference for the open grate militated against the widespread adoption of such remedial measures. The great hope seemed to be the low-temperature carbonisation of coal by which a smokeless fuel and power gas were produced, together with the recovery of the valuable by-products.

The Gas Committee of the Glasgow Corporation, in 1909, on the motion of ex-Bailie Smith, appointed a sub-committee "to inquire into and report on any process of gas making which will produce a form of coal residue that may be available for use in ordinary grates." The sub-committee reported that the process invented by Mr. Robert Maclaurin—a member of the Glasgow Section—had been tested at Port Dundas electricity generating station, and had been found very satisfactory. The investigations, temporarily interrupted by the war, had been completed and many different coals had been tested.

The results were very satisfactory, and in September, 1923, sanction was given for the erection of a five-unit battery of Maclaurin producers at Dalmarnock to produce smokeless fuel and supply the Dalmarnock electricity station with power gas. This installation was described in detail and the main advantages mentioned: (1) the low capital expenditure involved, and (2) the great elasticity of the process whereby smokeless fuel or coke, with increased production of gas, can be obtained as desired. Incidentally it had been proved that it was possible and cheaper to fire the boilers of the power station with the gas from the Maclaurin producers than by the present system of coal firing.

It was hoped that the Maclaurin process would materially hasten the coming of a pure atmosphere, and it was suggested that each new housing scheme could have its own carbonising plant, which would produce the fuel and gas required for local needs.

The interesting discussion which followed the lecture indicated that the subject of atmospheric purity had appealed to everyone present. In conveying the thanks of the Section to the lecturer, the Chairman said that the citizens of Glasgow were fortunate in having such an able exponent of the benefits of pure air as ex-Bailie Smith. Bailie Smith had identified himself with the subject for many years, and had served on the Royal Commission on Smoke Abatement. The members of the Section hoped that the desired end was now in sight, and they also expressed their thanks to their co-member, Mr. R. Maclaurin, for his material help towards the solution of such a vital problem.

LONDON SECTION

A joint meeting of the London Section and the Oil and Colour Chemists' Association was held at Burlington House on December 1, to discuss the subject of "Protective Paint Coatings." Dr. Bernard Dyer, Chairman of the Section presided, and he was supported by Dr. H. Houlston Morgan, President of the Oil and Colour Chemists' Association.

The discussion was opened by Sir Robert Hadfield, F.R.S., who, after summarising the various theories of corrosion, said there was yet no general agreement as to the fundamental principles involved. Apart from external coatings, however, there was the resistance to corrosion which might be offered by a metal itself. A striking advance in this direction was made on the introduction of alloys of iron and chromium. Thus the resistance of these chromium alloys to corrosion in the atmosphere at the east end of Sheffield was about ten times that of very pure ingot iron. In Sheffield tap water, the loss in weight per unit area of the chromium alloy was under one-eightieth that sustained by the ingot iron. More recently, alloys of iron containing nickel and chromium had been provided which offer effectual resistance over a much wider range of conditions, and were not merely unattacked at ordinary temperatures, but are scarcely affected at a red heat, or even higher temperatures.

Dr. R. S. Morrell discussed the water absorption and permeability of varnish films, and described the apparatus he uses for preparing and testing the films. The only chance for British oil and colour chemists to retain varnish and paint as a protection for metals would be to provide coatings which would not crack on exposure and were of very low water absorbing properties, and, moreover, did not allow metallic iron to pass through them, although they might allow water to pass. He believed it would be possible to fulfil all these conditions. The water absorption could be reduced to a very low figure, and yet maintain the elasticity which was so essential for durability. At the same time, there were many varnish coatings that only allowed water to pass through with difficulty, and yet they were no good as protectors because they deteriorated so quickly on exposure, and cracked. It might be concluded that there was a chance of getting a varnish that had a very low water-absorbing power, that would be elastic enough to stand extremes of temperature and, moreover, would refuse to allow metal to pass through with the water.

Mr. J. N. Tervet gave a description of some interesting results obtained by exposure tests on iron and steel.

Mr. C. A. Klein, dealing with the subject from the general and not the academic point of view, said the word "protective" as regard paints and varnishes was only a relative term in that the paint and varnish trade was not able to supply materials that would be protective against all kinds of corrosion under all conditions, and for all time. Therefore, in dealing with any protective coating, it was necessary to bear in mind the length of time the film would give protection, the particular corrosive influence to be dealt with, and finally, there was the economic aspect to be considered. Protection and cost were two expressions in this matter which could not be separated. On any large painting job 75 per cent. of the cost was for labour, and only 25 per cent. for materials, and therefore there was not much good in trying to save 6d. a gallon on the paint or varnish, and getting an inferior article. The reliability of any coating depended also upon the skill with which it was applied, and the conditions under which it was applied. The great need was skilled craftsmanship, as opposed to the too general idea that anybody could apply paint. This, however, was largely the fault of the manufacturers themselves, who sold ready-

made paints and advised people to do their own painting. He agreed with the tendency to emphasise the importance of physical tests of the properties rather than chemical analysis. It was not always the fault of the paint manufacturer that paints went wrong, because we in this country could and did make good paints and varnishes, although there was a good deal of rubbish on the market.

Dr. J. J. Fox said there were several points which needed clearing up in order to get some clear idea of what we were doing when testing. What was required was a method of testing which would determine, in a reasonably short time, whether a paint would be good or not, and such a test we had not got at the moment. There was great difficulty in interpreting results when they had been obtained. At present the pigment could be tested fairly easily but what about the medium? Supposing the original oil contained foots, a fairly objectionable feature, how could this be found out? There were many conditions under which this could not be determined. One of the chief things in the chemical examination of paints to-day was to get at the medium, if possible, and he did not for the moment see how that was to be done, in mixed paints, if they contained linseed oil or tung oil. In order to get round the difficulties of the chemical analysis, it had been said that we must adopt physical tests, and the question then arose what physical tests should be adopted. Many of them had been tried. There was the plasticity test and the emulsification test and the loaded needle test. He was afraid that what he had said had been all on the negative side but he hoped it would induce the makers to say something.

Mr. W. F. Reid said he was interested in paint as a mechanical protector as used in the linoleum trade. From the very earliest days, it had been found that a good linoleum could not be manufactured unless there was a certain percentage of oxide of iron mixed with it. In the same way, oxide of iron paints were largely used. There was, however, another ingredient that was even better than oxide of iron for external work and that was graphite, because that gave the very important property of resistance to wetting. A paint containing graphite did not permit water to adhere to it.

Mr. A. S. Jennings agreed with Mr. Klein that the encouragement of amateur painters was to be deplored. What was required was more service tests, and he believed the Engineering Standards Association was to take this matter up. This work needed to be done on a very large scale and he hoped it would be done by chemists supervising the mixtures and expert craftsmen applying them. It was essential in such practical service tests that they should have the assistance of skilled craftsmen. Moreover, every-day conditions must be followed absolutely. Very often in paint tests, the paint to be tested was put on to bare wood, whereas in practice there was always the priming coat and then the under-coat before the final paint—and the one to be tested—was put on.

Dr. H. Houlston Morgan said the whole subject of protective paint coatings teemed with difficulties, and the whole industry was at sixes and sevens over the matter as a result of the complexity of it. It was necessary to test and investigate paints and varnishes as complete substances and not to take the medium or pigment separately and form a judgment of the properties of a paint from such a single investigation. These separate investigations were necessary and must be carried out, but individually they must not be used to say that a paint was good or bad. He did not agree with Dr. Morrell that if a varnish emulsified by the absorption of water it was not a durable varnish. Paint and varnish films were always changing; the drying and hardening of a varnish film was a continuous process; it was never the same from the day it was put on until the day it disintegrated and peeled off two or three years hence. Therefore, before we could draw any drastic conclusions as to the water absorption through varnish, the emulsifying effect of water on varnish and its durability, very rigid conditions must be laid down as to the state of oxidation, the condition of dryness and so on, before its properties could be determined. More than that, we must find out the relation between those conditions and the proved durability of a similar film, and these were things we know very little about. Sir Robert Hadfield had shown the value of patient research by the results obtained with the production of rust-resisting steels, and he could only hope that the paint and varnish industry would take that lesson to heart.

OTTAWA SECTION

Dr. A. E. Macintyre presided over an attendance of 38 at the meeting held on November 13, 1924. The Secretary read a letter from the General Secretary intimating that the Entrance Fee had been suspended by the Council for members joining the Society in 1925. The benefits derived from membership in the Society were pointed out, and all who are not now members were urged to join the Society. The Secretary was asked to secure information regarding films disclosing chemical operations which might be secured for exhibition before the Section.

Dr. A. E. Macintyre then gave an address on "Some Aspects of the Chemistry of the Home." One or more divisions of all the sciences had application in the home, but those responsible for its management had little actual tuition in the applied sciences. Chemistry had a wide application in the home in the composition, conservation, and evaluation of all materials entering it, in the preparation of foods, the tarnishing and cleaning of metal articles, laundrying, and so on. Quantitative accuracy should be attained in recipes. Evaluation of food in calories was not sufficient, and the so-called food accessories should also be maintained. The dangers of carbon monoxide poisoning were considered, and the reactions by which the gas is formed explained. The processes of colouring non-ferrous metals were described, and the tarnishing of gold and silver articles, as well as the chemistry involved, was clearly explained. The processes of dyeing and the relation of animal and vegetable fibres to the various classes of dyes were discussed. The amount of chlorine in Ottawa water supply and the corrosion caused by it were also referred to.

YORKSHIRE SECTION

At the second meeting held on November 17, Mr. J. Evans in the chair, Mr. G. F. Pickering read a paper on the "Chemistry of the Distillation of Fatty Acids." After dealing with the infantile state of the analytical control and his own failure to obtain an insight into the nature of the mixed glycerides by fractionating the bromides, or by correlating pitch yield and iodine value, the author stated that the relationship free fatty acids—$\frac{3}{4}$ oxyacids present/total fatty acids = 1 had been found to hold good. It had taken a lot of getting, but only a fourth of the oxyacid distilled off. For candle making the pressing was best carried out after the acids were redistilled. The manufacture was then dealt with, and it was shown that during distillation, oxyacids were formed and carbon dioxide was always evolved. In the distillation of wool grease an unsaturated hydrocarbon, iodine value 60—70, which yielded a fatty acid on treatment with the Grignard reagent, had been definitely found; there was also (to the extent of 2—3 per cent.) anhydride formation and polymerisation of unsaturated acids. The paper concluded with a discussion of the physics of the colloids which required further research to facilitate the pressing of the distillates.

Dr. L. L. Lloyd and the chairman took part in the ensuing discussion.

SOCIETY OF DYERS AND COLOURISTS

A meeting of the Manchester Section of the Society o. Dyers and Colourists was held on November 21 in the Rooms of the Manchester Literary and Philosophical Society. Mr. J. Huebner, M.Sc.Tech., F.I.C., presided. Upon the motion of the chairman, seconded by Prof. E. Knecht, a vote of thanks was unanimously accorded the retiring chairman, Mr. William Marshall, J.P., for his services during his period of office.

A paper was read by Prof. E. Knecht and E. F. Muller on "Some Further Observations Relating to the Action of Heat on Cotton Fabrics," in which it was shown that when bleached cotton was heated for prolonged periods (up to 2000 hours) to 90° C., the material was found to behave differently according as it was exposed in open, sealed, or evacuated and sealed, glass tubes. In all cases, the material had deteriorated in strength, the least affected being that in the evacuated tubes; nevertheless the last-named specimens were scorched or browned more than the others. The deterioration was shown to be due partly to the action of heat *per se* and partly to oxidation. Discussing the question of the effect of higher temperatures, the "danger point" of a flat-iron was estimated to be in the vicinity of 250°.

In a subsequent paper on "The Interaction of Glucose and Methylene Blue," by Prof. Knecht and Miss Eva Hibbert, it was shown that the reducing action on the dyestuff in an alkaline medium could be measured quantitatively and that this reaction could be employed as a convenient and rapid means for the estimation of glucose.

FARADAY SOCIETY

Prof. F. G. Donnan, F.R.S., president, presided at the meeting on November 17, when the following papers were read:—

Principal A. P. Laurie read a note on the "Expansion of Water while Freezing." Assuming that the atomic diameters based on Bragg's crystal model for ice are true for liquid water and that liquid water at 0° is a trihydrol, it is shown to follow as a geometrical necessity that there will be an expansion from 1 to 1·088 when ice melts. This gives a specific gravity for ice of 0·918 and the experimental value is 0·917, thus confirming the original assumptions.

R. W. E. B. Harman and F. P. Worley discussed "The Hydrolysis of Alkali Cyanides in Aqueous Solution." The degree of hydrolysis has been determined by several methods, but results have not been concordant, owing to disturbing factors in the methods used. In that used by the authors the vapour pressure of hydrogen cyanide over solutions of potassium cyanide was compared with that over solutions of hydrocyanic acid. The results are shown graphically and compared with those obtained previously. The degree of hydrolysis of sodium cyanide at 25° at all concentrations was found to be the same as that of potassium cyanide. The effect of temperature was also studied.

The constancy of the hydrolytic constants at different concentrations at each temperature, the agreement of the values at different temperatures with the van't Hoff Isochore, and finally the agreement between the calculated heat of hydrolysis and the measured heat of neutralisation appear to confirm the accuracy of the values arrived at for degree of hydrolysis at the various concentrations and temperatures employed.

A paper on the "Viscosity of Reversible Emulsions" was read by S. S. Joshi. Viscosities of water-in-oil emulsions prepared from castor oil, olive oil and paraffin oil by means of four monovalent soaps are determined. Viscosity increases with increase of the dispersed phase and is maximum at the reversal point which is followed by a sudden drop in viscosity upon inversion. The concentration and the specific chemical nature of the emulsifying agent have no effect on the viscosity of the emulsion. Hatschek's equation for the viscosity of the emulsoids is not followed; observed viscosities are in approximate agreement with those estimated by Einstein' equation for suspensoids; Arrhenius' equation applic better still. The possibility of an increment in th size of the grains of the water-in-oil emulsions wit increase in the proportion of the aqueous phase is suggested.

D. B. Macleod discussed the "Viscosities of Liquids at their Boiling Points." Boiling points are unsatisfactory temperatures at which to compare the viscosities of liquids. By correcting the boiling points to a condition of equal free space, the viscosities of liquids become proportional to their molecular weights in the liquid state. Such a condition of equal free space corresponds very closely to a reduced temperature on the basis of van der Waal's equation of state.

A second paper by D. B. Macleod was on "The Kinetic Theory of Evaporation." It is assumed that the ratio of the density of the vapour above a liquid to the density of the liquid is really the ratio of the number of molecules with sufficient speed to escape from the liquid to the number with insufficient speed. Thus if D_v and D_e are the densities of the vapour and liquid respectively, then, $\frac{D_v}{D_e}=\frac{N_s}{N_i}$ where N_s is the number of molecules with sufficient speed to escape and N the number with insufficient speed. It is shown that the results which follow from this assumption are so simple and satisfactory as to make the truth of the assumption extremely probable.

J. T. Howarth and F. P. Burt described a "New Design for Apparatus to measure the Coefficient of Deviation from Boyle's Law and the Determination of this Coefficient for Acetylene." A modified apparatus for measuring the compressibility of gases has been designed in which the whole volume of the gas and also the mercury column which registers the pressure are kept at the temperature of melting ice. The coefficient of deviation from Boyle's law at 0° C. has been determined for acetylene and its value between 0 and 1 atmosphere found to be —0·00884.

HULL CHEMICAL AND ENGINEERING SOCIETY

On November 25, Mr. A. V. Slater delivered a lecture on "Adsorption" to a large and appreciative audience. The *New York Times* recently called the attention of the general public to the importance of adsorption and Mr. Slater emphasised its universality by saying that most natural and industrial processes occurred at surfaces where one of the substances might concentrate. Adsorption was the process taking place at a surface which resulted in a different concentration at the boundary between two heterogeneous phases. It increased with the rate at which the molecules struck the surface, that is, with increasing pressure or concentration. The amount adsorbed was greater the lower the rate of evaporation of the condensed molecules and this would be low if the adsorbed substance decreased the energy seated at the surface, whether it were surface tension, electric potential difference, or chemical valency forces. A comprehensive theory must reckon with all these forces and Langmuir's came nearest to satisfying this condition. A useful rule which helped in understanding *solution* and which was equally applicable to adsorption, was that the greatest attraction occurred between substances of similar polarity. In some cases adsorption took place because the unlikeness of components caused a liquid to "squeeze out" a solute and the adsorbent then played a neutral part in offering an extensive surface on which the substance might concentrate. Chemical attraction also played a large part in adsorption. Ordinary chemical reactions were due to strong deviations of the orbits of the outer electrons; with complex orbital systems strong deviations resulted in chemical reaction whereas slight deviations resulted in less defined reactions such as adsorption. A thorough study of the orbital displacement of electrons when charcoal adsorbed argon might lead to better understanding of chemical action.

Adsorbent carbon was characterised by a loose amorphous structure having a large proportion of free valencies. It was necessary to form the carbon at low temperatures to avoid graphitisation. Activation consisted in selective oxidation of the hydrocarbons adsorbed during carbonisation. Active carbon adsorbed organic substances in preference to water vapour and inorganic substances: the reverse held true for silica gel.

In emulsification, soaps were adsorbed at the interface and the stability and type of emulsion depended on the relative volumes of the two ends of the soap molecule which was orientated with one part in the oil and the other in the water. Increased lubricating power due to admixture of 1—2 per cent. fatty acid with a mineral oil depended on the adsorption of the fatty acid by the bearing surface, the carboxyl group being held by the metal and the hydrocarbon chain by the mineral oil. A new surface was thus formed by the adsorbed fatty acid which offered less resistance to shear. Catalysis depended upon adsorption which permitted greater concentration of reacting substances at the surface, or "activated" the adsorbed molecules.

A lengthy discussion followed. A point of special interest was the settling of paint pigments. Mr. Slater said that the principles involved were those of flocculation and deflocculation. A deflocculated pigment would settle while a flocculated one remained free. Flocculation was brought about by adsorption of a substance like sodium silicate. Although the principles involved were known it was often difficult in practice to obtain the right conditions because the flocculator might produce other deleterious reactions.

Dr. Thevenez congratulated the lecturer on his clear exposition of a difficult subject and Mr. Lowish seconded the vote of thanks.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB

On November 27, an address, entitled "Science and Mr. Wells," was delivered by Dr. T. S. Patterson, the "Gardiner" Professor of Organic Chemistry, before a joint meeting with the Glasgow University Geological Society, Dr. Tyrrell presiding.

Dr. Patterson said that consistency was very necessary if the scientific novel was to be not only acceptable but satisfying. He wondered if such novels could advance our knowledge; it was noteworthy that many of the forecasted conditions of life came to pass much sooner than had been predicted.

Mr. Wells had succeeded in presenting to us novels which, while affording pleasant entertainment, suggested many interesting possibilities.

The progress of science showed, however, that great discoveries had been made, not infrequently, as a result of research undertaken for entirely different purposes.

Scientific advances were made by pursuing the clues which Nature herself had from time to time revealed, and not by searching for new possibilities.

CORRESPONDENCE

OPTICAL ACTIVITY AND POLARITY THEORIES

Sir,—In your edition of September 12 (p. 917) in reply to a letter from Dr. Boyd, Dr. Rule states that his theory of polarity effects in optically active compounds dealt only with general polar effects and not with induced alternate effects. The general polar effect of a substituent has already been indicated in a paper published in the *Proceedings* of the Chemical Society (1914, **30**, 274) in which it was pointed out that the effect of a substituent on rotatory power was partly due to its disturbance of the intramolecular field of force and attention was drawn to the fact that the rotatory power of cinchotoxine was lowered by the introduction of the benzoyl group, lowered further by the more acidic *p*-toluene sulphonyl group and changed in sign by the introduction of the picryl group. Since, however, the value of the rotatory power of a dissolved substance is a complicated function of several variables, the effect of substitution was put on one side while, by an examination of rotatory powers and refractivities, values were obtained of a constant "b" which Livens had suggested should represent the actual electric force of an asymmetric character acting on the electrons of the active atoms.

Livens at the same time pointed out that the medium, purely by its disturbance of polar force (in the electrostatic sense) should considerably affect rotatory power and also pointed out that constants could be obtained independent of the wave length of the light used.

Furthermore, in the *Proceedings* of the Chemical Society (*loc. cit.*), it was stated that the influence of substituents on rotatory power there described might be explicable on the basis of Flürscheim's theory of strength of linkages, but further work was impossible at the time. Experiments, however, are now in progress with a series of substituted benzyl acetic acids and related compounds to test the applicability of Flürscheim's hypothesis to these results and also the applicability of the theory of induced alternate polarity which Dr. Rule now states is not part of his investigation.

Dr. Boyd in your issue of October 10 points out that if OH is more strongly polar than Cl then glycollic acid should be stronger than chloracetic. A somewhat similar anomaly is shown by *m*-nitrobenzyl chloride; the alternate polarity effect of the nitro group should make this compound more reactive than *p*-nitrobenzyl chloride and the general polar effect should also make it more reactive than benzyl chloride. The velocity constant for the rate of combination of aniline and *m*-nitrobenzyl chloride is, however, lower than that of benzyl chloride and Olivier found similar results by hydrolysis. Slator and Twiss found that the velocity constant with sodium thiosulphate was greater than for benzyl chloride but then the order of m and p was wrong. There is still much to be cleared up therefore. —I am, Sir, etc., D. H. Peacock

University College,
Rangoon

November 8, 1924

PERSONAL AND OTHER ITEMS

Dr. E. F. Armstrong, F.R.S., has returned from a long visit to Canada and the United States. During his stay he gave lectures or talks to the members of the Society of Chemical Industry at Toronto, Ottawa, Montreal and New York, and to the graduates and others at the Universities of Yale, Harvard and Princetown, in addition to an address before the American Chemical Society at Washington. There was ample opportunity to appreciate Dr. Armstrong's devotion to the cause of chemistry during his term of office as President of the Society of Chemical Industry, and his activities as a representative of British Chemistry in the United States have given him a further title to the gratitude of British chemists.

The Main Committee of the British Engineering Standards Association have recently authorised the Secretary, Mr. le Maistre, to accept the cordial invitation of the German Standards Committee (the N.D.I.) to be present at their annual meeting on December 13. He is also going to Prague to give an address on Industrial Standardisation before the recently formed Czechoslovakian Standards Committee.

B. D. Saklatwalla, of the Vanadium Company of America, will be presented with the Grasselli Medal at the December meeting of the American Section of the Society of Chemical Industry.

Mr. L. E. Hinkel has been awarded the D.Sc. degree of London University for a thesis entitled "Reactions in the Hydro-aromatic Series resulting in the Formation of Aromatic Compounds."

After a long discussion, the Swedish Academy of Sciences has decided not to award the Nobel Prizes for chemistry and physics for 1924, but to reserve them for another year.

Mr. H. K. G. Bamber, lately managing director of the Associated Portland Cement Manufacturers, and of the British Portland Cement Manufacturers, who was killed in a motor accident on September 20, left £72,475.

The late Mr. H. H. Dains, technical chemist, left £51,496, with net personalty, £50,434.

The death is announced of Mr. David Moseley, head of the firm of David Moseley and Sons, india-rubber manufacturers, Ardwick, Manchester.

We regret to have to record the death of Mr. J. M. Collett, chairman of J. M. Collett, Ltd., chemical manufacturers, Gloucester, and a member of the Society of Chemical Industry since 1887.

Problems Awaiting Solution

In an address delivered to the members of the guild of undergraduates at Birmingham University, the Warden, Sir Charles Hyde, discussed "The Value of Education and Great Problems to be solved." During his address he quoted statements specially obtained from leading authorities in various branches of science dealing with the problems awaiting solution. The committee of the Institute of Sanitary Engineers suggested that one problem was the full utilisation of the manurial qualities of sewage.

Sir H. Fowler, replying for the President of the Institution of Mechanical Engineers, said that a great question was the very low efficiency obtained in converting heat into work, and thought that a great advance must come in the utilisation of a low potential energy in heat, as exemplified by the tides and the loss of heat in condensing water. Dr. W. R. Ormandy, President of the Institution of Automobile Engineers, considered the outstanding problems were the provision of light alloys having aluminium or magnesium as a base; superior quality anti-friction bearing metals to withstand very high pressures; the conversion of coal into liquid fuels; and the discovery of means for improving the compression value of volatile fuels.

Mr. W. B. Woodhouse, the President of the Institution of Electrical Engineers, wrote that the problems to be solved in electrical engineering were innumerable, the most important problem in electricity supply being that of improving the efficiency of conversion of the energy in coal into electricity. At present the best efficiency obtained was only 20 per cent., though, if methods were adopted which followed experiments now in hand, this would be increased to 30 per cent.

One of the big problems in mining, according to Mr. Humphrey M. Morgans, President of the Institute of Mining and Metallurgy, was mining at great depths, say, deeper than 6000 ft. In metallurgy the problems were to develop methods of treating ever-poorer ores and previous workers' waste at a profit. Physics and chemistry came in here very much.

Canadian Chemical Industry

The financial statement for the year ending March 31 of the Standard Chemical Co. Ltd., of Canada, shows a deficit of $4963 as compared with a net profit of $42,626 for the previous year, and a deficit of $762,368 for the year ending March 31, 1922. The total assets are $6,193,418, of which the chief items are properties, $2,213,315; goodwill, $1,870,724; inventories, $962,927. The principal liabilities are common stock, $1,250,000; preferred stock, $3,602,700; debentures, $488,082; bonds, $310,500; and reserves, $402,457. Sales for the past year amounted to $2,089,396·40. The total wood carbonised during the year was 47,906 cords, which is 8440 cords less than in the previous year. The wood carbonisation industry is suffering from overproduction and the future of the older Canadian plants is obscure.

ERRATA

In the article by Prof. J. C. Drummond, D.Sc., on "Some Modern Tendencies of Vitamin Research," which appeared in the September 12 issue of *Chemistry and Industry*, the words, "one hydroxyl group," on the top line of col. ii, p. 910, should read "two hydroxyl groups."

In the issue of November 28, the following corrections should be made:—On p. 1195, the name of the author of the letter printed in col. i should read: "C. T. Kingzett." On p. 1196, col. i, the price of the silver plaque should be "21s.," not "2s."

REVIEWS

Cadmium, Its Metallurgy, Properties and Uses. By Norman F. Budgen, Ph.D., M.Sc. Pp. xv+239. London: Charles Griffin and Co., Ltd., 1924. Price 21s.

As Professor Turner points out in his "Foreword," no more opportune time could have been selected for the issue of a volume dealing with the occurrence, properties, extraction and uses of cadmium. Recent advances in electrolytic zinc production, a process necessitating the prior removal of cadmium and thus facilitating its recovery, have resulted in ensuring more regular supplies and a reduction in the cost of production which should tend towards an extension of the useful applications of the metal and its compounds.

The book is divided into eleven chapters dealing in detail with the ores and sources, intermediate products and their formation, the production of the metal, statistical information, physical and chemical properties and analytical determination, alloys, electro-deposition of cadmium and alloys and summary of its uses. Each chapter concludes with an excellent list of references giving the authority for practically every description and statement of importance appearing in the text. The author has included the results of some interesting researches of his own, but in the main the chief value of the book lies in the fact that it constitutes, as claimed, a comprehensive digest of all available information, collected with judgment from widely-scattered sources. Both author and publisher are to be congratulated on the thoroughness with which the work has been carried out and presented to the public.

The chief source of cadmium is zinc ores, with which it is invariably associated, but rarely in greater amount than 0·25 per cent. Latterly, the condensed fumes from the smelting of ores of lead and copper have yielded an increasingly important amount of cadmium whose presence is due, however, solely to minerals or compounds of zinc being present in such ores. The author estimates the maximum visible output possible from all sources at 1000 tons annually and the present production at 150 t. It is probable that the latter has now increased to 250 t. which is still 25 per cent. of the possible annual production.

The methods by which metallic cadmium is obtained are described under the three headings—direct distillation, solution and electrolytic precipitation, and solution and chemical precipitation. The first and last have been largely superseded by electrolytic precipitation by which method most of the cadmium is produced to-day. It is necessarily in this chapter that the lack of personal touch with the industry described is more apparent than in any other. Nevertheless, the author has taken full advantage of the material available and has given a well-balanced and readable account of both the old and newer processes.

Probably the greater part of the cadmium production is still consumed in the form of sulphide, a yellow pigment of great permanency, but the metallic alloys are of considerable interest. For

example, one of the most recent applications is its addition to copper for electric transmission wires. Copper wire containing 1 per cent. of cadmium has a higher tensile strength, is harder and more resistant to wear than hard-drawn copper wire and, further, the conductivity is not appreciably impaired. The superiority of this alloy has been proved, particularly in connexion with electrical trolley wires.

William G. Wagner

The Kinetic Theory of Gases. By Prof. E. Bloch. Translated by P. A. Smith. Pp. xiv + 178. London: Methuen and Co., Ltd. Price 7s. net.

The translation of Prof. Bloch's stimulating booklet, the French original of which appeared in 1921, affords to English readers not only an account of the classical kinetic theory, but also of those recent developments which have made the kinetic theory one of the most vital branches of modern theoretical physics.

The first four chapters deal with the classical theory in the form associated with the names of Maxwell and Clausius, and a clear outline account is given of the more important considerations which are characteristic of this stage of the development of the theory. In Chapter 5 the methods of statistical mechanics and the theoretical developments which we owe to Boltzmann are briefly considered, and in Chapter 6 the reader is introduced to the theory of quanta and to those modern views on energy exchange which are associated in particular with the theories of Planck and Einstein.

The remaining four chapters are devoted to the consideration of Brownian motion, fluctuations, rarefied gases, the width of spectral lines and molecular constants. Undoubtedly this is the most interesting part of the book, and the various directions in which modern research has served to amplify the fundamental notions underlying the kinetic theory are clearly expounded. All purely mathematical developments are avoided, the object of the author being to present fundamental ideas in logical sequence, and to show that the kinetic theory is built upon foundations which are almost unassailable.

In some few instances, statements are made which in form or substance are at least questionable. For instance, on p. 63, in a discussion of the distribution of a mixture of gases under the influence of gravity, it is said that "each of the gases distributes itself in height under the influence of gravity as if it were alone, *the law of distribution varying more rapidly* the greater the molecular weight of the gas." Again, on p. 80, there is an argument relative to the heat capacities of gases and the equipartition theory which would not meet with general acceptance. Such minor blemishes do not however suffice to depreciate sensibly the intrinsic value of the book, which can be warmly recommended to all students of physical chemistry.

H. M. Dawson

COMPANY NEWS

SANTA CATALINA NITRATE CO., LTD.

During the year manufacture has been practically uninterrupted, resulting in an output of 15,000 tons of nitrate. Of that quantity roughly 9300 t. have been brought into the accounts, realising with gain on iodine and interest, £23,226 gross, or, after deducting London expenses and a proportion of taxes, £21,099, subject to final adjustment of corporation profits tax, which latter, it is hoped, will appear for the last time in the company's accounts. On account of that profit a dividend of $7\frac{1}{2}$ per cent. was paid last June, and subject to approval, a final distribution of 15 per cent. on the year's operation is now to be made. £1200 has been placed to reserve. Since the end of last season until a few weeks ago, the nitrate market was extremely active, and sales for the current year's supply were brought up to 2,200,000 t.

DUNLOP RUBBER CO.

The company has a nominal capital of £20,000,000, divided into 5,000,000 £1 preference and 15,000,000 ordinary "A," "B," and "C" shares, the whole of the preference shares having been issued with the exception of 108,686. According to evidence given in the Chancery Division on November 19, when a reduction of capital by the company was sanctioned, the gross loss amounted to £12,582,000, but this sum had been reduced by the appropriation of certain reserves and certain other items, amounting together to rather over £2,000,000, the net loss therefore amounting to £10,527,542. It was proposed to meet the loss by reducing the share capital. The bulk of the loss appeared in the balance sheet for the year ended August 31, 1921, and arose chiefly through the depreciation of rubber and cotton and partly on foreign exchange. Preference shareholders had agreed to the cancellation of 4s. per share, making them 16s. each. The rest of the loss fell on the ordinary shareholders whose £1 shares would be brought down in value to 6s. 8d.

SCOTTISH OILS, LTD.

An interim dividend has been declared of $3\frac{1}{2}$ per cent. actual, less tax, on the non-cumulative participating preference shares. No interim payment was made last year, but $3\frac{1}{2}$ per cent. was paid, less tax, at the end of the year, the last dividend on ordinary shares being in 1920, of $6\frac{1}{12}$ per cent.

AMELIA NITRATE CO.

The annual report for the year to June 30, 1924, showed a trading profit of £21,268. The gross profit, including interest received, amounted to £24,548 (£46,075 in 1923 and £4827 in 1922), and the net profit, after deducting interest and London expenses, was £20,385. An ordinary dividend—the first for two years—of 15 per cent., less tax, had been proposed by the Directors, the sum to be carried forward amounting to £5000 as against £5750 brought in. At the annual general meeting it was stated that the company had now £53,000 cash in hand instead

of £2500, cash and securities amounting to £73,000, and stocks of nitrate totalling £128,000 against £142,000. Debts were £45,895, against £70,000. The future of the nitrate industry looked quite hopeful, the shipments for the twelve months ended June 30, 1924, amounting to 2,175,000 tons, an increase of 69,500 t. over last year. Sales for the current year, commencing July 1, both shipped and unshipped, already totalled 1,859,931 t. A dividend of 15 per cent. less income-tax, on the ordinary shares was declared.

BRITISH OXYGEN CO.

This company which, in July last, issued £250,000 additional capital, including a bonus issue of 35 per cent., has declared an interim dividend of 3¾ per cent., less tax, on the capital of £750,000, compared with 3¾ per cent. paid, free of tax, on £500,000 last year.

CASSEL CYANIDE CO., LTD.

The accounts for the year to September 30, 1924, show a net profit of £70,283, which together with the balance of £14,513 brought forward from last year, amounts to £84,796. From this has to be deducted £17,625 for interim dividend of 3d. per share paid in June, 1924, leaving a sum of £67,171 of which it is recommended £52,875 should be disposed of in payment of a final dividend of 9d. per share, the balance of £14,296 being carried forward.

DORMAN, LONG AND CO.

The annual report for the year to September 30, 1924, shows a profit of £504,984, and a balance brought forward of £202,667. No dividend has been declared on the ordinary shares.

ANGLO-PERSIAN OIL CO.

It has been authoritatively announced that H.M. Government has no intention of disposing of its shares in this company, as, on a full examination by the departments concerned, it was satisfied that it would not have been in the national interest to part with the shares to a combine, and, also, that naval interests, for which the original investment in an independent oil company was made, would have been seriously prejudiced.

BRITISH COTTON & WOOL DYERS' ASSOCIATION, LTD.

The accounts for the six months to September 30, 1924, show a profit of £79,597, which includes income from investments, etc., after charging administration expenses, £4266 for specific depreciation, £29,929 for repairs and renewals, and providing an estimated amount for income tax, corporation profits tax, etc. From this amount is deducted £713 for audit fee and other professional charges, £12,400 interest on first mortgage debenture stock to September 30, 1924, £100 debenture holders' trustees, and £12,500 transferred to depreciation fund (now standing at £227,500), which makes a profit for the period of £53,884. The sum of £39,690, being the amount brought forward at March 31 last (after deducting £5250 voted at shareholders' meeting) should be added, leaving a credit balance on profit and loss account of £93,583.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	.. £45 per ton.
Powder.. ..	.. £47 per ton.
Acid Hydrochloric	.. 3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	.. £21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric ..	.. Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali..	.. £6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	.. Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	.. £7 10s. per ton, packages extra.
Borax, Commercial—	
Crystal	.. £25 per ton.
Powder.. ..	.. £26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	.. £5 17s. 6d. per ton d/d.
Copper Sulphate ..	.. £25 per ton.
Methylated Spirit 64 o.p.—	
Industrial ..	.. 2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised ..	.. 3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate .. .. Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic ..	.. £30—£33 per ton.
Potass. Bichromate	.. 5¾d. per lb.
Potass. Chlorate..	.. 3d.—4d. per lb.
Salammoniac ..	.. £32 per ton d/d.
Salt Cake.. ..	.. £3 10s. per ton d/d.
Soda Caustic, solid	.. Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals ..	.. £5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	.. £24 per ton.
Sod. Bicarbonate	.. £10 10s. per ton, carr. paid.
Sod. Bichromate..	.. 4¼d. per lb.
Sod. Bisulphite Powder 60/62%.. ..	.. £17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate ..	.. 3d. per lb.
Sod. Nitrate refd. 96%	.. £13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	.. £9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	.. 6½d.—1s. 2d. per lb., according to quality.

example, one of the most recent applications is its addition to copper for electric transmission wires. Copper wire containing 1 per cent. of cadmium has a higher tensile strength, is harder and more resistant to wear than hard-drawn copper wire and, further, the conductivity is not appreciably impaired. The superiority of this alloy has been proved, particularly in connexion with electrical trolley wires.

WILLIAM G. WAGNER

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Nitraniline ..	.. 2s. 2½d. per lb. d/d.
itrobenzene ..	.. 5½d.—5¾d. per lb. naked at works.
Nitrochlorbenzol	.. 2s. 11d. per lb. 100% basis d/d.
itronaphthalene	.. 10d. per lb. d/d.
-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
-Phenylene Diamine	.. 4s.. per lb. d/d.
-Phenylene Diamine	.. 10s. per lb. 100% basis d/d.
. Salt	.. 2s. 4d. per lb. 100% basis d/d.
odium Naphthionate	.. 2s. 2d. per lb. 100% basis d/d.
-Toluidine ..	.. 10d. per lb. naked at works.
-Toluidine ..	.. 2s. 10d. per lb. naked at works.
-Toluylene Diamine	.. 4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

cid, Acetic 80% B.P.	.. £45 per ton, ex wharf London, in glass containers.
cid, Acetyl Salicylic	.. 3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
cid, Benzoic B.P.	.. 2s. 6d. per lb.
cid Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
cid, Camphoric ..	.. 19s.—21s. per lb.
cid, Citric ..	.. 1s. 3d. per lb., less 5% for ton lots. Increased export inquiry.
cid, Gallic ..	.. 2s. 9d. per lb. for pure crystal in cwt. lots. Easier.
cid, Pyrogallic, Cryst.	.. 7s. per lb. Resublimed quality 8s. per lb. Market firm.
cid Salicylic	.. 1s. 6d.—1s. 7d. per lb., according to quantity.
cid, Tannic B.P.	.. 2s. 10d. per lb. Forward quotations higher spot value likely to increase.
cid, Tartaric ..	.. 1s. per lb., less 5%.
midol	.. 9s. per lb. d/d.
cetanilide ..	.. 1s. 10d.—2s. per lb. More enquiry.
midopyrin ..	.. 14s. 6d. per lb.
mmon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
mmon. Carbonate B.P.	£37 per ton.
tropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone	.. 13s. 9d. per lb. Slightly lower. Quiet steady demand.
Benzonaphthol ..	.. 5s. 3d. per lb. spot.
Bismuth Carbonate	.. 8s. 6d.—10s. 6d. per lb.
„ Citrate ..	.. 8s. 6d.—10s. 6d. „
„ Salicylate	.. 8s. 0d.—10s. 0d. „
„ Subnitrate	.. 7s. 7d.—9s. 7d. „ According to quantity. Prices recently reduced.
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Very scarce and dear. Prices uncertain.
Ammonium ..	.. 2s. 1d. per lb.
Potassium ..	.. 1s. 11d. per lb.
Sodium	.. 2s. per lb.
Calcium Lactate ..	.. 1s. 7d.—2s. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate ..	.. 4s. per lb.
Chloroform ..	.. 2s. 6d. per lb. for cwt. lots.
Formaldehyde ..	.. £48—£49 per ton in barrels, ex wharf London. Supplies exceed demand.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Glycerophosphates—	
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. „
Guaiacol Carbonate	.. 9s. 6d. per lb.
Hexamine ..	.. 3s. per lb. for bold crystal. Powder slightly less.
Homatropine Hydrobromide	.. 25s.—30s. per oz.
Hydrastine hydrochlor	.. English make offered, 120s. per oz.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. „
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb. Price recently reduced.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Light, pure ..	.. £46 per ton.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £25 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 57s. per lb. for December delivery. No spot deliveries available.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials ..	.. Market very quiet.
Red oxide ..	.. 5s. 2d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 5d.—3s. 7d. „
White precip. ..	.. 4s. 6d.—4s. 8d. „
Calomel ..	.. 3s. 10d.—4s. „
Methyl Salicylate	.. 1s. 9d.—2s. per lb.
Methyl Sulphonal	.. 22s. 6d. per lb. Slightly weaker.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 2s. 8d. per lb. for B.P. quality.
Paraldehyde ..	.. 1s. 2d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin ..	.. 5s. 6d. per lb.
Phenazone ..	.. 6s. 10d. per lb.
Phenolphthalein ..	.. 5s. 6d. per lb. for cwt. lots. Supply exceeds demand.
Potass. Bitartrate— 99/100% (Cream of Tartar) ..	.. 84s. per cwt., less 2½% for ton lots.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Ferricyanide	.. 1s. 9d. per lb. Quiet.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	.. 7¼d. per lb. spot. Forward prices higher.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 5s. 3d. per lb.
Saccharin ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. 6d. per lb. for cwt. lots. Slightly lower. Limited demand.
Silver Proteinate..	.. 9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite— Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.

Sod. Nitroprusside	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Fair demand. Powder 2s. 1d.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 4d. per lb. Flake 2s. 6d. per lb. Good demand. Market firmer.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.
Sulphonal	14s. 6d. per lb. Little demand.
Thymol	18s. per lb. Firmer market.

PERFUMERY CHEMICALS

Acetophenone	11s. 3d.	per lb.	
Aubepine	13s. 6d.	„	Again cheaper.
Amyl Acetate	3s.	„	
Amyl Butyrate	6s. 6d.	„	
Amyl Salicylate	3s. 3d.	„	
Anethol (M.P. 21/22° C.)	4s. 6d.	„	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d.	„	
Benzyl Alcohol free from Chlorine	3s. 3d.	„	Cheaper.
Benzaldehyde free from Chlorine	3s. 3d.	„	Cheaper
Benzyl Benzoate	3s. 6d.	„	
Cinnamic Aldehyde—			
Natural	18s. 6d.	„	
Coumarin	18s. 3d.	„	Cheaper.
Citronellol	18s.	„	Dearer.
Citral	8s.	„	
Ethyl Cinnamate	12s. 6d.	„	
Ethyl Phthalate	3s.	„	
Eugenol	10s. 6d.	„	
Geraniol (Palmarosa)	33s. 6d.	„	
Geraniol	12s. 6d.—20s. per lb.		
Heliotropine	6s. 9d.	per lb.	
Iso Eugenol	16s.	„	
Linalol ex Bois de Rose	26s.	„	
Linalyl Acetate	26s.	„	
Methyl Anthranilate	10s.	„	
Methyl Benzoate	5s.	„	
Musk Ambrette	50s.	„	
Musk Xylol	14s.	„	
Nerolin	4s. 6d.	„	
Phenyl Ethyl Acetate	15s. 6d.	„	
Phenyl Ethyl Alcohol	16s.	„	
Rhodinol	52s. 6d.	„	Cheaper.
Safrol	1s. 10d.	„	
Terpineol	2s. 4d.	„	
Vanillin	25s. 6d.	„	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 10d. per lb.
Bergamot Oil	15s. 6d. per lb. Cheaper.
Bourbon Geranium Oil	32s. per lb. Cheaper.
Camphor Oil	65s. per cwt
Cananga Oil Java	11s. 3d. per lb. Dearer.
Cassia Oil, 80/85%	9s. 9d. per lb.
Cinnamon Oil, Leaf	6½d. per oz.
Citronella Oil—	
Java 85/90%	7s. per lb. Dearer.
Ceylon	3s. 5d. per lb. Cheaper.
Clove Oil	8s. 3d. per lb.
Eucalyptus Oil 70/75%	2s. 2s. per lb. Cheaper.
Lavender Oil—	
French 38/40% Esters	35s. per lb.
Lemon Oil	3s. 2d. per lb.
Lemongrass Oil	5s. 9d. per lb. Dearer.
Orange Oil, Sweet	11s. per lb.
Otto of Rose Oil—	
Bulgarian	42s. 6d. per oz. Dearer.
Anatolian	28s. per oz. Dearer.
Palma Rosa Oil	17s. per lb. Dearer.
Peppermint Oil—	
Wayne County	43s. 6d. per lb. nominal.
Japanese	22s. 6d. per lb. nominal.
Petitgrain Oil	9s. 9d. per lb.
Sandal Wood Oil—	
Mysore	26s. 7d. per lb.
Australian	18s. 6d. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Jan. 26th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Dec. 11th.

I.—Applications

Best. Emulsifying or mixing apparatus 27,429. Nov. 17.

Blumenfeld and Weizmann. Filtration of solutions etc. 27,928. Nov. 21.

Courtaulds, Ltd., and Lungo. Filters. 27,830. Nov. 20.

Crozemarie and Malvos. Furnaces. 27,726. Nov. 19.

Jenaer Glaswerk Schott and Gen. Filters. 28,016. Nov. 22. (Ger., 11.12.23.)

Kirkup and Thompson. Rotary screen and dryer. 27,874, 27,875. Nov. 21.

Lamplough. Drying and mixing granular etc. materials. 27,669. Nov. 19.

Metropolitan-Vickers Electrical Co., Ltd. Deoxidiser 28,002. Nov. 22. (U.S., 21.12.23.)

Metropolitan-Vickers Electrical Co., Ltd. Deoxidisation of gases. 28,003. Nov. 22. (U.S., 29.12.23.)

Nathorst. Roller grinding mills. 28,030. Nov. 22. (Sweden, 24.11.23.)

Oughtibridge Silica Firebrick Co., Ltd., and Brooke. Kilns. 27,723. Nov. 19.

Owen. Drying. 27,916. Nov. 21.

Surtees. Centrifugal machines for emulsifying, mixing, or grinding. 27,620. Nov. 19.

Thomassen. Centrifugal separators. 27,483. Nov. 17. (Ger., 27.5.24.)

I.—Complete Specifications Accepted

17,891 (1923). Cutler. Drying-kilns. (224,575.)

20,866 (1923). Aluminium Plant and Vessel Co., Ltd., and Gough. Mixing and agitating machines. (224,607.)

20,934 (1923). Lucas. Gas-fired oven furnaces. (224,610.)

23,396 (1923). Borner. Treatment of granulated, pulverulent, and the like materials. (224,652.)

30,540 (1923). Risberg. Centrifugal liquid separators. (224,734.)

7734 (1924). Dupuy. Apparatus for distilling solids or liquids. (213,586.)

9446 (1924). Jones. Separation of substances having different density. (224,806.)

10,972 (1924). Patentaktiebolaget Grondalramen. Rotary or like furnaces. (215,745.)

12,277 (1924). Karpinsky and Anderson. Installation for the separation of liquids. (217,197.)

II.—Applications

Auld and Dunstan. Treatment of hydrocarbons. 27,956. Nov 21

Barrett Co. Manufacture of polymerised naphthas. 27,612 Nov. 18. (U.S., 23.11.23.)

Birkner, Otte, Walther u. Co. Combustion of watery, woody, and bituminous fuels. 27,951. Nov. 21. (Ger., 9.12.23.)

Chomó and Defossez. Coke ovens. 27,487. Nov. 17.
Helps. Gas manufacture. 27,373. Nov. 17.
Metropolitan-Vickers Electrical Co., Ltd. 28,003. *See* I.
Rude. Gasifying oil in water-gas production etc. 27,894. Nov. 21.
Suida. Process for obtaining gases rich in ethylene. 28,027. Nov. 22. (Austria, 30.11.23.)
Terrell. Manufacture of incandescent gas mantles. 27,953. Nov. 21.
Trent. Manufacture of fuel. 27,457. Nov. 17. (U.S., 9.2.24.)

II.—Complete Specifications Accepted

13,033 and 31,983 (1923). Salerni and Salerni. Distillation or treatment of carbonaceous and other materials. (224,568.)
20,298 (1923). Ricard, Allenet et Cie. Conversion of gaseous aliphatic ethylene hydrocarbons into liquid hydrocarbons. (202,311.)
26,015 (1923). Chadwick. Separating gasolene from natural gas or hydrocarbon vapours. (224,688.)
7734 (1924). Dupuy. *See* I.

III.—Application

Barrett Co. 27,612. *See* II.

IV.—Application

Soc. of Chemical Industry in Basle. Manufacture of indigoid dyestuffs. 28,017. Nov. 22. (Switz., 30.11.23.)

V.—Applications

Courtaulds, Ltd., and Lungo. Apparatus for manufacture of artificial silk. 27,828, 27,829. Nov. 20.
Ferdinando and Griffiths. Apparatus for manufacture of artificial silk. 27,607, 27,608 and 27,670. Nov. 18 and 19.
Granton. Washing cellulose etc. 27,999. Nov. 22.
Kuhn, Le Breton, and Schaeffer. 27,846. *See* XIX.
Lilienfeld. Manufacture of cellulose compounds. 27,837. Nov. 20. (Austria, 10.10.24.)
Rogers (Präcisionsgussfabrik Geb. Eckert). Melting celluloid masses. 27,478. Nov. 17.

V.—Complete Specifications Accepted

17,765 (1923). Lilienfeld. Process of preparing alkali celluloses and cellulose ethers. (200,816.)
18,091 (1923). Lilienfeld. Process of preparing low-water-content alkali cellulose and cellulose ethers. (200,827.)
20,212 (1923). Cellon-Werke, Eichengrun. Production of thin films of cellulose derivatives. (202,306.)
25,348 (1923). British Celanese, Ltd., Ellis, Stevenson, and Croft. *See* VI.
26,329 (1924). Cellon-Werke, Eichengrun. Production of thin films of cellulose derivatives. (224,848.)

VI.—Applications

Akt.-Ges. für Anilin-Fabrikation. Process for dyeing furs etc. 28,018. Nov. 22. (Ger., 23.1.24.)
Baddiley, and British Dyestuffs Corp., Ltd., and Browning. Dyeing acetyl cellulose. 28,013. Nov. 22.
Jackson (Fuld and Hatch Knitting Co.). Yarn-dyeing tanks. 27,484. Nov. 17.
Sandoz Chemical Co., Ltd. Dyeing cotton materials. 27,545. Nov. 17.

VI.—Complete Specifications Accepted

25,348 (1923). British Celanese, Ltd., Ellis, Stevenson, and Croft. Dyeing, printing or stencilling of cellulose acetate. (224,681.)
25,412 (1923). Brandwood and Brandwood. Apparatus for the dyeing or other fluid-treatment of yarn packages on spindles. (224,683.)
32,591 and 32,605 (1923). Jackson (Flint-kote Co.). Manufacture of saturated or impregnated fibrous material (224,751 and 224,752.)
23,101 (1924). Standard Silk Dyeing Co. Washable dyed silk piece goods, and process of dyeing same. (222,520.)

VII.—Applications

Atlantic Chemical Co., Ltd., and Fleming. Manufacture of concentrated borate from crude borate of lime. 28,021, 28,022. Nov. 22.
Bailey. Production of helium from radio-active ores etc. 27,616. Nov. 19.
Farbwerke vorm. Meister, Lucius, und Brüning. Feeding salt-cake furnace. 28,019. Nov. 22. (Ger., 26.11.23.)
Naamlooze Vennootschap Philips' Gloeilampenfabrieken. Process of separating a mixture of hafnium and zirconium compounds. 27,836. Nov. 20. (Holland, 12.12.23.)
Packards and J. Fison (Thetford), Ltd., and Mills. Chambers for manufacture of sulphuric acid. 27,449, 27,450. Nov. 17.
Soc. Chimique des Usines du Rhône. Manufacture of arsenates of the alkaline-earth metals. 27,566. Nov. 18. (Fr., 3.1.24.)

VII.—Complete Specifications Accepted

25,936 (1923). L'Oxhydrique Française. Manufacture of hydrogen. (206,822.)
26,526 (1923). Henshaw, Stonier, and Talk O' th' Hill Colliery, Ltd. Production of dry neutral sulphate of ammonia. (224,697.)
2581 (1924). Soc. Chimique des Usines du Rhône. Manufacture of the arsenates of the alkaline-earth metals. (216,098.)
3230 (1924). Soc. Chimique des Usines du Rhône. Manufacture of calcium arsenate. (214,951.)
11,846 (1924). Schmidt and Ges. für Chemische Produktion. Obtaining hydrochloric acid free from arsenic. (216,129.)

VIII.—Applications

Manufacture des Glaces et Produits Chimiques de St. Gobain, Chauny, et Cirey. Continuous furnace for glass manufacture. 27,436. Nov. 17. (Fr., 6.12.23.)
Tams. Semi-porcelain body for pottery. 27,972. Nov. 22.

VIII.—Complete Specification Accepted

21,327 (1923). Shaw. Furnaces for melting and refining glass etc. (224,622.)

IX.—Applications

Eckel. Process of making cement and iron. 27,485. Nov. 17.
Hemming. Material for roads etc. 27,446. Nov. 17.
Wade (Soc. Anon. Italiana per la Produzione di Calci é Cementi di Segni). Manufacture of hydraulic cement. 27,431. Nov. 17.

X.—Applications

Apold and Fleissner. Treatment of ores etc. 27,577. Nov. 18.
Brunskill. Preventing surface corrosion in aluminium alloys. 27,619. Nov. 19.
Eckel. 27,485. *See* IX.
Grunder and Maas. Composition for treating hot metals. 27,721. Nov. 19.
Hernandez, de. Apparatus for distillation of ores. 27,710. Nov. 19.
Prentice. Method of heat-treating oxides, ores, etc. 27,759. Nov. 20.
Swingler and Wilson. Aluminium alloy. 27,790. Nov. 20.
Wade (International Nickel Co.). Manufacture of alloys. 27,917. Nov. 21.

X.—Complete Specifications Accepted

18,228 (1923) and 9279 (1924). Scrivon and Guise. Treatment of metal articles to prevent tarnish. (224,579.)
22,135 (1923). British Thomson-Houston Co., Ltd. (General Electric Co.). Composite metals. (224,639.)
32,416 (1923). Clerc and Nihoul. Treatment of complex ores containing zinc. (209,100.)
13,939 (1924). Chemische Fabrik Griesheim-Elektron and Beielstein. Recovery of light metals from scrap. (219,287.)
17,612 (1924). Western Electric Co., Ltd. (Western Electric Co., Inc.). Metallic composition. (224,836.)

XI—Applications

British Thomson-Houston Co., Ltd. Electron-emitting electrodes. 27,549. Nov 18. (U.S., 18.12.23.)

Kirkaldy. Electrodes. 27,787. Nov. 20. (U.S., 20.11.23.)

Willment. Electric battery. 27,899. Nov. 21

XII.—Applications

Bollmann. Decolorising ... etc. 27,842 Nov. 20. (Ger., 24.3.24.)

British Glues and Chemicals, Ltd., ... Drew. Extraction of fat from bones. 27,714. Nov. ...

Falck. Production of soaps. 27,... Nov. 17.

Riedel Akt.-Ges. Fat-splitting ag... Nov. 17. (Ger., 5.1.24.)

Wade (Divine). Manufacture of soap. ...

XIII.—Application

British Cyanide... Ltd., and Rossiter ... artificial resins. ... Nov. 22.

XIII.—Complete Sp... Accepted

26,093 (1923). P... Insulating fire-resisting water-paint. (224,700.)

XIV.—Complete Spec... Accepted

27,465 (1923). A... Rubber Co., Ltd. Direct production of rubber she... (223,189.)

XVI.—Application

Cowles. Production ... fertilisers. 27,947. Nov. 21.

XVII.—Application

Philipp. Manufacture of sugar. 27,736. Nov. 20 (Ger., 24.11.23.)

XVIII.—Application

Barbet. 27,473. *See* XX.

XVIII.—Co... Specifications Accepted

20,579 (1923). Horst, von. Production of hop extracts. (224,594.)

1795 (1924). Ricard, Allenet et Cie. *See* XX.

XIX.—Applications

Hitchcock. Manufacture of wholemeal. 27,741. Nov. 20.

Kahn, Le Breton, and Schaeffer. Transforming lower vegetables into useful products. 27,846. Nov. 20. (Fr., 20.11.23.)

XIX.—Complete Specification Accepted

23,838 (1923). Hilditch, Wheaton, and Crosfield and Sons, Ltd. Purifying or softening of water by means of base-exchanging compounds, and regeneration of such compounds when spent. (224,656.)

XX.—Applications

Barbet. Production of alcohol. 27,473. Nov. 17. (Fr., 17.11.23.)

Blagden, and Howards and Sons. Manufacture of thymol. 27,707. Nov 19

Soc. Chimiques des Usines du Rhône. Process for manufacture of malonic-acid esters. 27,567. Nov. 18. (Fr., 7.2.24.)

Timmer and Vogl. Medical compound. 28,014. Nov. 22. (Austria, 23.11.23.)

XX.—Complete Specifications Accepted

20,298 (1923). Ricard, Allenet et Cie. *See* II.

1764 (1924). Ellis (Soc. Chimique des Usines du Rhône). Preparation of salts of the p-oxyomacylamino-phenol-arsinic acids. (224,764.)

1795 (1924). Ricard, Allenet et Cie. Process of dehydrating alcohol. (210,761.)

11,327 (1924). Soc. of Chemical Industry in Basle. Use of medicaments insoluble or sparingly soluble in water. (218,982.)

XXI.—Applications

Dawson. Colour photography. 27,807. Nov. 20.

Haling. Emulsion for repairing kinematograph films. 27,391. Nov. 17.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number :—*Australia :* Iron, steel, (529); Artificial silk, (412/7/1/1/296); *Brazil :* Tinplate, iron, steel, copper, brass, cement, (554); *British India :* Paper, iron (Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); *China :* Chemicals, ...urgical and scientific instruments, (547); *Egypt :* ...os, (543); Varnish, chemicals, (545); *Sweden :* ... wire, sulphur, limestone, steel, lead, rubber, ... *Tunis :* Artificial silk, oil, (546). *Canada :* Paper ... Leather (B.X./1377); *China :* Artificial ...); *Egypt :* Chemicals, glassware (B.X./13...) ...*ary :* Soap, perfumery (568); *Norway :* C... (569); *Portugal :* Creosote (570); *Swed...* Rubber (572).

Notes on Plant an. Products

The Thermal Syndicate, Ltd., of Neptune Bank, Wallsend-on-Tyne, has sent a copy of the latest illustrated list of Vitreosil laboratory ware and apparatus, including the transparent variety of Vitreosil made from fused quartz. The list reveals the rapid advances made in the manufacture and applications of Vitreosil. the latest product being a mercury condensation pump made of pure fused quartz. The pump is compact in design (length 25 cm., diameter 3·3 cm., gas inlet 1·5 cm.), water cooled and works at about 200 c.c. per second. With a backing pump giving a vacuum of 0·2 mm., a vacuum of 0·000002 mm. may be readily and quickly obtained. A liquid air trap is required to remove the last traces of mercury vapour. The pump, which is silent in operation, can be heated electrically or by gas and will work effectively with only 5 c.c. of mercury. Such a piece of apparatus has long been wanted in the laboratory, and its high efficiency, ease of operation and reasonable price (without mercury, £5 2s. 6d.; with mercury seal and silica to ground glass joints £6 12s. 6d.). make it of interest to all who have to work with high vacua. The list and prices describe laboratory and other ware in transparent, translucent and opaque Vitreosil, and includes a useful bibliography relating to silica ware that alone should tempt chemists to send for a copy.

PUBLICATIONS RECEIVED

Elements of Colloidal Chemistry. By H. Freundlich. Translated by G. Barger, F.R.S. Pp. vii + 210. London: Methuen and Co., Ltd., 1924. Price 7s. 6d.

Scientific Research and Human Welfare. By F. S. Harris, with the collaboration of N. I. Butt... Pp. ... + 406. London and New York: MacMillan Co., Ltd., 1924. Price 12s.

Sulphuric Acid Concentration. Vol. II. In Heated Vessels. By P. Parrish and F. C. Snelling. Pp. xi + 147. London: E. Benn, Ltd., 1924. Price 6s.

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY.

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

VOL. 43 NEW SERIES | LONDON, DECEMBER 12, 1924 | NO. 50

EDITORIAL

THERE is a limit to the amount of work a man can do; the limit varies greatly, and the busy man learns by experience how to economise his time and his energy: he learns how to cast on to others the routine work which they can do better than he can and how to concentrate his own energies so as to bring into action those qualities of judgment, of intuition or of persuasion which cause the busy man to be busy. The limit nevertheless exists, and Sir William Alexander finds that the attention he chooses to give to his own business and the attention he chooses to give to Parliament do not leave him a sufficient margin to deal with so important a task as the chairmanship of the British Dyestuffs Corporation. He has therefore resigned this office. Sir William Alexander has impressed everyone by his business ability; he has had a singularly difficult task, and the current opinion is that he has done well; in his retirement he will treasure the goodwill and the gratitude of the many shareholders whose fortunes he has gradually steered into smoother water, though not quite into that haven which denotes leisure and comfort. He is succeeded in the chairmanship by Lord Ashfield, who is well acquainted with the affairs of the Corporation, having been on the board for several years, and is a business man with singular energy and powers of organisation. The Government in the place vacated by Lord Ashfield, as a Government director, has appointed Sir Alfred Mond. Sir Alfred Mond has not quite reached his limit; he is known to our readers as a successful man of business, a capable chemical manufacturer, and a statesman. He is reputed to have sufficient shrewdness in business to enable him to earn an income of no mean size; he does not waste time, but gets to the root of the matter at once; he was a clever politician when he entered the House of Commons, and his appearance speedily obtained for him that prize so much coveted by the politician, a caricature in *Punch*. For a short time his political opponents scoffed, but only for a short time. He talked good sense; he has, and from the early days had, a political *flair*; he learned the atmosphere of the House, and all varieties of men there quickly learned to respect him for his sound judgment and convincing power of speech. He developed from the clever politician into the weighty statesman very speedily, and is now the rising hope of that small band of stern and unbending Liberals who have survived the flood.

* * *

It is not, however, Sir Alfred Mond's eminence in politics which is significant. He has all his life been connected with the chemical industry. In textbooks it is convenient, and in Acts of Parliament it is necessary, to draw an exact and arbitrary line between organic and inorganic chemistry. It is unnecessary and impossible to divide the chemical industry in this manner. Our chemical industry is bound together by links and by interests as innumerable as the stars that shine. It is, we think, essential that our heavy chemical industry, our fine chemical and our dyestuffs industry shall have far greater community of interest, of ambition, of purpose. We welcome the fact that one of the leaders in our successful heavy chemical industry should join the board of our leading dyestuffs company. We sincerely trust

that this policy will be continued and that those who have proved their ability to guide firms engaged in the manufacture of chemicals will be given the opportunity of helping those interested in the newer and less sturdy branches of the industry. We notice that Lord Colwyn has also been invited to join the Board; his great experience in important undertakings makes him a director of exceptional value. His wise counsel will be a great asset to the Dyestuffs Corporation. The next time that a vacancy occurs on the Board we think someone with chemical experience, having an acquaintance with chemists and their ways and with the broad outlines of chemical research and chemical development, should prove also of great value. We learn that in the treaty with Germany it is agreed that the importation of dyestuffs into this country will continue to be subject to the licensing restrictions now in force. We scrupulously avoid any reference to political topics in these columns; but for this reservation we should have indicated at some length our belief that the chemical industry of this country is so bound together that no one branch of it can become weak or even threatened without doing incalculable harm to the other branches, and to the science which is the foundation of the whole industry.

* * *

The electrolytic decomposition of salts enabled Davy in the year 1807 to make the important discovery of the metals potassium and sodium, but the nature of electrolysis was imperfectly understood until the classical work of Faraday was published ninety years ago. It was in 1840 that Messrs. Wright and Parkes made electro-plating in silver a commercial success. Nickel-plating became commercially possible about the year 1870. The paper we publish this week by Prof. A. J. Hale shows how interesting and useful this method of preparing elements has become. Prof. Hale is the author of one of our standard books on the subject, and the detailed account we publish of the various types of cells and processes in use to-day is full of valuable information. The preparation of metals and their purification is merely one application of electrolysis; the coating of one metal with a veneer of a different metal is merely another application; the production of gases merely a third. The methods described by Prof. Hale are examples of a great principle of enormous importance. How much this principle will be developed during the next fifty years no one can say! The cheap electric power available in Norway, Switzerland, Italy, America, and some other countries makes many industries possible which would otherwise be too expensive. It was cheap water-power, we have always understood, rather than cheap coal which first established our textile industries in Lancashire and the West Riding of Yorkshire. The time may come again when the most favoured parts of the world will be places whose hills and mountains yield an annual rainfall of fifty or sixty inches a year. Shall we some time in the future have local sections of the Society whose habitations and names suggest the Himalayas, the Caucasus or the Ural Mountains?

MODERN ELECTROLYTIC CELLS

By Professor A. J. HALE

The cells in use at the present time for producing metals or chemicals by electrolysis may be conveniently divided into three groups according as they are employed for: (*a*) The winning or refining of metals; (*b*) the production of industrial gases; or (*c*) the production of various inorganic and organic compounds.

WINNING AND REFINING OF METALS

In this group are the simplest and, at the same time, some of the most complicated designs, as may be realised by considering, on the one hand, the ordinary type of vat used for copper refining and, on the other hand, such cells as are used for winning metals from fused chlorides or even the cell employed

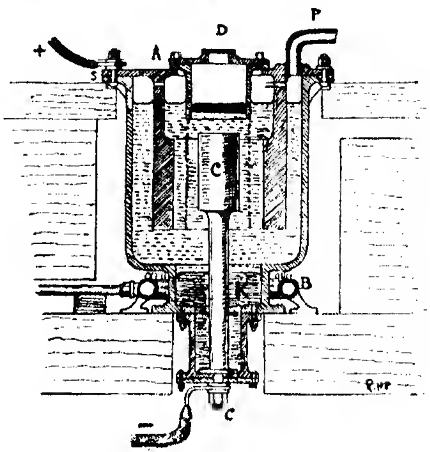


Fig. 1
Castner Sodium Cell

in the Castner process for obtaining metallic sodium. The rectangular vats used for refining copper and lead, and for the electrolytic extraction of copper and zinc are usually constructed of wood and lined with lead. They may be 30 ft. long, 4 ft. wide, and 5 ft. deep, the sheet cathodes and anodes being suspended alternately from bus bars, which cross the width of the tank and, resting on the top of the sides, make contact with their appropriate positive or negative leads. No covering is required and the process, which is akin to electro-plating, is of a simple and well-known type.

Enormous quantities of high-grade copper are refined in this manner, and the process is now in extensive use for dealing with copper and zinc solutions obtained by the extraction of low-grade ores. Similar vats, but smaller, are employed for refining lead, tin, nickel, iron, silver and gold but, occasionally, diaphragms, moving electrodes or scraping devices render the construction less simple than usual.

The cells used for obtaining aluminium, sodium, magnesium and calcium are of different design from those just considered because the electrolysis of a fused salt or compound at temperatures ranging from 300° up to 1000° C. necessitates what may be

termed an electrolytic furnace. The ordinary graphite tank, supported externally by an iron frame, in which aluminium is obtained from a molten mixture of alumina and cryolite will be familiar to all students of electrochemistry. This cell was first employed in 1885, and the cell, introduced a few years later by Castner, for preparing metallic sodium from fused caustic soda (Fig. 1) is almost as well-known. Experience gained from these two cells has enabled later workers to devise suitable electrolysers for dealing with the molten chlorides or fluorides of magnesium, sodium, calcium, lead and zinc.

Aluminium is sufficiently dense to sink to the bottom of the cell from which it can be tapped at intervals, but sodium, calcium and magnesium are less dense than the electrolyte of fused chlorides employed in obtaining them, and the metals must therefore be collected at the top of the cell in some similar manner as that used in the Castner sodium cell

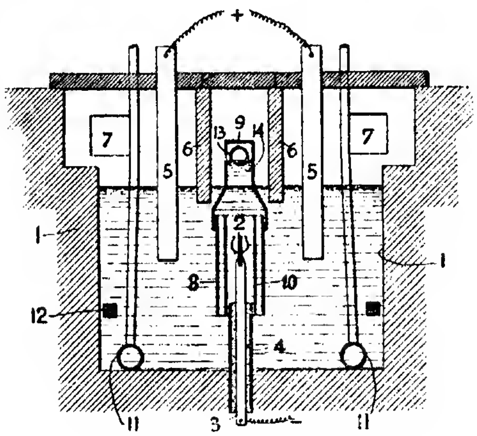


Fig. 2

Sodium Cell of the Society of Chemical Industry in Basle

in which the metal collects on the fused caustic soda beneath the cover, in an atmosphere of hydrogen

One of the earliest cells to be used successfully with fused sodium chloride was that of the Society of Chemical Industry in Basle (Fig. 2). The furnace is of rectangular cross section, and built of fire-brick, in which are helical coils, 11, for heating and melting the charge by suitable alternating current, and electrodes, 12, for the same purpose, whilst outlets, 7, for chlorine discharged from the graphite anodes, 5, are provided in the outer compartments of the cell, which is divided in two parts by diaphragms, 6, attached to the cover and further diaphragms, 8, attached to the bell, 9, in which the sodium, 14, collects prior to overflowing through pipe, 13, to a receiving vessel. The metal cathode, 2, is encased in a sleeve, 4, which also carries the negative lead, 3, tightly wedged in the sleeve by a packing of magnesite, and one or more wire nets, 10, are fixed between the cathode and the diaphragm 8, in order to prevent any sodium from passing into the anode compartments.

Difficulty has been experienced in preventing volatilisation of sodium at the temperature of molten salt (850° C.), and the process of McNitt (1916) is

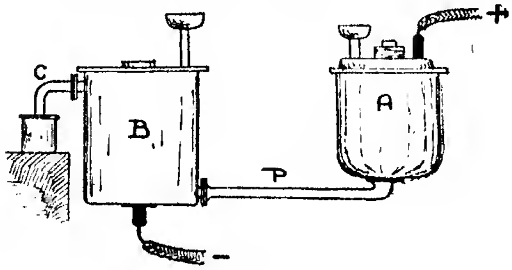


Fig. 3

Ashcroft Cell for Metallic Sodium

carried out in a cell resembling that of Castner in most respects, but a pressure of 900 millimetres is maintained within the cell, so that the boiling point of the sodium is raised by about 100° C. A side tube is provided for the metal to overflow into a suitable receiver (U.S.P. 1,197,137/16). Subsequently, McNitt attempted to overcome the difficulty due to the volatilisation of sodium by using an electrolyte composed of sodium chloride 36 parts, and sodium carbonate 64 parts, the mixture having a melting point of 600° (U.S.P. 1,219,808/17).

Ashcroft, in his earlier cell for electrolysing fused salt, adopted the twin-cell principle (Fig. 3) with a movable electrode of molten lead. In compartment, A, chlorine is liberated on graphite anodes and sodium discharged into the lead; the alloy is then impelled to compartment, B, containing fused soda, where it becomes the anode and the sodium, passing to the iron cathode, overflows by a side pipe, C, to a receiver.

This principle has been adopted in modern cells for obtaining magnesium. For example, the Mag-

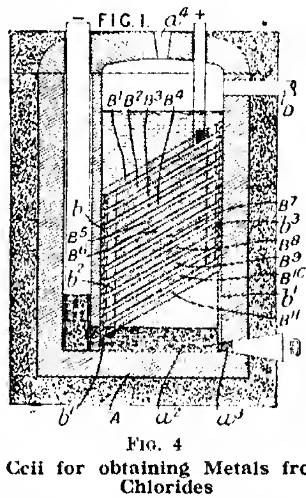


Fig. 4

Ashcroft Cell for obtaining Metals from Fused Chlorides

nesium Company in their works at Wolverhampton (S. T. Allen, *Electrician*, 1922, 88, 92) employ two connected cells containing fused magnesium

chloride and a movable molten lead-magnesium electrode. Each unit takes 5000 ampères at 5 volts and liberates 100 lb. of magnesium from the fused chloride per 24 hours, with an energy expenditure of 8·5 kw.-hrs. per pound of metal.

This cell is modelled on similar lines to that of Ashcroft (E.P. 152,879/19) in which molten lead acts as a carrier of the magnesium which is deposited from the fused salt in the anode compartment containing the graphite electrodes. The alloy is allowed to overflow into the cathode cell which is fitted with iron electrodes; here the magnesium is discharged and rises to the surface of the electrolyte, where it may be collected.

A further cell, suitable more particularly for obtaining zinc and lead from their fused chlorides (E.P. 198,024/22), is shown in Fig. 4. A series of closely spaced inclined graphite electrodes, B_1—B_{11}, is immersed in the electrolyte contained in a tank

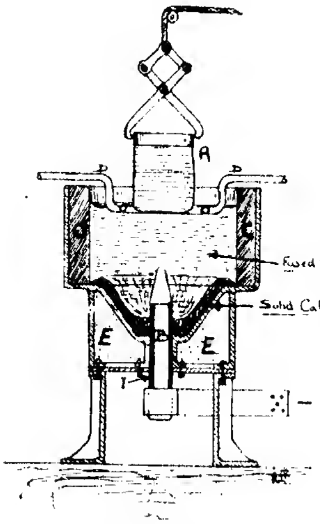


Fig. 5
Cell for Obtaining Metallic Calcium

of refractory material. The first and last electrodes only act as terminals and the rest are bi-polar, positive on the upper surfaces on which metal will be discharged and negative on the under surface on which chlorine is discharged. Holes, b^2, near the lower ends of the electrodes, allow metal to run down to the reservoir, a^2, and the holes, b^3, near the upper ends, allow chlorine to pass away to the collecting chamber.

Carrier's cell for electrolysing fused salt (U.S.P. 830,051/1906) was constructed on the twin-cell principle, the molten alloy of lead and sodium being allowed to overflow from the anode to the cathode compartment in which the sodium was discharged.

Cells used for obtaining magnesium from the fused chlorides are sometimes based upon the design used by Seward and von Kügelgen in their cell for calcium (Fig. 5), in which the iron cathode is fixed to the bottom of the tank, whilst the calcium rising to the

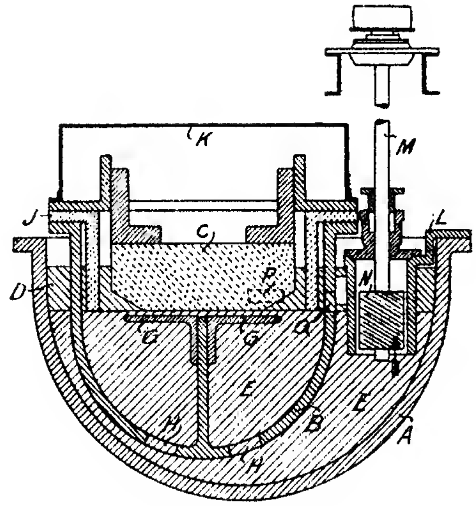


Fig. 6
Mathesius Cell

water-cooled region of the electrolyte is removed, as indicated in the diagram.

In a later cell of the Westinghouse Electric Company (U.S.P. 1,396,919/20), the cathode is supported centrally, so that it dips into the fused chloride and is moved continuously upwards, carrying with it the adherent stick of metallic calcium formed by a circular water-cooling arrangement round the cathode. The bottom of the tank is water-cooled and anodes

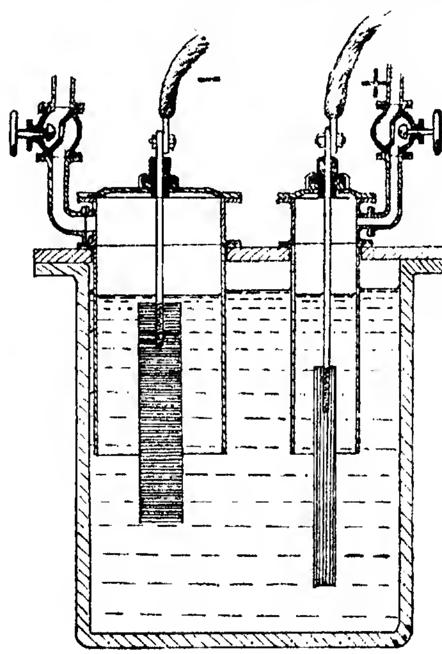


Fig. 7
Jaubert Cell

of graphite are arranged round the cathode external to the water-cooling pipe.

Later, G. O. Seward and the American Magnesium Company brought out a cell in which the cathode is fixed in the bottom of the cell, and the molten metal

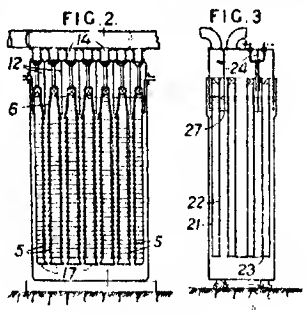


FIG. 8
Casale Cell

rising from the cathode is allowed to collect on the top of the electrolyte in a cylindrical space formed by a water-cooled crust of magnesium chloride or fluoride, whence the metal is removed by a ladle (U.S.P. 1,408,141/22).

An interesting cell in which alloys of lead with the alkaline earth metals can be produced is that devised by Mathesius (E.P. 201,447/22), which is shown in vertical section in Fig. 6. Fused chloride is electrolysed over a bath of molten lead, arrangement being made to circulate the lead cathode until it carries the required amount of discharged alkaline earth metal. The cast-iron vessel situated within a larger vessel of the same metal serves for the electrolyser proper and contains a carbon anode, C, partly immersed in the fused salt, D, whilst the fluid lead fills the part, E, of both iron vessels and is covered by a layer of fused salt. The inner vessel is provided with a horizontal plate, G, which lies slightly below the level of

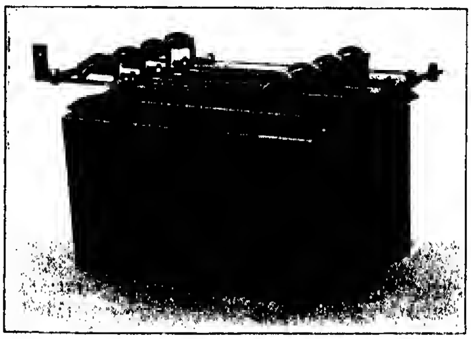


FIG. 9
Schuckert Cell

the lead and conducts the flowing metal uniformly under the surface of the anode. Openings, HH, serve for the passage of lead from the inner to the outer vessel, and an insulating ring, J, of fireclay serves to support the collecting hood, K, for chlorine. The casing, L, in the outer vessel, supports a worm and shaft which, on rotation, drives lead through a channel in N, and through P, into the inner vessel, where it flows between the anode, C, and the plate, G, receiving a fresh charge of alkali or other metal. Circulation of the lead is continued until it contains the required amount of alkaline earth metal, when it may be ladled or tapped from the outer vessel.

Amalgams of alkali or alkaline earth metals are obtained by the electrolysis of aqueous solutions, using a mercury cathode. They are useful reducing agents and their formation may be considered under mercury cells for preparing caustic soda and chlorine.

CELLS FOR THE PRODUCTION OF GASES

Oxygen, hydrogen and chlorine are often produced by electrolysis, the last named being almost entirely obtained by this method together with caustic soda.

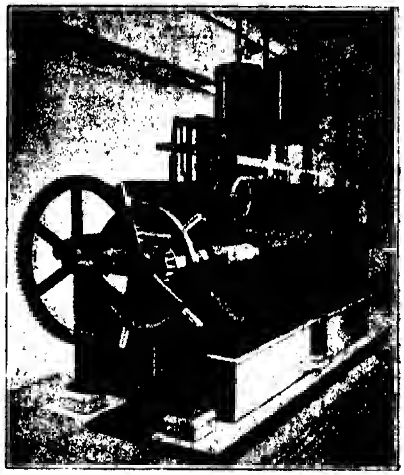


FIG. 10
Oerlikon Electrolyser

Most cells for the production of hydrogen and oxygen by electrolysis of water containing caustic soda are of the diaphragm type. The earlier non-diaphragm type, such as the Garuti and Schoop cells, contained electrodes each of which was almost completely encased by a bell of metal or earthenware. The only cells now used in which this method is employed are those of the Oxygen, Hydrogen and Plant Company, whose cells are based on the original design of Jaubert (see Fig. 7), and the Schuckert cell.

It is possible to construct the face of the electrodes either with projecting vanes or similar structure, so that the gas given off from each face rises immediately, in close proximity to the electrode face, to its appropriate collecting reservoir. This construction is utilised in the electrode of the Churchill cell and that of the Casale cell for generating electrolytic gas.

The Churchill cell is of the filter-press type, each bi-polar electrode being constructed of iron on the surface of which glass vanes are fixed in order to prevent the mixing of the gases evolved from

adjacent faces. Each electrode is insulated from its neighbour by a rubber joint, which also renders the electrolyser water-tight when the plates are screwed firmly into position. In the Casale cell each electrode consists of a pile of sheet-iron strips, 5 (Fig. 8), bent to form a rectangular frame with sloping sides. A terminal member, 6, of similar shape, is arranged above the column, 5, so that its upper surface projects above the level of the liquid. The cover of the vessel is provided with partitions, 12, extending to form a closed cell above each electrode, and each cell is provided with a delivery tube, 14. The electrodes are alternately anodes and cathodes, and between them a descending movement of the electrolyte is set up by the ascending movement, due to gas evolution, taking place inside the electrodes, which are fed with electrolyte through gap, 17, at the bottom of the electrodes. This cell is in use in Italy.

In a modified form of the cell the cathode consists of a cylindrical sheet, 22, provided with sloping gaps and an unperforated cylinder, 21, connected to it at the bottom by an annular plate, 23. The anode is mounted within the cathode and consists of an outer cylinder with sloping gaps and an inner unperforated sheet, the space between the electrodes being closed at the top by a plane annular disc, 27, fixed to the partition, 24. E.P. 200,376/22.

The Schuckert cell (Fig. 9), widely used in Germany before the war, and even at the present time, somewhat resembles the "Oxylithe" cell of the Jaubert Company, referred to above. Each iron electrode is encased by an iron bell, and the container holding electrolyte (caustic potash solution) is also of iron, the whole being placed in a wooden box filled with sand to prevent loss of heat by radiation. These cells require a lower voltage than diaphragm cells, but the purity of the gases is not high, occasionally falling to 90 per cent.

Diaphragm cells which are at present important will now be briefly described. All are made in 500 up to 2000 ampere units, and give approximately 7·0 cb. ft. of hydrogen per kw.-hr., except in the Schmidt Oerlikon filter-press type, of which the output is sometimes not more than 6 cb. ft. per kw.-hr.

The construction of the Schmidt unit will be clear from the illustration (Fig. 10). The number of cells per unit ranges from 30, requiring 70 volts, to 130, requiring 300 volts; and, owing to the filter-press structure, the plant is fairly inexpensive. Each plate is separated from its neighbour by sheet asbestos, which prevents mixing of the hydrogen and oxygen given off from adjacent faces of the bi-polar electrodes.

The Davis-Bournonville cell (New Jersey) is an improved form of the tank cell which was introduced in the United States about 1911. The outer tank of iron forms the cathode, whilst the anodes, L, suspended from the lid are each encased in asbestos sheet, K. Two or more anodes may be present, and between them auxiliary sheet iron cathodes, M, in contact with the tank itself may be fixed. The lid carrying the anodes and asbestos diaphragm is, of course, insulated from the tank. A view of the tank and interior is given in Fig. 11.

The Levin cell of the Electrolabs Company, Pittsburg, and the I.O.C. cell of the International Electrolytic Plant Company, England, are somewhat similar, and are illustrated in Figs. 12 and 13. Both are flat diaphragm cells, a 600-ampere unit of the Levin type having outside dimensions 43 in. by 37 in. by 8½ in., with an output of 9·6 cb. ft. of hydrogen per hour. The I.O.C. cell is flatter, because the anode and cathode plates form the casing of the cell, being separated from each other by a suitably clamped

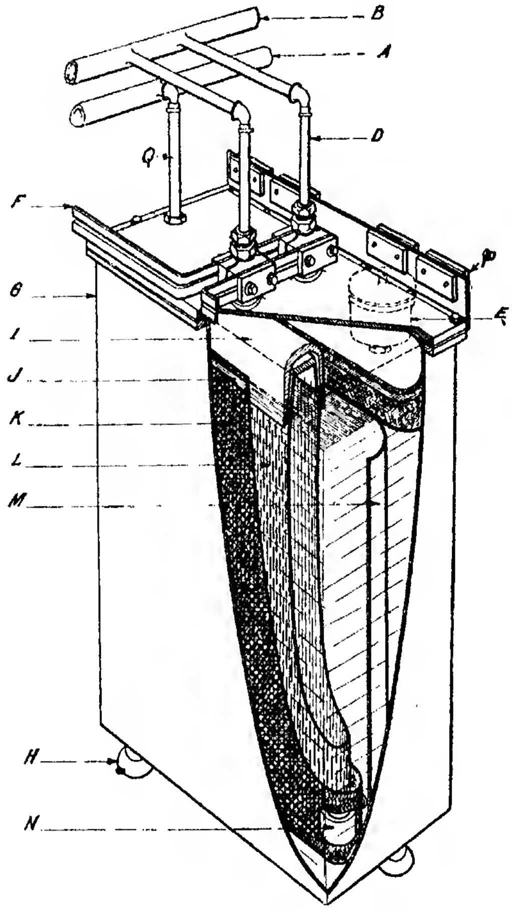


Fig. 11
Davis-Bournonville Cell

diaphragm; whereas the Levin cell contains two anode plates and two cathode plates separated by a diaphragm, and external to these, on each side, is the outer casing, which does not act as an electrode but only as a container.

No special device is needed for purifying the gases evolved, as their purity is usually about 99·5 to 99·8 per cent. A detailed explanation of the structure of the cells is not necessary, as the diagrams show all essential parts and indicate their relation to each other.

The last cell to be described is the Knowles Cell of the International Electrolytic Plant Company. This is an efficient multipolar iron cell which is somewhat less expensive than some of those already described, and which has recently been developed into a column cell with considerable economy in floor space when compared with other cells for generating hydrogen and oxygen.

Each cell consists of a tank in which anodes and cathodes, AA, are suspended alternately, each covered by a collecting bell, BB, and encased by asbestos diaphragms, LL (Fig. 14). Electrode bolts, CC, from which the anodes and cathodes are suspended, are insulated from the sealing tubes, DD, by ebonite tubes, EE, and top insulators, FF. Copper connexions, GG, connect the two bolts on the same electrode whilst HH are copper strips connected to the electrodes in parallel. Collecting pipes, JJ, serve to lead away the gases to the main off-take pipes, KK, whilst the skirting, MM, surrounds the entire block of bells and forms a stand on which it rests when lifted from the cell for examination.

The column cells shown in Fig. 15 are similar in design, but the superimposed arrangement is new, and allows a plant of high capacity to occupy exceptionally small space. Current passes from each cell to the one above, external current connexion being made only to the bottom and top cells, since the polarity is reversed as the current passes from cell to cell. Upstanding electrodes, A, on the base of one cell alternate with electrodes, B, hanging from the base of the cell above and form the anodes and cathodes of one cell unit. Asbestos diaphragms, C, hang from the bell plate, D, and prevent the gases which collect in spaces, E and F, from mixing.

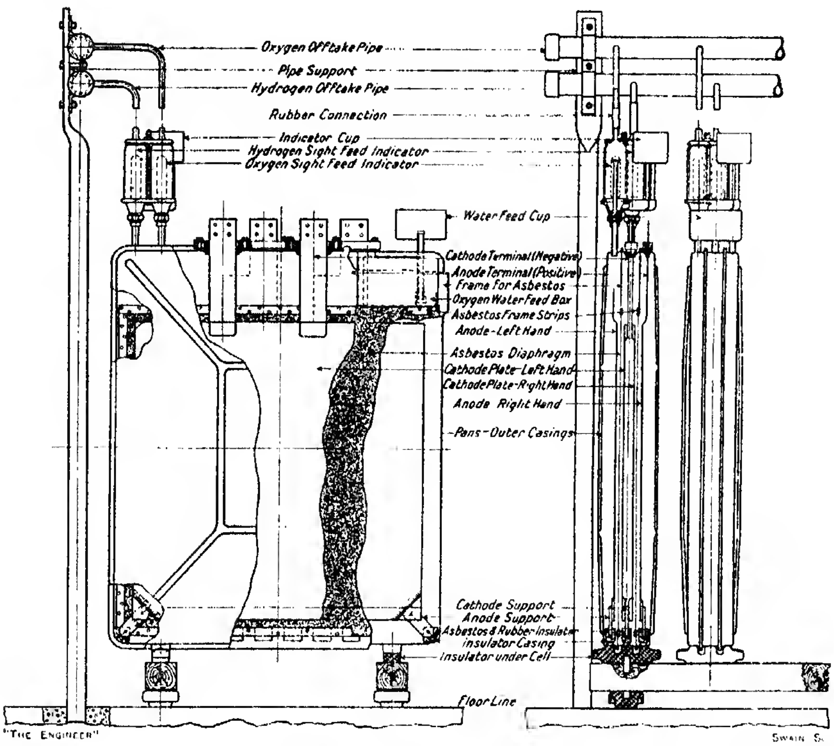


Fig. 12

Levin Electrolytic Cell

All the tanks are identical and interchangeable, so that any one may be used for the bottom cell, without risk of failure from the weight above.

The tanks of adjacent cells are insulated from each other by jointing rings, L, which also form a gas-tight ring and insulate the bell plate from both the tank above and below it. Copper bars, NN, carry the current between the top cells and bottom cells of adjacent columns which may be arranged ten or twenty cells high.

The voltage required by most of the cells described is 2·1 to 2·5 volts, and the energy output 7—7·5 cb. ft. of hydrogen per kw.-hr. with half this amount of oxygen. A 600 ampere unit will give in most cases 9·6 cb. ft. of hydrogen per hour.

CELLS FOR PRODUCTION OF CAUSTIC SODA AND CHLORINE

These are of great importance to-day and belong to one of three groups—*i.e.*, mercury cells, bell cells, or diaphragm cells, the last being the most important and most generally used.

The Castner rocking cell (1895) was followed later by the stationary Solvay-Kellner cell of larger dimensions (Fig. 16), and this is still used in the alkali industry. The cell itself is a large rectangular tank of cement along the floor of which a layer of mercury is caused to flow from one end to the other. This mercury cathode is in electrical contact with leads passing through the bottom of the tank and immediately over it are suspended the graphite anodes. As the thin mercury layer flows slowly through in contact with the brine electrolyte passing in the same direction, a sodium amalgam is formed which is decomposed by water in a separate tank with formation of caustic soda liquor. The liberated mercury is passed back to the cell whilst the chlorine discharged on the anodes is drawn off by an outlet pipe

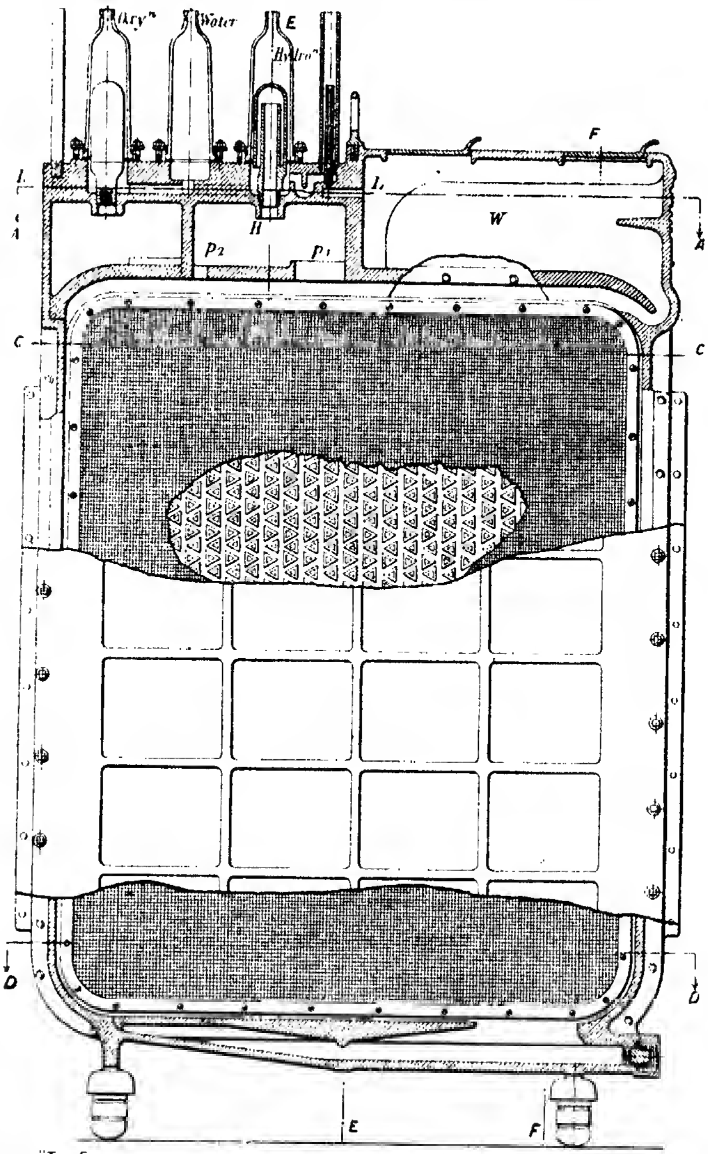


FIG. 13

I.O.C. Cell

on the top of the electrolytic tank. Cells taking as much as 4000 ampères have been constructed. The Wilderman cell is the only other mercury unit which has met with any success, a large installation being worked for some years in Germany before the War. A vertical section through one of the cylindrical cells (Fig. 17) shows that the mercury is contained in circular V-shaped channels which divide the central anode compartment from the outer cathode chamber. By means of stirrers, BB, fitted with ebonite blades, the mercury is kept in motion so that a greater concentration of sodium for a given weight of mercury can be obtained than in most cells of this type, because there is less tendency for solid amalgam to form when current densities greater than 6—8 ampères per dm^2 are employed. Recently, improvements in the design of the cell have been patented, in order to accelerate rate of working, and possibly it will continue in use where already installed.

In connexion with the Castner-cell production of sodium amalgam, its use as a reducing agent in plant for dealing with nitro-compound has been patented (E.P. 200,167/23), whilst another process (E.P. 198,855/22) deals with a method for producing sodium amalgam by electrolysis of brine and utilising it in another compartment for effecting chemical reaction—*i.e.*, the reduction of oxalic acid to glyoxylic acid.

Bell Cells or gravity cells usually consist of cement troughs or tanks in which a number of earthenware bells are suspended which encase the graphite anodes. These alternate with iron cathodes and the separation of caustic soda from the chlorine is effected by the flow of liquid from the bell or anode compartment to the cathode, from which caustic soda liquor overflows.

Such cells have been in use at Aussig and other Continental works for many years, as also have installations of a similar cell, the Billiter-Leykam bell cell (Fig. 18), and a recent type due to H. C. Jenkins, the illustration of which (Fig. 19) will show the principles involved. The Billiter-Leykam cell, which dates back to 1910 (E.P. 11,693/10), and is still in use on the Continent (Austria), is an improved form of the original bell cell in that the overflow takes place from the bottom of the cell and the iron cathodes, C, are encased in asbestos to facilitate the removal of hydrogen. The chlorine is drawn off from the top of the bell by the pipe, B, and fresh brine supplied through D.

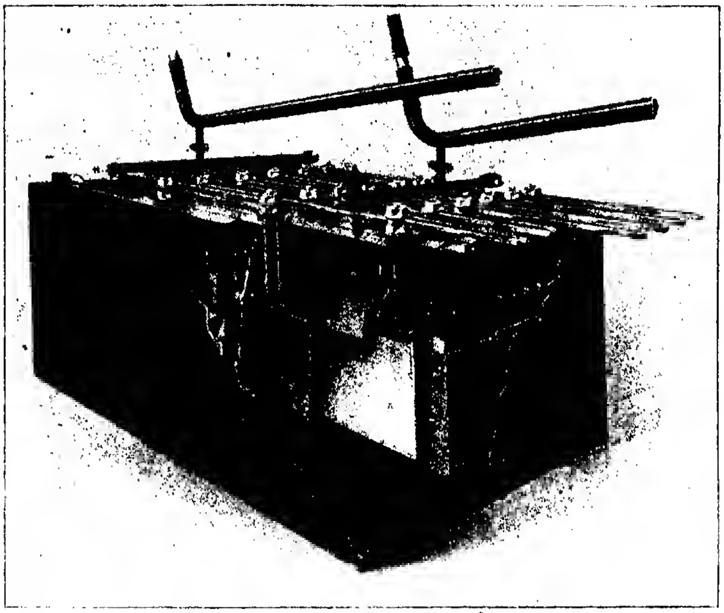


FIG. 14

Knowles Cell

Jenkins bell cell (Fig. 19) consists of a shallow concrete tank about 25 ft. long, 2·5 ft. high, and about 2 ft. deep, the floor of which is corrugated and the base of which is provided with four longitudinal pipes 10, 11, 12, 13, which open to a particular part of anode or cathode space. The pipe 10 is for emptying the tank when it is to be shut down, and is connected with depressions in the floor; pipe 11 supplies fresh electrolyte to the anode spaces; pipe 12 serves for removal of chlorine whilst caustic alkali is drawn off by pipe 13.

The anodes 2 are rectangular blocks of graphite arranged transversely across the cell, and are attached to the bells which enclose them by two graphite rods, 4 and 5. These anodes almost fill the bells, leaving only a small space for the anolyte. An iron cathode 6 is situated between each pair

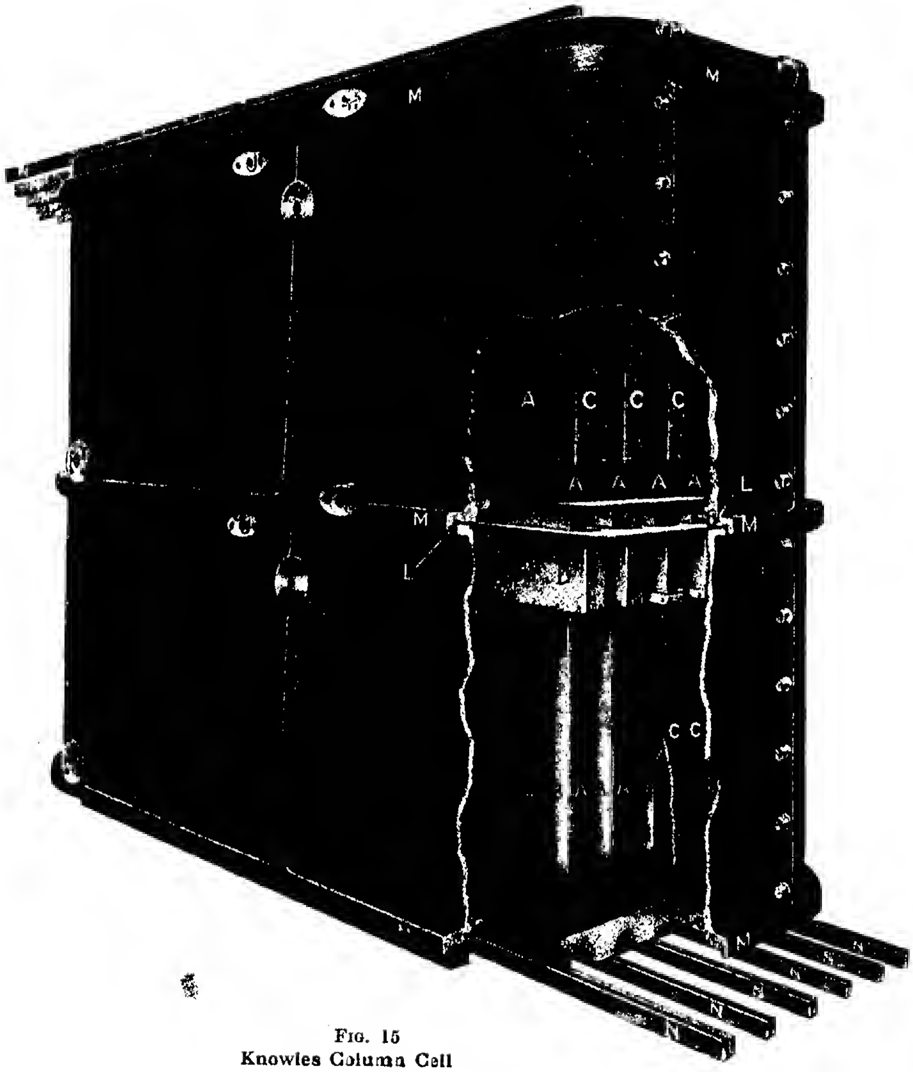


Fig. 15
Knowles Column Cell

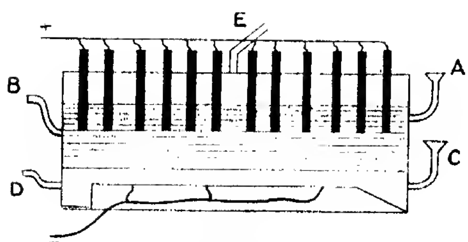


Fig. 16
Solvay-Kellner Cell

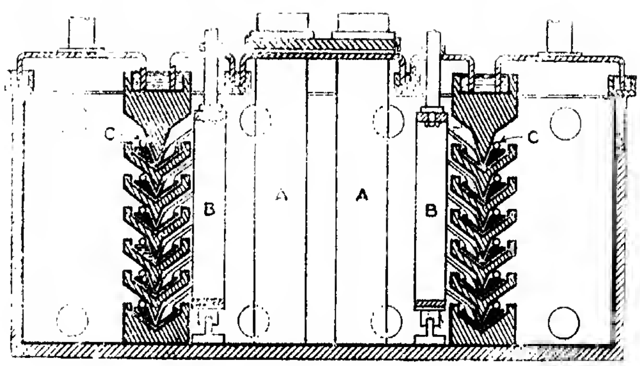


Fig. 17
Wilderman Cell

of bells, and is fitted with a collector 7 for hydrogen. All cathodes are connected to a bus bar 8, and are situated above the depressions in the cell floor, whilst all anodes are connected to the bus bar 9.

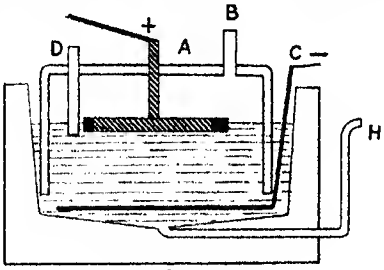


FIG. 18
Billiter-Leykam Cell

Fresh electrolyte is supplied at intervals through jets 20, which discharge into a small well 10, connected with the pipe 11, this liquid subsequently overflowing into a second well 17, containing an annular float 18. The liquid cannot escape out of 17 except by the path through which it entered, but it does so escape when the supply of liquid from the jet is cut off. The float 18 then falls back to its original position. Working at 4 to 4·5 volts per cell, a caustic soda liquor of 10-12 per cent. concentration is obtained.

(To be continued)

[Figures 1, 3, 5, and 20 are reproduced from the author's "Modern Chemistry, Pure and Applied," published by Messrs. Virtue and Co., Ltd., and Figs. 16, 17, 18, 21, and 27 from the author's monograph on "The Applications of Electrolysis in Chemical Industry," published by Messrs. Longmans, Green and Co. Acknowledgment is due to both these firms for permission to reproduce these figures and for their kindness in lending the blocks. Thanks must also be tendered to the other firms who have lent illustrations of their products.]

SOUTH AFRICAN IRON INDUSTRY

It is reported that a representative of the South African Iron and Steel Corporation is at present in London "probably conducting negotiations for the establishment of an iron industry in South Africa." It is also stated that the report of the four steel experts—Drs. Kipper, Lilge, Philippi and Reusch—who visited South Africa last year at the instance of the South African Iron and Steel Corporation to investigate the possibility of utilising South African iron ore at Pretoria and in other parts of the country, is now in the hands of the Government and is believed to be most favourable. The Government organ, *Ons Vaderland*, on the other hand, states that no report has been received, but adds that the Government would support any reasonable proposal made to it.

FORTHCOMING EVENTS

Dec. 13. SOCIETY OF CHEMICAL INDUSTRY and INSTITUTE OF CHEMISTRY, *Birmingham and Midland Sections*, The Annual Dinner, Queen's Hotel, Birmingham at 6.45 for 7 p.m.

Dec. 15. ROYAL COLLEGE OF SCIENCE MATHEMATICAL AND PHYSICAL SOCIETY and the IMPERIAL COLLEGE CHEMICAL SOCIETY, at Royal College of Science, S. Kensington, S.W. 7, at 5 p.m. "Intense Magnetic Fields," by Dr. T. F. Wall.

Dec. 15 to 20. UNIVERSITY OF LEEDS. Jubilee of the Yorkshire College, and Coming of Age of the University.

Dec. 16. WEST OF SCOTLAND IRON AND STEEL INSTITUTE. "The Application of Producer and Coke Oven Gas to the Metallurgical Industry," by Prof. R. V. Wheeler.

Dec. 17. INSTITUTE OF CHEMISTRY, *London Section*, 30, Russell Square, London, W.C. 1.

Dec. 17. SOCIETY OF CHEMICAL INDUSTRY, *Newcastle-on-Tyne Section*, Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. (1) "A Method of Measuring Specific Inductive Capacity," by L. A. Sayce and H. V. A. Briscoe. (2) "The Electrical Explosion of Tungsten Wires," by H. V. A. Briscoe, P. L. Robinson and G. E. Stephenson. (3) "A Redetermination of the Atomic Weight of Bromine; and an attempt to confirm that Isotypes are inseparable by Fractional Crystallisation," by P. L. Robinson and H. V. A. Briscoe. (4) "The Use of Fused Borax in Determination of the Atomic Weight of Boron," by H. V. A. Briscoe, P. L. Robinson, and G. E. Stephenson. An exhibition of Pyrex laboratory ware and blown Pyrex glass will be made.
Visit to the Wear Flint Glass Works, Millfield, Sunderland, will be made, leaving Newcastle at 1.17 p.m.

Dec. 18. INSTITUTE OF CHEMISTRY, *Belfast and District Section*, Queen's University, Belfast, at 7.30 p.m. "The Rutherford-Bohr Atom from a Chemical and Physical Standpoint," by Dr. R. C. Johnson.

Dec. 18. SOCIETY OF DYERS AND COLOURISTS, *West Riding Section*, "The Blending of Materials in the Woollen Trade with Relation to Dyeing," by J. W. Radcliffe.

Dec. 18. CHEMICAL SOCIETY *Ordinary Scientific Meeting* Burlington House, Piccadilly, London, W. 1 at 8 p.m. (1) "A Method of Determining the Presence or Absence of Complex Salts or Ions in Dilute Aqueous Solutions," by W. H Patterson and J. Duckett. (2) "The Nature of the Alternating Effect in Carbon Chains. Part 1. The Directing Influence of the Nitroso-Group in Aromatic-substitution," by C. K. Ingold. (3) "The Additive Formation of Four-membered Rings. Part VI. The Addition of Azo-compounds to Ethylenes and some Transformations of the Dimethylene-1:2-di-imine Ring," by C. K. Ingold and S. D. Weaver. (4) "The Chemistry of the Glutaconic Acids. Part XVII. Three-carbon Tautomerism in the Cyclopropane Series. Part 4." by F. R. Goss, C. K. Ingold, and J. F. Thorpe. (5) "The Condition Underlying the Formation of Unsaturated and Cyclic Compounds from Halogenated. Open-chain derivatives. Part IV. Products Derived from Halogenated α-methyl Glutaric Acids," by C. K. Ingold.

Dec. 19. SOCIETY OF CHEMICAL INDUSTRY, *South Wales Section*. Joint Meeting with the Institute of Chemistry, the Chamber of Commerce, Exchange Buildings, Swansea, at 6.30 p.m. "Fire Damp Explosions," by Prof. R. V. Wheeler, D.Sc.

SOCIETY OF CHEMICAL INDUSTRY

SUSPENSION OF ENTRANCE FEE

As an inducement to Chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Socioty in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 4, June 13 and 27, July 4 and 25, September 19, or October 3 and 17, 1924, that they are willing to dispose of to the Society.

DEATHS

Hake, C. Naper (Original Member) of the Oriental Club, Hanover Square, London, W.1. Chemical Adviser On Oct. 16, 1924.

Collett, J. M. (elected 1887) of Wynstone Place, Brookthorpe, Gloucester, Chemical Manufacturer. On Nov. 25, 1924.

BRISTOL SECTION

The third meeting was held jointly with the Institute of Chemistry, at the University, Mr. M. W Jones occupying the chair. A paper was to have been read by Mr. W. E. Fearnsides, of Messrs. L. B. Holliday and Co., Ltd., of Huddersfield, on "Some International Aspects of the Dyestuffs Industry," but owing to his absence in Central Europe Mr. H. N. Cliffe deputised.

After outlining the history of dyestuffs the lecturer discussed modern dyestuffs, and pointed out that the arguments for supporting the dyestuffs industry in Great Britain are based on a national outlook only, whilst the international view was largely neglected. There was a great change during the past fifty years in the colour trade, and nothing short of a "dyestuffs famine" would bring home to the nation what it would mean to be again in the position existing before any synthetic colours were available in the dyehouse, and only a strictly limited number of vegetable dyes which were difficult to apply and very unequal in fastness. From the seventies onwards ranges of dyes were produced at periods of about ten years, each range possessing greater fastness than its predecessor, and each marked by a flood of patents. This periodicity had not been maintained since 1910, and was not likely to recur because we had now almost arrived at the point when a nearly complete range of fast colours, no longer protected by patents, would be produced on every fibre and material.

The situation now developing was fundamentally different from the forty years of rapid development which preceded 1914. It would inevitably tend to the formation of rings and the elimination of less efficient units. The present development of the rings was indicated, and factors making for efficiency, permanence and competitive power were discussed. Among these factors were availability of raw materials; financial or economic soundness; trained and experienced personnel and maximum output based on widespread markets and complete range. These points received full treatment and particularly was the necessity urged for the extension of our overseas trade in dyes. Vast markets in Central Europe, South America, China, India and Scandinavia, together with the growing demands of our Colonies, were open to our products and there was the possibility that our production could be multiplied several times if we could satisfy foreign demands as to quality, price and service. This took time and required much hard work, but it could be and was being done.

The paper resulted in an excellent discussion in which Dr. Rixon and Messrs. Marsden, Southerden, Storey, Waterfall and others took part. Mr. A. Marsden read a letter from Mr. Fearnsides, apologising for his absence, and Mr. M. W. Jones gave an interesting account of his personal associations with some of the pioneers of the dyestuffs industry. The proceedings concluded with a hearty vote of thanks to Mr. Cliffe.

LIVERPOOL SECTION

A meeting was held in the Muspratt Lecture Theatre, The University, on December 5, Mr. Alfred Smetham in the chair, in the unavoidable absence of the chairman of the Section. A paper was read by Dr. Percy Lewis-Dale on "Liquid Hydrocarbons obtained in the Compression of Oil Gas."

The liquid was a by-product obtained when oil gas was submitted to a pressure of 150 lb. per sq. in. In 1825 Faraday discovered benzene in a similar liquid, and in 1884–6 H. E. Armstrong and A. K. Miller found many olefines, naphthenes and benzenoid hydrocarbons, but only traces of paraffins, whilst true acetylenes were absent or practically so. The liquid now examined contained an appreciable though small amount of mono-alkyl acetylenes, and acetylenes were also present in the gas from which the liquid was derived. Agreement was reached with the results obtained by Armstrong and Miller. There was little doubt that the liquids examined by these authors and by Faraday were of the same general character as that under discussion, although produced by different methods. The best use that had been made of the liquid in recent years was in the manufacture of a motor spirit of high volatility and great propellent power. Unfortunately, the tendency of the spirit to resinify militated against its use, and further, in view of the low cost of petrol, it was doubtful if the manufacture was an economical proposition at present.

A good separation of the constituents of various classes had been effected by careful fractionation. Unsaturated open-chain compounds of the general formula C_nH_{2n} were found in larger quantity than those of formula C_nH_{2n-2}, especially C_5H_{10} in much larger quantity than C_5H_8. Many ring compounds were found. The olefines were highly reactive, and some use might be made of them in industry. A suitable fraction might be used as a turpentine substitute, and possibly a satisfactory and economical motor spirit might be produced from a portion of the remainder, but perhaps the most profitable use of the liquid would be its return to the retorts

with the original uncracked oil. The higher boiling fractions were exceedingly complex and very interesting, and might form the subject of further investigation.

The quantity of liquid produced was limited by the amount of oil gas manufactured, and the use of oil gas was only possible where circumstances demanded the employment of the richest gas obtainable. Its use was practically confined to gas for cooking in railway restaurant cars and for light-buoys. In the past the chief use of the gas was for train lighting, but for this purpose electric light was becoming general.

After some discussion, a hearty vote of thanks was passed to Dr. Lewis-Dale, on the motion of Mr. W. Mansbridge, seconded by Prof. W. H. Roberts.

MANCHESTER SECTION

Dr. H. Levinstein presided over an attendance of fifty-five at the meeting held on December 5 when Mr. A. V. Slater read a paper on "Peptisation." The paper was an argument for the "complex" theory of colloidal solution, peptisation being a special case of true solution. Graham's definition of peptisation as the transformation of a gel to a sol by addition of a dispersing agent, was accepted, and the conditions for peptisation were discussed. A substance could be peptised if present in gel form with particles not above colloid dimensions. It could be peptised by a substance that was easily adsorbed by reason of primary or secondary valence forces. The colloidal particles were drawn into solution by the solution pressure exerted by the peptiser. Ions of low electro-affinity of the same sign of charge as the colloid, combined with ions of small coagulating power which increased the potential difference within a wide limit of concentration, would be good peptisers, and the peptiser must possess a high solution pressure of its own. In general, substances capable of forming soluble compounds with the colloid in high concentration would peptise easily in low concentration; raising the temperature and increasing the pressure would enable some substances to peptise a colloid which at lower temperatures and pressures were unable to overcome the cohesion of the colloid. If a peptiser did not exert sufficient solution-pressure or the eventual formation of a soluble complex salt of high concentration, the concentration must be kept low to prevent flocculation.

The rest of the paper consisted of a classified list of peptisations, concluding with a discussion of deflocculation.

MONTREAL SECTION

At the meeting held on November 17, Mr. L. H. Cole, of the Mines Branch, Dominion Government, Ottawa, stated that Canada had salt deposits of approximately 100,000,000 tons in the western provinces, and chiefly in Saskatchewan, but there was little hope of their industrial development in face of the tremendous competition of Great Britain and the United States, unless the freight rates for these salts from the west were sufficiently low to allow it. About 90 per cent. of the deposits of Saskatchewan had been found to be sodium salts with a 10 per cent. admixture of clays and other salts. In 1921 a thorough examination of the contents of the western lakes revealed some 100,000,000 t. of hydrous sodium and magnesium salts, in deposits varying from two or three inches to 140 ft., samples, on analysis, proving to contain about 90 per cent. of sodium salts. Near the lakes were salt and fresh water springs, and in the lakes themselves were found both intermittent and permanent beds, the former being the ones that were now worked. The permanent beds lay underneath, whereas the intermittent beds were formed by the seasonal crystallising of salt deposits on the surface of the lakes. More or less successful attempts had been made to deal with the salts industrially, and there are several companies harvesting the intermittent deposits. Investigation had also been made of deposits in British Columbia, where sodium carbonate and bicarbonate deposits had been found that were used in the manufacture of soap. In the discussion that followed, Mr. Cole stated that although they had found no potash of any importance in the West there was a possibility that there were deposits hidden there by the mud.

SOCIETY OF PUBLIC ANALYSTS

Four papers were read at the meeting held on December 3, Mr. G. Rudd Thompson in the chair :—

(1) "The Analytical Value of the Melting Point of the Insoluble Volatile Acids from Fats," by G. Van B. Gilmour, B.Sc. The method put forward by Blichfeldt for distinguishing between and estimating coconut and palm-kernel fats in mixtures is investigated. It is found that the method has considerable limitations, especially when there is a preponderance of other fats present. The melting points of the insoluble volatile acids from a number of edible oils and fats are given and it is shown that as little as 1 per cent. contamination with coconut or palm-kernel fat can be detected by the lowering of the melting point. The volatility of oleic acid in ordinary distillations is demonstrated.

(2) "The Use of Mitchell's Ferrous Tartrate Reagent in Qualitative Analysis," by A. H. Ware. The author describes and discusses results obtained by the use of Mitchell's reagent with plant extractives in the presence and absence of alkalis, including a new modification of the test in which acetic acid is used. He finds the test in its different variations to be of very great value in plant analysis and pharmacognosy. A list of a considerable number of phenolic bodies of different classes is given, including catechol-bodies, giving in plant extractives a good violet colour-reaction to the test, in the presence of definite amounts of alkali; also of catechol-bodies, which, although they resemble those of the first list in giving good green colour reactions with ferric alum, yield no violet colour to the test under discussion. The test affords a useful means of distinguishing between ipecacuanha extractives and a number of other extractives yielding a green colour to ferric alum, but which, like ipecacuanha, do not contain tannin. The modification of the test given

by boiling with dilute acetic acid after adding the iron reagent affords a very valuable means of distinguishing between two classes of gallic acid tannins. Those of one class give a good blue or violet colour reaction under the conditions named, whilst those of the other class do not show this result. The author gives a list of drugs and tanning materials falling into the two classes referred to, and proposes that the term "gallotannins" should be confined to tannins which give the blue or violet coloration to the acetic acid modification of Mitchell's test.

(3) "The Influence of Hydrogen-Ion Concentration on the Colorimetric Estimation of Pyrogallol and Catechol Derivatives," by S. Glasstone, M.Sc., Ph.D. The maximum intensity of coloration with Mitchell's ferrous tartrate reagent is obtained within the limits of p_H 6·5 and 10·3 for pyrogallol, 5·9 and 10·3 for gallic acid, and 4·1 and 11·1 for gallotannin. Hence the conditions described by Mitchell are suitable for obtaining equal intensities of the violet colour. In the case of catechol derivatives, however, the limits are much narrower and suitable adjustments of the p_H value are necessary to obtain quantitative results. The author recommends the addition of ammonium acetate, to act as a buffer and to give a p_H value of about 7·6.

(4) "The Futility of Sealing: A Suggestion for its Safeguarding," by B. S. Evans, M.B.E., M.C., B.Sc. The suggestion is made that plain wax seals should be used on which the person sealing should write his initials in special ink. A number of these inks should be kept, consisting of ordinary ink holding in solution substances easily identifiable in minute traces. The person breaking the seal would, after identifying the signature, dissolve it off the wax and test the solution for the key substance of which he would be privately notified.

SOCIETY OF GLASS TECHNOLOGY

A meeting was held in the Coal Gas and Fuel Industries Department, The University, Leeds, on November 19, the President, Col. S. C. Halse, in the chair. Four papers were presented and discussed.

(1) "Note on the Glasshouses of the Leeds district in the 17th, 18th, and early 19th Centuries," by Francis Buckley. John Houghton, writing in 1691, stated that there were then three glasshouses in Yorkshire, one near Ferrybridge, and two near Silkstone. They could now identify these as the glasshouses at Houghton, Bolsterstone and Silkstone. Henry Fenny was in possession of the Houghton glass factory in 1740, but by the end of the century the business had ceased. The glasshouse at Rothwell Haigh was erected before 1726. A good description of it appeared in the *Daily Post* of March 10, 1726. From the Rothwell Registers it was fairly evident that the firm which took the glasshouse in 1726 included Stourbridge glassmakers. The last actual mention of the glasshouse was in 1773.

The only glasshouse actually in or near the town of Leeds in the eighteenth century was known as the Engine Glasshouse, and this was probably the factory that supplied all the ordinary needs of the town for the greater part of the eighteenth century. It could be traced between 1738 and 1770. The Engine Glasshouse might have been the present as well as the predecessor of the famous Hunslet Glass Works, though the connexion had still to be proved. Between 1814 and 1861 at any rate, the Bower family had several factories there. The people of Leeds must have owed as much to this family in the nineteenth century, as they did to the Fennys in the previous century. In 1883 they had four glasshouses at work, and no competition in the town itself. Just before 1850, however, there was a sudden increase in the glass concerns in Leeds and the surrounding district, especially in the neighbourhood of Castleford.

An early nineteenth century glasshouse at Thornhill Lees could be traced back to 1830. Here Noah Turner made flint glass until the glasshouse was taken over by the Kilners before 1847, and converted into a bottle works. There was a glasshouse also at Worsborough Dale in 1833, worked by William Usherwood, but in the following year Messrs. Wood and Perkes were found in possession, making cut-glass.

(2) "A Striking Instance of Fireclay Corrosion through the Action of Saltcake," by Prof. W. E. S Turner, D.Sc. During the emptying of a glass tank with the gas-flame still running, the fireclay blocks surrounding the dog-hole in a bottle-glass furnace began to swell and to flow, soon after they became exposed to the action of the flame, as the tank was drained. There was a suspicion that when the tank was started a charge of saltcake had been put into the dog-hole, under the belief that the blocking of the hole would be prevented. After examination it was found that the exposed portion of the blocks had absorbed saltcake at an early stage in the operation of the furnace, and being covered with glass and the dissociation temperature very high, the saltcake had remained unattacked, until contact with the flame during the emptying of the tank brought about decomposition.

(3) "A Note on some Properties of a Sandstone Block after use in a Glass Furnace," by H. S. Houldsworth, M.Sc. In the experiments described refractory material (Penshaw stone) and glass were ground separately until they passed a 100 mesh I.M.M. sieve, and were then thoroughly mixed in the desired proportions. A little gelatin solution was added, and cones were shaped from the mixture. These were then heated alongside standard Seger cones in a gas-fired laboratory furnace. The results obtained indicated that powdered Penshaw stone interac as readily with a soda-lime glass as did powd or good fireclay bricks. Penshaw stone devel a close compact structure when used in a furnace. This tended to hinder the penetratio glass into the stone, thus adding to the life of refractory, and pointing to its successful use furnace-construction.

(4) "The Production of Colourless Glass in Tank Furnaces, with special reference to the use of Selenium. Part IV. The Influence of Arsenious Oxide," by A. Cousen, M.Sc., and Prof. W. E. S. Turner, D.Sc. Previous work by the authors had shown the great influence of arsenious oxide in

preventing the development of colour in a selenium decolorised glass. It was evident that some of the effect was due to the action of the oxide upon the iron present. In confirmation of this fact meltings of a glass batch with addition of various quantities of arsenious oxide were made, and the colour of the glass was found to be less the more of the oxide there was in the batch. This then was the first important effect of arsenious oxide in decolorising; the second consisted in the suppression of the brown selenium colour. From this point of view selenium and cobalt oxide were only secondary materials in the decolorising process. The pink colour due to selenium was developed at the commencement of melting. For its successful production it required a hot furnace for the first stages of melting, and a low iron oxide content of the glass. An attempt to réplace arsenic by its equivalent of phosphorus in the form of calcium phosphate showed the latter substance to have little or no effect upon the brown selenium colour. Antimonious oxide used instead of arsenious oxide with selenium gave a deep bluish green colour. The cobalt oxide required in decolorising was about 1/12 oz. per 1000 lb. of sand, and this quantity could not be increased by 50 per cent. without producing a distinct blue colour in the glass.

UNIVERSITY OF BIRMINGHAM CHEMICAL SOCIETY

At a recent meeting Mr. S. H. Edgar, B.Sc., read a paper on "The Chemistry of Blood." An outline of the chemical theories of coagulation was followed by a brief study of the blood-pigments and the compounds of hæmoglobin with gases. The exchange of oxygen between the blood and the tissues was then dealt with from the chemical standpoint, and the latter half of the paper was devoted to a survey of the study of immunity. The nature of toxins and anti-toxins was briefly discussed, and the theory of antibody formation in the blood was explained by means of Ehrlich's sidechain hypothesis. A few practical applications of immuno-chemistry were mentioned, in particular the precipitin test used in criminology.

At the last meeting a paper on "The Bohr Theory of Atomic Structure" was read by Mr. R. E. Kellett. The lecturer showed how the theory enunciated by Bohr in 1913, from being merely a physical interpretation of the Balmer-Ritz spectral formula in terms of Rutherford's atom and the quantum theory, had now developed through the recent work of Bohr and others into something of the greatest importance to the chemist. Not only did the extended Bohr theory interpret the phenomena of radiation, but it gave an explanation of photochemistry, catalysis, activation, theories of the union of atoms into molecules, and not only outlined the architecture of even the most complex atomic structures, but also explained the known regularities and the apparent irregularities of the Periodic System (*e.g.*, the apparently anomalous behaviour of manganese and iron, and the unexpected appearance of the rare earths group of elements). More important still it had given rise to valuable predictions and discoveries, such as the new element hafnium.

CHEMICAL SOCIETY

Before scientific communications were made at a meeting held on Thursday, December 4, the President, Prof. W. P. Wynne, referred to the address of congratulation which he would shortly present, on behalf of the Council and Fellows, to the University of Leeds on the occasion of the jubilee of Yorkshire College.

The first two papers were read by Mr. H. Burgess:—

New halogen derivatives of camphor. Part VI. β-Bromocamphor-α-sulphonic acid. [With T. M. Lowry.]

(*a*) A SERIES of α-sulphonic derivatives of camphor is described.

(*b*) Since these were only obtained when a halogen atom occupies the β-position, the view that β-bromocamphor and Reychler's camphorsulphonic acid contain the substituent in the same position is considerably strengthened.

(*c*) β-Bromocamphorquinone has been prepared and investigated.

New halogen derivatives of camphor. Part. VII. The constitution of the Reychler series of camphor-sulphonic acids. Experiments on chlorosulphoxides. [With T. M. Lowry.]

(*a*) α-BROMOCAMPHOR-π-CHLOROSULPHOXIDE has been prepared from the π-sulphonyl chloride and oxidised to *trans*-camphortricarboxylic acid.

(*b*) Under the same conditions *o*-toluenesulphonyl chloride does not give a corresponding chloro-sulphoxide.

(*c*) These experiments indicate that the conversion of a sulphonyl chloride to a chlorosulphoxide takes place when the sulphonic-group is linked to methylene, and not as a result of eliminating water with a neighbouring methyl-group.

(*d*) The conclusion is, therefore, drawn that no migration occurs during the formation of ketopinic acid from Reychler's camphorsulphonyl chloride, and consequently that the sulphonic group must be in the 10-position as stated by Wedekind.

Prof. T. M. Lowry said that the work had been rendered both difficult and interesting by the fact that at nearly every point the actions went in a different way from that which was expected. Reychler's acid had had a very curious history, since the radical had been put in position 2 by Reychler, in position 6 by Armstrong and Lowry, and now in position 10 by Wedekind; incidentally, in the confirmation of Wedekind's orientation, Reychler's dream of α-sulphonation had at last been realised. It was, however, very difficult to understand why 10-bromocamphor should always behave as if it were the 6-compound. It looked as if there were some sort of a linking between the two positions which was not shown by the conventional formula, like that which must exist between the ketonic group and the π and β methyl groups to account for their altogether unexpected sulphonation, and the complete neglect of the reactive α-atoms. The π-sulphonation of camphor

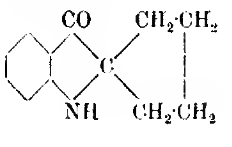
was also the only action in which the molecule underwent optical inversion; this had suggested to Armstrong and Lowry that the sulphonation might involve the rupture of the *gem*-dimethyl chain, with the formation of an intermediate compound derived from *p*-cymene, and the subsequent restoration of the chain on the other side of the 6-atom ring. The speaker had been working on camphor for over twenty-five years, and the camphor-chemist was still perplexed and fascinated by the many mysteries of that molecule.

In according very hearty thanks to the authors, and expressing the hope that the work would be continued, the President humorously feigned surprise that the results had not been interpreted in terms of the electron hypothesis, and that Prof. Lowry had discussed the work without even employing a + or − sign.

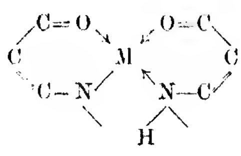
Dr. N. V. Sidgwick then gave an account of views which, he hastened with mock seriousness to explain, were fortunately conceived prior to the recent publication of a book prohibiting the application of electronic ideas to organic compounds. The substance of the paper was as follows:—

Some co-ordinated compounds of the alkali metals. [With S. G. P. Plant.]

THE action of alkali hydroxides on ψ-indoxyl-*spirocyclo*pentane (I) gives a substance MB, HB (M = Li, Na or K; HB = I) in which one metallic atom replaces one hydrogen atom in two molecules. The sodium and potassium derivatives can be recrystallised from toluene and lose one molecule of HB on heating, either alone or in toluene solution, forming no doubt the simple salt MB, which we should expect the indoxyl derivative to produce. There can be little doubt that the first product MB, HB contains a 4 co-valent metallic atom. The indoxyl ring admits of co-ordination between a metal replacing the imide hydrogen and the carbonyl oxygen, with the formation of the typical chelate ring of 6 atoms with two conjugate linkings (see formula II),



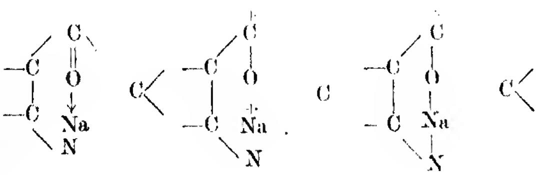
I



II

The strong tendency of the alkali metals to ionise will prevent the formation of this ring in the simple derivatives MB, which therefore are salts; but the greater stability secured by the completion of 4 non-polar linkings causes these compounds to add a second molecule of the indoxyl derivative (without replacement of hydrogen) giving the structure II. The remarkable solubility in toluene is thus explained, since the compound is not a salt. The sodium has its octet completed by means of three pairs of shared electrons borrowed from the two oxygens and the now quadrivalent nitrogen. The second ring, being attached only by co-ordinate linkings, is easily removed, and hence the compound dissociates on heating.

Prof. Lowry said that he was interested in the properties of Dr. Sidgwick's co-ordinated sodium-compound, because it appeared that the sodium-derivative of nitrocamphor did not possess these properties and must therefore be classed as a mere salt; also because of the dramatic verification of Dr. Sidgwick's own prediction that the co-ordination-number of sodium would be found to be 4 and not 2. He was, however, also interested in the structural formula assigned to the compound, since this showed all the bonds of a carbon atom pointing in the same downward direction. This he believed to be impossible in the case of a *quadrivalent* carbon-atom. On the other hand, in discussing the Walden inversion and the problem of "free rotation," he had urged that the three bonds of a *tercovalent* carbonium-ion, although they could easily become coplanar, need not necessarily assume this form, but might retain a "tetrahedral" configuration, since the NO_3 ion, although planar in sodium nitrate, is not so in lead nitrate. Dr. Sidgwick appeared to have carried out (perhaps unintentionally) a crucial experiment to determine whether the carbon atom in a cyclic co-ordination-compound is quadrivalent or tervalent, and to have proved that it must be tercovalent. The scheme I must therefore be incorrect and ought to be replaced, in this and in all analogous cases, by an alternative scheme, such as II or III, in which the carbonyl-group is ionised in such a way as to convert the quadrivalent carbon atom into a tervalent carbonium ion.



I II III

Prof. T. S. Moore briefly indicated how some of his own earlier results were now explained on the lines indicated by Dr. Sidgwick. Thus *o*-hydroxy-*m*-methylbenzophenone has only faint hydroxylic properties, and does not absorb gaseous ammonia. Two parts of the ketone with one of sodium in dry ether yield hydrogen in the cold until all the sodium is dissolved, whereas if equal parts are used hydrogen evolution stops while much sodium remains; on warming, the sodium ultimately disappears with slow evolution of hydrogen, but a solid sodium salt is precipitated.

Dr. Sidgwick confessed that he had not yet seriously contemplated a stereo-formula of the type suggested by Prof. Lowry. In connexion with Prof. Moore's remarks, he referred to the fact that *o*-nitrophenol, which is a co-ordinated compound, will not combine with aniline, whereas this is not the case with the other isomerides.

CORRESPONDENCE

THE TEACHING OF CHEMISTRY

SIR,—May I appeal, through your correspondence columns, for a more enlightened attitude on the part of those who control our qualifying examinations on chemistry ? It seems to me that this question is one of paramount importance, since it is to those who are now being ground in our educational mills that we must look for the future control of industry.

I hope I shall not be considered heretical when I state as my considered opinion that the present-day teacher of chemistry has to choose whether he will get his students through their examinations, or whether he will train them as chemists, and that the two aims are rapidly becoming mutually exclusive.

The immediate cause of this letter is a question set by a powerful university—shall we call it the University of "A" ?—in a chemistry paper in the last week of November. The question takes the form of a problem on Victor Meyer's method of determining vapour density. The data supplied are—weight of substance, volume of air displaced (collected over water), temperature of air, height of barometer, and the vapour tension of water at the temperature given.

Now I submit, Sir, that the problem as it stands is insoluble. The candidate is told either too much or too little. If he is intended to apply the vapour tension correction, he must be told the state of the air as regards humidity in the apparatus at the beginning of the determination : the "air" displaced is not air at all, but air plus a certain amount (usually 60–80 per cent. of its saturation value) of water vapour. The vapour tension correction is thus not p, where p is the vapour pressure of water at the temperature of the air, but $(100-x)\,p/100$, where x is the percentage saturation of the air in the laboratory. With $x>50$, which is almost invariably the case, more harm than good is done by applying the full correction.

I find it discouraging, to say the least, after I have trained students to think logically on this subject, to see the old fallacy cropping up again in an examination paper of repute. It will be objected, perhaps, that the treatment expected is that given in all the standard text-books (the new edition of Findlay's "Practical Physical Chemistry" is an honourable exception), and that in any case the point is a minor one. To these I would reply that examiners should be expected to point the way, not to follow in the wake of obsolescent text-books ; and secondly, that the point, though numerically negligible, forms excellent material for logical reasoning on the part of the student, and that we cannot expect him to be capable of clear thinking if his examiners show by their questions that they do not require it.—
I am, Sir, etc., HAROLD HUNTER

OPTICAL ACTIVITY AND POLARITY THEORIES

Sir,—In a letter in your issue of December 5 (p. 1214), Prof. Peacock refers to some suggestions of mine relating to the above subject (*J.C.S.*, 1924, **125**, 1121). He describes my paper as one dealing with *general polar effects* (a description incorrectly attributed to me) and states that the general polar effect of a substituent on optical activity had already been indicated by him in 1914 (*Proc. Chem. Soc.*, **30**, 274).

There is, however, no question of priority on this point. The polarity of a group has for long been associated more or less definitely with its acidic character, and the connexion between the influence of substitution on optical activity and acidity was already being developed at an earlier date by Betti (*Gazzetta*, 1906 onwards). A summary published by this investigator (*Ibid.*, 1923, **53**, 417) contains the rotatory powers of thirty-six derivatives of an optically active base and demonstrates the remarkably close parallel existing in this case between the two properties. I was unaware of the full extent of this work until recently.

On my part, I have attempted to show that the relative change in electrical field following on substitution by simple groups can be deduced from the electronic theory. And that the *polar series* so obtained expresses in certain cases the influence of these groups on optical activity and other properties. From this standpoint a positive group such as NO_2 will displace the rotation in the opposite sense to a negative group such as OH. Further, if the rotation of a benzenoid compound is affected by a positive substituent in the order o > m, H > p, the influence of a negative substituent should be given by p > m, H > o and *vice versa*.

These views are quite distinct from those implied by the phrase "general polar effect" (see also *J.C.S.*, 1924, **125**, 2155, 2156) by which is usually understood the influence of the groups as deduced directly from their effect on acidity (compare Flürscheim, *J.C.S.*, 1909, **95**, 718 ; Robinson, *Ann. Rep.*, 1922, 98). Investigations being carried out in these laboratories appear to confirm the existence of both these effects in optical activity.—
I am, Sir, etc., H. G. RULE

Chemistry Dept.,
University of Edinburgh

PERSONAL AND OTHER ITEMS

Sir William Alexander, who is at present in the United States, has resigned his position as chairman of the British Dyestuffs Corporation, on account of increasing business and political activities. Lord Ashfield, whose activities in connexion with London transport are well known, has resigned his Government directorship of the Corporation to succeed Sir William Alexander as chairman and the Rt. Hon. Sir Alfred Mond has accepted nomination as Lord Ashfield's successor on the board.

Mr. T. V. Barker has been reappointed University Lecturer in Chemical Crystallography at Oxford for a further period of five years.

The Chandler medal, given each year by Columbia University for services to science, has been awarded to Prof. E. C. Kendall, of the University of Minnesota, who isolated the active constituent of the thyroid gland.

Prof. Pascal, of the University of Lille, has presented three pieces of apparatus used by Louis Pasteur to the Columbia University. The apparatus —two flasks and a U-tube—will be placed on view in the Chandler Chemical Museum.

Sir John Wormald has resigned his seat on the Board of Messrs. Mather and Platt, after thirty-six years' connexion with the firm.

The Scottish Society of Arts has awarded a Keith Prize, value £20, to Mr. R. MacLaurin for his paper on "Carbonisation of Coal for Smokeless Fuel and Industrial Gas." An award of £85 was also recommended for C. N. Kemp to continue his X-ray work on coal.

The Chemical Department of the University of Manchester has received a gift, from Miss E. M. Scott, of a portrait of John Dalton.

Dr. J. Reilly, Assistant State Chemist to the Irish Free State, has been appointed professor of chemistry in University College, Cork (National University of Ireland), as successor to Prof. Dixon, M.D.

Dr. E. König, who died on October 29, was the chief chemist of the Höchst Farbwerke and a well-known worker in photo-chemistry. To him was due the development of the Pinachrome and Pinatype processes of colour reproduction, and the production of colour-sensitising dyes such as Pinaverdol and Pinachrome for photographic plates, as well as of the photographic desensitiser Pinacryptol.

Atomic and Molecular Structure

The fourth of a series of public lectures on "Atomic and Molecular Structure" was given on November 26 by Dr. J. D. Main Smith, in the Chemistry Department, Birmingham University. The lecturer outlined a new and comprehensive system of classification for simple and complex, and organic and inorganic compounds generally, and indicated that modern problems of isomerism and optical activity necessitated the classification of compounds according to stereo-chemical conceptions.

It was shown that Werner's co-ordination theory, in which molecules are regarded as spatial complexes consisting of atoms closely bound to a central atom, furnished a comprehensive basis for the general classification of chemical compounds. Four main types of compounds were distinguished characterised by the co-ordination numbers 2, 3, 4 and 6, and no others, each type being divisible into subtypes, according to the maximum number of atoms in a plane, and further subdivided according to whether or not the atoms are or are not in cyclic structures—*i.e.*, whether the central atom is or is not combined with chelate groups. The types were further classified according to the number of chelate groups per central atom, and illustrative examples were drawn from every sort of chemical compound.

The spatial conceptions involved in the classification were shown to afford simple explanations of general and optical isomerism, and it was suggested that optical activity is simply due to the rotation of a plane wave on reflection by atoms, the rotation being in a preferential direction when atoms are arranged asymmetrically.

The co-ordination theory was shown to lead to an exact knowledge of the structure of molecules and the superficial features of the structure of atoms.

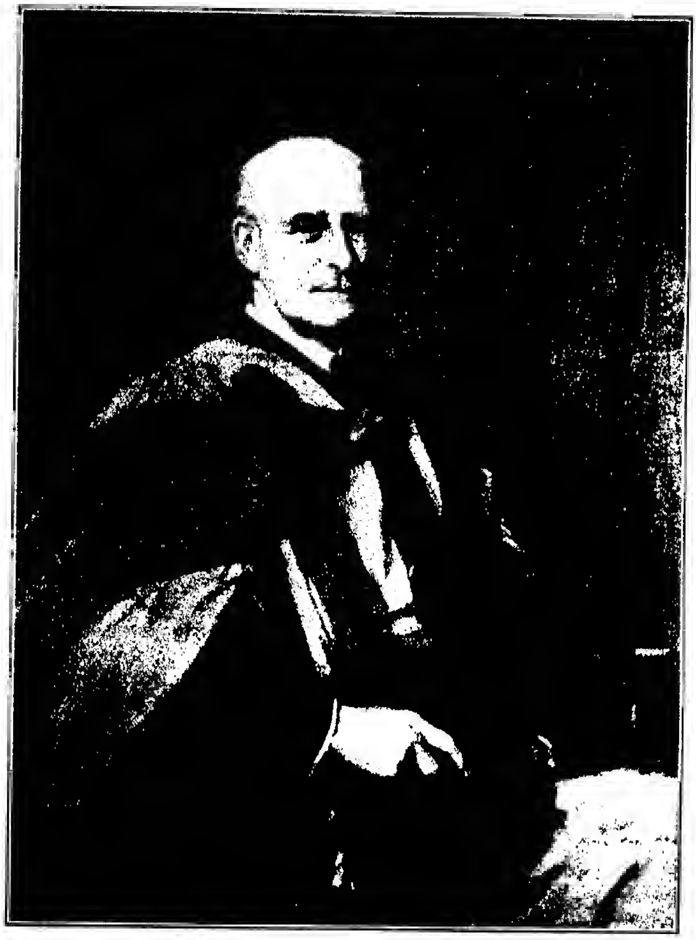
Pulp and Paper in Canada

The preliminary report of the pulp and paper industry for 1923 recently issued by the Forest Products Branch of the Dominion Bureau of Statistics indicates that the industry has made another advance in its recovery from the unsatisfactory conditions three years ago. From the time of its establishment in Canada in 1803, until the post-war depression of 1921, paper-making showed a steady increase. There was a heavy falling-off in 1921, 1922 was a period of readjustment, but with increases in several lines, and 1923 shows a total increase. If the net value of production for the entire pulp and paper industry be considered as the sum of the value of (1) pulpwood exported; (2) pulp made for export, and (3) paper manufactured, then the totals for the years mentioned stand as follows: 1920, \$230,199,717; 1921, \$157,426,587; 1922, \$152,209,711; 1923, \$183,266,218. The total capital investment of \$417,611,678 represented an increase of 9·6 per cent. over 1922. The total number of employees was 29,179, as compared with 25,830 in 1922, and the total pay-roll \$38,305,157 as compared with \$32,918,955. The Province of Quebec maintained the lead on the production of wood-pulp, the value of which was no less than \$50,255,367. This Province also led in the production of paper valued at \$58,566,143.

PRESENTATION OF PROFESSOR SMITHELLS' PORTRAIT TO THE UNIVERSITY OF LEEDS

The presentation to the University of Leeds of the portrait of Prof. Arthur Smithells, C.M.G., D.Sc., F.R.S., who resigned in 1923 the chair of chemistry which he had held in the University and in the Yorkshire College for thirty-eight years, took place on November 25. The chair was taken by Mr. E. George Arnold, Pro-chancellor of the University, and the presentation was made by Mr. A. G. Lupton, treasurer of the Smithells' Fund, who was Pro-chancellor of the University during most of the period of Prof. Smithells' tenure of the chair of chemistry. Prof. Cobb, speaking on behalf of the subscribers to the fund, said it was impossible to enumerate or even to summarise the valuable services which Prof. Smithells had rendered inside and outside the University in so many ways. Even confining himself to University activities it would be impossible to deal with them at all adequately, and to do justice to him, without telling the story of the University, so intimate had been his connexion with all the main features in its development. The record of Professor Smithells as the head of the chemical department of the University, which had grown so much under his care, was one of which any man might be proud.

luates were doing excellent work all over the and its reputation had gone steadily upwards. s work had meant much more than all that. s a great step forward when it was decided to ve no stone unturned in making Leeds a centre of niversity education, but it was important to bear n mind that what was done at that time was not imply to institute another University, but a new ind of University, in which not only should science munity and to the University also. It had meant bringing together people who, unfortunately, had too much come to regard themselves as having very little in common, and to do it thoroughly required the exercise of very special gifts in dealing with men and affairs. It had, however, been done, and the story of this achievement could not be told without prominence being given to the great part played in this development by Prof. Smithells. No one had



By Fiddes Watt, R.A.

Prof. A. Smithells, C.M.G., D.Sc., F.R.S.

ave a place of honour but where a Faculty of Technology should be included, ranking along with Arts, cience and Medicine, and living in closest union ith them. This was based upon an essentially new lea that the principles operative in industrial processes so important in this country, could be made fitting subjects for university study, training, and research, if they were only treated in the proper way. It was a bold policy and made the institution of the University very much of a pioneering venture, but its success had meant much to the industrial com- spoken more strongly, however, than Prof. Smithells himself on the importance of the lay element in the University. In closing, Prof. Cobb spoke of the unique position that Prof. Smithells had held in the University for so many years in relation to the staff and Students. Nobody, he thought, had been the repository of more confidences. Nobody had been so much called upon for advice or had been at more pains to give it to the best of his ability, drawing upon a rare faculty of judgment and a wealth of experience for the purpose.

REVIEWS

Stickstoffindustrie. By Bruno Waeser. (Technische Fortschrittsberichte, Band V). Pp. viii+128. Dresden and Leipzig: Theodor Steinkopff, 1924. Price 4 marks.

Dr. Waeser's small monograph gives a condensed and useful account of the present position of the Nitrogen Industry, including Chile nitre and by-product ammonia. It is mainly a series of brief abstracts, with fairly complete references to the literature and to patent specifications, with useful statistics, and presents a large amount of information in small compass. The index is too brief to be really useful. The information given in the book does not go beyond what is already known in this country, but one or two points of interest may be noted. There has been no production of importance by the Haüsser process, and the processes of Burkheiser and Feld for the recovery of sulphur in gas by conversion into ammonium sulphate, after long runs on large scale operation, have given no important results. The Polzenius method for the production of cyanamid is used only to a very limited extent. Cement can be made satisfactorily from cyanamid mud. Attention is directed to the estimated loss of 600,000 tons of potassium nitrate annually in Chile. The synthetic production of ammonia is well treated, and the results of the Claude, Casale, and Fauser processes are given. To those who have not kept in touch with the important developments in nitrogen fixation since the war, Dr. Waeser's book will be found useful. J. R. Partington

The Enlarged Callender Steam Tables. By Prof. H. L. Callender. Pp. 80. London: Edwin Arnold and Co., 1924. Price 7s. 6d. net.

The publication of this neat and well-printed edition of Prof. Callender's Steam Tables, now extended in Fahrenheit units to 2000 lb. per square inch pressure, and with superheat up to 1000° F. temperature, is an indication of the enormous advances that have been made in the science of steam generation during the past few years. The ordinary steam tables hitherto available in Great Britain have generally ceased at about 250 lb. per square inch absolute because there was no use for further data, and until quite recently the maximum power station conditions were about 200 lb. gauge pressure and 600° F. superheat temperature, most chemical works, for example, using at the present time less than 160 lb. To-day 350 lb. and 700° F. is comparatively common practice for super stations, the North Tees station is working at 475 lb., the Crawford Avenue station at Chicago, now being completed, will be 550 lb., and several experimental boilers both in the United States and Germany are built for 800—1200 lb. gauge pressure.

Further, the "Atmos" boiler of Blomquist in Sweden works at 1500 lb., so that much enlarged steam tables are imperative. It seems a pity, however, that the present book of Prof. Callender's, excellent though it is, stops short at 2000 lb. and is restricted to the Fahrenheit figures only. The "Benson" coil steam generator, for example, operates at 3200 lb. pressure, that is the actual "critical" temperature, and in order to study such conditions the British engineer or chemist has still to purchase American or German steam tables. However, it is understood that Prof. Callender is prepared to extend his book and to add the centigrade figures when there is "sufficient demand to justify publication." It is to be hoped, therefore, this will be forthcoming, for the present volume is certainly a necessity on the shelves of a very wide circle of technical readers and students, especially as the figures given for saturated steam are extended to a vacuum of 29·5 in. with 0·05 in. divisions for the lower figures.

COMPANY NEWS

POWER-GAS CORPORATION

The report for the year ended September 30, 1924, states that a substantial volume of orders has been obtained, especially towards the end of the year, the financing of which, together with the settlement of liabilities for taxation, make it advisable that the resources of the company should be conserved. The profit, after crediting the amount transferred from taxation reserve, was £12,198 (£14,197 last year), which, together with £11,070 brought in, makes £23,268. The sum of £2000 has been placed to reserve, carrying forward £21,268.

PEACHEY LEATHER PRODUCTS, LTD.

The Rt. Hon. Lord Daryngton, P.C., presided over the first ordinary general meeting of this company which was formed in 1923 to work the Peachey process for the cold vulcanisation of rubber. Although there had been some delay in completing the plant, the works were fully employed early this year, producing between 1500 to 2000 yards per day of leather cloth. The decision not to place any material on the market until a large stock in all colours and qualities was accumulated had proved unwise, as the requirements of the market should have been fully tested first. The want of uniformity in the material was thought to be due largely to the use of too large a vulcaniser, and it was found that the vulcanising process then operating had a weakening effect of a serious nature upon the fabric backing. It was therefore decided to discontinue sales until that defect had been eliminated. They had sufficient raw materials in stock to las for from four to six months, and although it w impossible to state what their requirements won be, they did not expect to be in full production the next few months. Samples of the experiment product had been shown to many leading fir and the company were satisfied with the recept given to their material and were confident that th sales would develop with considerable rapidi Agents were in every country in the world ready to push the sale of their products when the improvements had been completed. The major difficulties had now been solved, and an early production of the standard lines of manufacture, which would compete favourably with any other leather cloth on the market, might soon be expected. In order

ilise the space in their works not required for nanufacture of their basic product, the company in negotiation for the manufacture, of side-s, including overshoes for Shoemacs, Ltd., and uring of proofed fabrics for the Textile Company.

PAN DE AZUCAR NITRATE CO., LTD.

The twenty-third annual general meeting took place on November 27, the Rt. Hon. Lord Hunsdon (chairman) presiding. The accounts for the year under review showed a gross profit of £39,162. The sum of £10,472 was debited for depreciation, £4000 reserved for taxes and London expenses and sundry charges came to £4372, of which £1667 was for interest on the purchase price of new grounds, acquired by the company in February, 1924. The net profit was £20,317, which, together with £30,492 brought forward from last year makes a total of £50,809. The results for the year's working were considered satisfactory, and the dividend of 20 per cent. for the year was 5 per cent. in excess of that paid in any of the three previous years. Results obtained from the new grounds were fully up to expectation, and the investment was of considerable value. Co-operation in propaganda was urged between makers of all nitrogenous products. There was a slight improvement in the trade in nitrate of soda, the world's consumption for the year to June 30, 1924, being 2,190,000 t., against 2,160,000 t. for the previous year and 1,545,000 t. for 1922. Sales for the current year had been satisfactory so far, the Producers' Association having sold 1,830,000 t. for shipment from July 1, 1924, to May 31, 1925. Future prospects were considered satisfactory, although it should be remembered that there was likely to be a considerable increase in the output of sulphate of ammonia, both from synthetic plants and as a by-product, but the world demand for fertilisers could be expected to increase considerably as time went on, and it was not improbable that the whole production of nitrogenous substances would be needed.

LONDON NITRATE CO.

A final dividend has been recommended of 12½ per cent., tax free, making 20 per cent., tax free, for the year, compared with 12½ per cent. for 1922–23. It is proposed to place £50,000 (against £30,000) to reserve for redemption of debentures, leaving 11,992 to be carried forward, compared with 16,418 last year.

CONSETT IRON CO.

An interim dividend of 6d. per share on the linary shares, less tax, has been declared, as com-ed with 6d. per share in December last, which paid tax free, the full dividend for the year lling 7½ per cent. In October last a further 1,000,000 six per cent. debenture stock was placed, ranking at the same rate with existing stock of £1,500,000.

MIDLAND BANK LIMITED

The Midland Bank, Ltd., announces that Mr. A. T. Jackson, formerly an assistant general manager, has been appointed a joint general manager.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£21 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder..	£47 per ton.
Acid Hydrochloric ..	3s. 6d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali.. ..	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 10s. per ton, packages extra.
Borax, Commercial—	
Crystal..	£25 per ton.
Powder..	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride (Solid)..	£5 12s. 6d. to £5 17s. 6d. per ton, carriage paid.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate	£38 per ton d/d. Normal business.
Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¾d. per lb.
Potass. Chlorate.. ..	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake..	£3 10s. per ton d/d.
Soda Caustic, solid ..	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5—£5 5s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate (refined)	£10 10s. per ton, carr. paid.
Sod. Bichromate.. ..	4½d. per lb.
Sod. Bisulphite Powder 60/62%..	£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. solid 60/65	About £15 per ton d/d.
Sod. Sulphide cryst. ..	£9 5s. per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	6¼d.—1s. 2d. per lb., according to quality.

Antimony sulphide—
Crimson .. .. 1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow 1s. 11d. per lb.
Barytes .. .. .. £3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide .. 3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide .. £30—£33 per ton, according to quantity.
Carbon Black .. .. 7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride .. £60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green .. 1s. 3d. per lb.
Indiarubber Substitutes White and Dark .. 5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black .. .. £48 per ton, barrels free.
Lead Hyposulphite .. 7½d. per lb.
Lithopone, 30% .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. .. £16 5s. per ton f.o.r. London.
Sulphur .. .. .. £10—£12 per ton, according to quality.
Sulphur Precip. B.P. .. £50—£65 per ton, according to quantity.
Sulphur Chloride .. 4d. per lb., carboys extra.
Thiocarbanilide .. .. 2s. 6d. per lb.
Vermilion, pale or deep .. 5s. 1d. per lb.
Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—
Brown .. .. .. £11 5s. per ton, and upwards.
Grey .. .. .. £14 10s.—£15 per ton. Firmer.
Liquor .. .. .. 9d. per gall. 32° Tw.
Charcoal .. .. .. £7 5s.—£9 per ton, according to grade and locality. Demand brisker in many localities.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. ,, ,, 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 9d. per gall. Unrefined.
Wood Naphtha—
Miscible .. .. 4s. 9d. per gall. 60% O.P.
Solvent .. .. 5s.—5s. 3d. per gall. 40% O.P. Firmer.
Wood Tar .. .. £4 10s.—£5 10s. per ton. Demand slack and stocks being held.
Brown Sugar of Lead .. £42 per ton. Steady market.

TAR PRODUCTS

Acid Carbolic—
Crystals .. .. 5¾d.—6d. per lb. Quiet.
Crude 60's .. .. 1s. 7d.—1s. 9d. per gall. Market quiet but fairly steady.
Acid Cresylic, 97/99 .. 1s. 11d.—2s. 1d. per gall. Fair business.
Pale 95% .. .. 1s. 8d.—1s. 11d. per gall. Not much business.
Dark .. .. .. 1s. 7d.—1s. 9d. per gall. Market dull.
Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—
Strained .. .. 6½d.—7½d. per gall. Small demand
Unstrained .. .. 6d.—6½d. per gall.
Prices advanced; supplies very scarce.
Benzole—
Crude 65's .. .. 9d.—11½d. per gall. ex works in tank wagons.
Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure .. .. .. 1s. 9½d.—1s. 11d. per gall. ex works in tank wagons.

Toluole—90% .. .. 1s. 5½d.—1s. 7d. per gall. inquiry.
Toluole—Pure .. .. 1s. 7d.—1s. 9d. per gall. Steady demand.
Xylol—Coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 8d.—8½d. per gall. More inquiry.
Middle Oil .. .. } 5½d.—6½d. per gall., according to quality and district. Market firmer. Steady demand.
Heavy Oil .. .. }
Standard Specification }
Naphtha—
Solvent 90/160 .. 1s. 3d.—1s. 4d. per gall. Demand good. Higher prices probable.
Solvent 90/190 .. 11½d.—1s. 1d. per gall. Demand maintained.
Naphthalene Crude—
Cheaper in Yorkshire than Lancashire. Demand rather better.
Drained Creosote Salts £3—£5 per ton. Steady but quiet.
Whizzed or hot pressed £6—£9 per ton. No business.
Naphthalene—
Crystals and Flaked .. £12—£15 per ton, according to district.
Pitch, medium soft .. 47s. 6d.—60s. per ton, according to district. Plenty of inquiry. Prospects brighter.
Pyridine—90/160 .. 18s. 6d.—19s. per gall. Steady business.
Heavy .. .. 11s. 6d.—12s. per gall. Steady.

INTERMEDIATES AND DYES

Business in dyestuffs has been maintained but without further improvement.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 7d. per lb. naked.
Acid H. .. .. .. 3s. 10d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 1d. per lb. Good demand.
Acid Sulphanilic .. 9d. per lb. 100% basis d/d.
AluminiumChloride, anhyd. 10d. per lb. d/d.
Aniline Oil .. .. 8d. per lb. naked at works.
Aniline Salts .. .. 8½d. per lb., naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 3s. 10d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 1d. per lb.
p-Chloraniline .. .. 3s. per lb. 100% basis.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
o-Cresol 29/31° C. .. 3½d.—4d. per lb. Easier.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline .. .. 2s. 3d. per lb.
Dichloraniline S. Acid .. 2s. 3d. per lb. 100% basis.
p-Dichlorbenzol .. .. £85 per ton.
Diethylaniline .. .. 4s. 3d. per lb. d/d., packages extra, returnable.
Dimethylaniline .. .. 2s. 2½d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 2s. 10d. per lb. d/d.
G. Salt. .. .. .. 2s. 3d. per lb. 100% basis d/d.
Monochlorbenzol .. .. £63 per ton.
α-Naphthol .. .. 2s. 4d. per lb. d/d.
β-Naphthol .. .. 1s. per lb. d/d.
α- Naphthylamine .. 1s. 3½d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 4s. 2½d. per lb. d/d.

…aniline	2s. 2½d. per lb. d/d.
…obenzene	5¼d.—5½d. per lb. naked at works.
…-Nitrochlorbenzol	2s. 3d. per lb d/d.
Nitronaphthalene	10d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	4s., per lb. d/d.
p-Phenylene Diamine	10s. per lb. 100% basis d/d.
R. Salt	2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 2d. per lb. 100% basis d/d.
o-Toluidine	10d. per lb. naked at works.
p-Toluidine	2s. 10d. per lb. naked at works.
m-Toluylene Diamine	4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£45 per ton, ex wharf London, in glass containers.
Acid, Acetyl Salicylic	3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P.	2s. 6d. per lb.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 3½d.—1s. 5d. per lb., less 5%. Increased demand.
Acid, Gallic	2s. 9d. per lb. for pure crystal in cwt. lots. Easier.
Acid, Pyrogallic, Cryst.	7s. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	1s. 6d.—1s. 7d. per lb., according to quantity.
Acid, Tannic B.P.	2s. 10d. per lb. Quiet steady demand.
Acid, Tartaric	1s. per lb., less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	1s. 10d.—2s. per lb. More enquiry.
Amidopyrin	14s. 6d. per lb.
Ammon. Benzoate	3s. 3d.—3s. 9d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	13s. 9d. per lb. Slightly lower. Quiet steady demand.
Benzonaphthol	5s. 3d. per lb. spot.
Bismuth Carbonate	8s. 6d.—10s. 6d. per lb.
" Citrate	8s. 6d.—10s. 6d. "
" Salicylate	8s. 0d.—10s. 0d. "
" Subnitrate	7s. 7d.—9s. 7d. " According to quantity. Prices recently reduced.
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Market very firm. Prices uncertain.
Ammonium	2s. 1d. per lb.
Potassium	1s. 10d. per lb.
Sodium	1s. 11d. per lb.
Calcium Lactate	1s. 6d.—1s. 8d. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate	4s. per lb.
Chloroform	2s. 6d. per lb. for cwt. lots.
Formaldehyde	£48—£49 per ton in barrels, ex wharf London. Supplies exceed demand.
…phosphates—	Fair business passing.
…m, soluble and	
…e free	7s. per lb.
…	8s. 9d. per lb.
Glycerophosphates—	
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. "
Guaiacol Carbonate	9s. 6d. per lb.
Hexamine	3s. per lb. for bold crystal. Powder slightly less.
Homatropine Hydrobromide	25s.—30s. per oz.
Hydrastine hydrochlor	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. "
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb. Price recently reduced.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Light, pure	£46 per ton.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£25 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	57s. per lb. for December delivery.
Synthetic	26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials	Market very quiet.
Red oxide	5s. 2d.—5s. 4d. per lb.
Corrosive sublimate	3s. 5d.—3s. 7d. "
White precip.	4s. 6d.—4s. 8d. "
Calomel	3s. 10d.—4s. "
Methyl Salicylate	1s. 9d.—2s. per lb.
Methyl Sulphonal	22s. 6d. per lb. Slightly weaker.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 8d. per lb. for B.P. quality.
Paraldehyde	1s. 2d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin	5s. 6d. per lb.
Phenazone	6s. 10d. per lb.
Phenolphthalein	5s. 6d. per lb. for cwt. lots. Supply exceeds demand.
Potass. Bitartrate—99/100% (Cream of Tartar)	84s. per cwt., less 2½% for ton lots.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Ferricyanide	1s. 9d. per lb. Quiet.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	7½d. per lb. spot. Forward prices higher.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. per lb. in fair quantities. Supplies exceed demand.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d. per lb. for cwt. lots Slightly lower. Limited demand
Silver Proteinate	9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P.	2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—	
Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash. according to quantity.

Sod. Nitroprusside	16s. per lb.	
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. **Quiet market.**	
Sod. Salicylate	Powder 2s. 1d.–2s. 3d. per lb. Crystal at 2s. 2d.–2s. 4d. per lb. Flake 2s. 6d. per lb. Strong demand. Market firm.	
Sod. Sulphide—		
Pure recryst.	10d.—1s. 2d. per lb.	
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.	
Sulphonal	14s. 6d. per lb. Little demand.	
Thymol	18s. per lb. Firmer market.	

PERFUMERY CHEMICALS

Acetophenone	11s. 3d. per lb.	
Aubepine	13s. 6d. "	
Amyl Acetate	3s "	
Amyl Butyrate	6s. 6d. "	
Amyl Salicylate	3s. 3d. "	
Anethol (M.P. 21/22° C.)	4s. 6d. "	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. "	
Benzyl Alcohol free from Chlorine	2s. 9d. "	Again cheaper.
Benzaldehyde free from Chlorine	3s. 3d. "	
Benzyl Benzoate	3s. 6d. "	
Cinnamic Aldehyde—		
Natural	18s. 6d. "	
Coumarin	17s. 9d. "	Again cheaper.
Citonellol	20s. "	Again dearer.
Citral	8s. "	
Ethyl Cinnamate	12s. 6d. "	
Ethyl Phthalate	3s. "	
Eugenol	10s. 6d. "	
Geraniol (Palmarosa)	33s. 6d. "	
Geraniol	12s. 6d.—20s. per lb.	
Heliotropine	6s. 9d. per lb.	
Iso Eugenol	16s. "	
Linalol ex Bois de Rose	26s. "	
Linalyl Acetate	26s. "	
Methyl Anthranilate	10s. "	
Methyl Benzoate	5s. "	
Musk Ambrette	50s. "	
Musk Xylol	14s. "	
Nerolin	4s. 6d. "	
Phenyl Ethyl Acetate	15s. 6d. "	
Phenyl Ethyl Alcohol	16s. "	
Rhodinol	50s. "	Again cheaper.
Safrol	1s. 10d. "	
Terpineol	2s. 4d. "	
Vanillin	25s. 6d. "	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	
Aniso Oil	2s. 10d. per lb.	
Bergamot Oil	15s. 6d. per lb.	
Bourbon Geranium Oil	30s. per lb.	Again cheaper.
Camphor Oil	65s. per cwt	
Cananga Oil Java	11s. 3d. per lb.	
Cassia Oil, 80/85%	9s. 9d. per lb.	
Cinnamon Oil, Leaf	6½d. per oz.	
Citronella Oil—		
Java 85/90%	7s. per lb.	
Ceylon	3s. 4d. per lb.	Again cheaper.
Clove Oil	8s 3d. per lb.	
Eucalyptus Oil 70/75%	2s. 2d. per lb.	
Lavender Oil—		
French 38/40% Esters	35s. per lb.	
Lemon Oil	3s. 2d. per lb.	
Lemongrass Oil	5s. 9d. per lb.	
Orange Oil, Sweet	11s. per lb.	
Otto of Rose Oil—		
Bulgarian	42s. 6d. per oz.	
Anatolian	28s. per oz.	
Palma Rosa Oil	17s. per lb.	
Petitgrain Oil	9s. 9d. per lb.	
Sandal Wood Oil—		
Mysore	26s. 7d. per lb	
Australian	18s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Feb. 3rd, they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Dec. 18th.

I.—Applications

Farbwerke vorm. Meister, Lucius, und Bruning. Calcining etc. furnaces. 28,114. Nov. 24. (Ger., 29.11.23.)

Farbwerke vorm. Meister, Lucius, und Bruning. Calcining etc. furnaces. 28,465. Nov. 27. (Ger., 18.1.24.)

Imray (International Combustion Engineering Corp.). Pulverising and drying of materials. 28,602. Nov. 28.

McLeod. Recovery of solid constituents from liquids. 28,537. Nov. 28.

Norrie. Filtering-apparatus. 28,260. Nov. 25.

Perkins. Grinding-oills. 28,590. Nov. 28.

Perry. Apparatus for cooling and filtering air and gases. 28,648. Nov. 29.

Rigby. Drying. 28,381. Nov. 27.

I.—Complete Specifications Accepted

18,817 (1923). Empson. Centrifugal purifying and dehydrating apparatus. (224,935.)

21,273 (1923). Obermiller. Method of giving to air or other gases a definite moisture content. (202,993.)

21,385 (1923). Reid. Furnaces. (224,965.)

12,314 (1924). Nagel. Filtering-devices. (216,167.)

II.—Applications

Heneage. Apparatus for distillation of lignites etc. 28,570. Nov. 28.

Illingworth Carbonization Co., Ltd., and Illingworth. Carbonisation of coal. 28,463. Nov. 27.

Illingworth Carbonization Co., Ltd., and Illingworth. Treatment of coal and coke. 28,464. Nov. 27.

Jones and Parker. Vertical retorts. 28,484. Nov. 27.

Laing and Nielsen. Purification of carbonaceous materials etc. 28,468. Nov. 27.

Marecsche. Manufacture of artificial fuel. 28,387. Nov. 27. (Fr., 8.9.24.)

Schlesisches Kohlenforschungsinstitut der Kaiser-Wilhelm Ges. Method of purifying oils. 28,448. Nov. 27. (Ger., 11.12.23.)

With. Manufacture of coal briquettes etc. 28,490. Nov. 28.

II.—Complete Specifications Accepted

21,082 (1923). Dvorkovitz. Apparatus for making water-gas. (224,950.)

24,440 (1923). Wollaston. Gasification of coke breeze and the like. (225,008.)

3379 (1924). Hinselmann. Obtaining valuable substances from fuels, oil-shale, etc. (217,174.)

III.—Applications

Billinghamo. Emulsification of tar, bitumen, etc. 28,395. Nov. 27.

Lomax, Lucas, and V. L. Oil Processes, Ltd. Methods of separating phenols. 28,138. Nov. 24.

III.—Complete Specification Accepted

6608 (1924). Rütgerswerke Akt.-Ges. Decreosoting of tar and tar-oils. (213,249.)

IV.—Complete Specifications Accepted

295 (1924). Soc. of Chemical Industry in Basle. Manufacture of intermediate products and dyestuffs of anthraquinone and anthracene series. (210,413.)

1306 (1924). Farbenfabriken vorm. F. Bayer und Co. Manufacture of lakes. (216,486.)

710 (1924). Holliday and Co., Ltd., Clayton, and Stokes. Yellow colouring-matter of the pyrazolone series. (225,097.)

V.—Applications

Akt.-Ges. fur Anilin-Fabrikation. Treatment of artificial threads. 28,375. Nov. 26. (Ger., 30.11.23.)

Case, Garrow, and Novocretes, Ltd. Method of treating fibrous materials. 28,672 and 28,673. Nov. 29.

Crosfield. Manufacture of paper etc. 28,284. Nov. 26.

Deutsche Gasglühlicht Auer Ges. Manufacture of solutions from cellulose etc. 28,574. Nov. 28. (Ger., 29.11.23.)

Soc. de Stéarinerie et Savonnerie de Lyon, and Berthon. Manufacture of soluble cellulose esters. 28,576. Nov. 28.

V.—Complete Specifications Accepted

18,666 (1923). Lilienfeld. Process for improving cotton. (216,476.)

12,797 (1924). Stevenson. Manufacture of artificial silk from viscose. (225,135.)

VI.—Applications

Colloisil Colour Co., Ltd., and Eberlein. Dyeing fabrics 28,660. Nov. 29.

Southcombe. Dyeing and compositions therefor. 28,078. Nov. 24.

VI.—Complete Specifications Accepted

13,445 (1923). British Celanese, Ltd., and Ellis. Dyeing colouring of products made with cellulose acetate. (224,925.)

15,279 (1924). Schlumpf. Machines for treating yarns in hanks with liquid. (218,297.)

VII.—Applications

Crosland. Kiln for calcining lime, cement, etc. 28,409. Nov. 27.

Forrester (International Filter Co.). 28,368. *See* XIX.

VIII.—Applications

Eijssen. Metallisation of porcelain or glass. 28,542. Nov. 28. (Holland, 15.2.24.)

Tams. China body for manufacture of pottery. 28,044. Nov. 24.

IX.—Applications

Crosland. 28,409. *See* VII.

Parker, and Vickers, Ltd. Rotary kilns for burning cement etc. 28,567. Nov. 27.

X.—Applications

Coles. Protection of metallic surfaces. 28,617. Nov. 29.

Haglund. Production of metals and alloys. 28,366. Nov. 26.

Johannsen. Treatment of ores etc. 28,269. Nov. 25. (Ger., 7.12.23.)

Marino. Process for de-tinning iron etc. 28,256. Nov. 25.

Metals Production, Ltd., Moulden, and Taplin. Heat-treatment of copper ores. 28,478. Nov. 27.

Penkert. Welding aluminium etc. 28,446. Nov. 27. (Ger., 12.12.23.)

X.—Complete Specifications Accepted

13,036 (1923). Edwards. Treatment of tin ores, concentrates, etc. (224,923.)

253 (1923). Mordey. Electromagnetic separation or concentration of minerals. (224,924.)

687 (1923). Wade (Byers Co.). Manufacture of wrought iron and alloys thereof. (224,941.)

21,558 (1923). Smith and Garnett. Magnetic alloys and their application. (224,972.)

26,478 (1923). Masclmeyer. Tilting furnaces for smelting metals. (205,835.)

29,123 (1923). Jones. Anodes for use in electro-plating. (225,052.)

29,477 (1923). Dyson and Sutton. Method of electro-plating aluminium and its alloys. (225,058.)

30,948 (1923). Connelly and Stewart. Metallic coating-composition. (225,072.)

XI.—Applications

Browne. Electric batteries. 28,351. Nov. 26.

Constantin. Electrodes. 28,656. Nov. 29.

XI.—Complete Specifications Accepted

21,558 (1923). Smith and Garnett. *See* X.

29,123 (1923). Jones. *See* X.

29,477 (1923). Dyson and Sutton. *See* X.

XII. Applications

Barnes and Johnstone. Treatment of oleaginous matter. 28,555. Nov. 28.

Metallbank und Metallurgische Ges. Akt.-Ges., and Gensecke. 28,155. *See* XX.

XII.—Complete Specification Accepted

13,763 (1923). Lever Bros., Ltd., and Craig. Refining of oils and fats. (224,928.)

XIII.—Applications

Blumenfeld and Mayer. Preparation of titanium pigments. 28,557 and 28,558. Nov. 28.

Coleman. Luminous paint. 28,234. Nov. 25.

XIII.—Complete Specifications Accepted

21,412 (1923). Chemische Fabrik auf Actien vorm. E. Schering. Manufacture of resin-like products. (202,997.)

23,099 (1923). Whyte. Paint. (225,001.)

1306 (1924). Farbenfabriken vorm. F. Bayer und Co. *See* IV.

XV.—Applications

Neill. Production of glues etc. 28,222. Nov. 25.

Schryver. Manufacture of gelatin. 28,676. Nov. 29.

XV.—Complete Specification Accepted

25,611 (1923). Leather Products (Yorkshire), Ltd., and Hutchinson. Strengthening and waterproofing leather. (225,018.)

XVII.—Complete Specifications Accepted

555 (1924). Vecchis. Extracting sugar from beet. (209,738.)

5510 (1924). Schluter. Production of rice starch. (225,101.)

XIX. Applications

Forrester (International Filter Co.). Base-exchange materials. 28,368. Nov. 26.

Hartley. Dewatering activated sludge. 28,064. Nov. 24.

Rigby. Cereal products. 28,282. Nov. 26.

XX.—Applications

Deutsche Gold- und Silberscheideanstalt vorm. Roessler, and Albert. Production of unsymmetrical arseno-compounds. 28,158. Nov. 24.

Deutsche Gold- und Silberscheideanstalt vorm Roessler, and Albert. Production of derivatives of organic arseno-compounds. 28,589. Nov. 28.

Johnson (Badische Anilin und Soda Fabrik). Manufacture of carbonyl compounds. 28,349. Nov. 26.

Metallbank und Metallurgische Ges. Akt. Ges. and Gensecke. Distillation of fatty acids etc. 28,155. Nov. 24. (Ger. 28.11.23.)

XX.—Complete Specifications Accepted

26,617 (1923). Etablissements Poulenc Frères, and Oechslin. Manufacture of hydroxylated aliphatic arsinic acids. (206,152.)

9590 (1924). Cassella u. Co. Manufacture of an arsenic compound of the aromatic series. (214,628.)

XXII.—Application

Mexco, Ltd., and Scott. Explosives. 28,670. Nov. 29.

XXIII.—Application

Jung. Apparatus for ascertaining composition of gaseous mixtures. 28,120. Nov. 24. (Ger. 29.11.23.)

XXIII.—Complete Specification Accepted

51 (1924). Conick. Pipette. (225,081.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W.1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number :—*Algeria* : Oils, copper, sulphate (591) ; *British India* : Copper (The Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E.1) ; *Chile* : Leather (593) ; *Egypt* : Leather (590) ; Oil, paint, varnish (C.X./1328) ; *Switzerland* : Rubber, asbestos (589) ; *United States* : Cement (592).

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during November has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 439, of which 335 were from merchants or importers. To these should be added 12 cases outstanding on November 1, making a total for the month of 451. These were dealt with as follows : Granted, 304 (of which 273 were dealt with within seven days of receipt). Referred to British makers of similar products, 89 (of which 77 were dealt with within seven days of receipt). Referred to reparation supplies available, 23 (all dealt with within two days of receipt). Outstanding on November 29, 1924, 35.

Of the total of 451 applications received, 373 or 83 per cent. were dealt with within seven days of receipt.

Irish Beet Sugar

The British Sugar Beet Society is informed that the Irish Free State Government is prepared to give State assistance to any beet sugar factory scheme operated in that country, on lines which will take into account the entire absence up to the present of experience and education in this new industry. Lord ffrench has consented to act as secretary and take charge of preliminary arrangements for the formation of an Irish society which is already in contemplation.

Tar and Tar Products in Germany

H.M. Commercial Secretary at Cologne reports that the recent revival in business in tar products in Germany is due to the decrease in production which is forcing the distillers to buy from producers who are not bound by contracts and are able to sell tar freely. Prices have increased from 3·50 marks to 5·50 and 6 m. or more per 100 kg., but prices for finished products have not risen, but rather fallen, despite the fact that distillation costs are estimated to be at least one-third of the raw tar price. In East, South and Central Germany stocks of pitch are completely sold out and the oil production is entirely absorbed by the consumers. Business in naphthalene is quiet, but the demand for anthracene for dye manufacture exceeds the production.

PUBLICATIONS RECEIVED

FUEL, SOLID, LIQUID AND GASEOUS. By J. S. S. Brame. Third edition. Pp. xv+388. London : E. Arnold and Co., 1924. Price 18s.

THE RARE EARTHS, THEIR OCCURRENCE, CHEMISTRY AND TECHNOLOGY. By S. I. Levy. Second edition. Pp. xiii+362. London : E. Arnold and Co., 1924. Price 18s.

PATENTS, INVENTION AND METHOD. By H. E. Potts. Pp. vii+160. London : The Open Court Company, 1924. Price 3s. 6d.

PHYSICS IN INDUSTRY. Lectures delivered before the Institute of Physics by J. W. Mellor, D.Sc., A.E. Oxley, D.Sc., and C. H. Desch, D.Sc. With a Foreword by the Hon. Sir C. A. Parsons. Vol. II. Pp. 48. London : Oxford University Press, 1924. Price 3s.

BULLETIN OF THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION, No. 13, October, 1924. Pp. 28. Birmingham : Offices of the Association, Athenæum Chambers, 71, Temple Row.

EMPIRE TEXTILE CONFERENCE, OFFICIAL REPORT OF PROCEEDINGS OF CONFERENCE held at the British Empire Exhibition, 1924. Pp. 368. Manchester : The Textile Institute, 1924.

MITTEILUNGEN DES CHEMIKER-FACHAUSSCHUSSES DER GESELLSCHAFT DEUTSCHER METALLHÜTTEN- UND BERGLEUTE, BERLIN. Part I. : AUSGEWÄHLTE METHODEN FÜR SCHIEDSANALYSEN UND KONTRADIKTORISCHES ARBEITEN BEI DER UNTERSUCHUNG VON ERZEN, METALLEN UND SONSTIGEN HÜTTENPRODUKTEN. Pp. xii+154. Berlin : Gesellschaft Deutscher Metallhütten- und Bergleute, 1924. Price $2.

ELEKTROCHEMISCHES PRAKTIKUM. By Dr. E. Müller. With a Foreword by Dr. Fritz Foerster. Fourth enlarged edition. Pp. xvi+264. Dresden and Leipzig : T. Steinkopff, 1924. Price 10 marks.

L'ENERGETIQUE DES REACTIONS CHIMIQUES. By G. Urbain. Collection de Physique et Chimie. Pp. viii+267. Paris : Librairie Octave Doin, 1924. Price 25 fr.

ARABISCHE ALCHEMISTEN. (1) Chalid ibn Jazid ibn Mu'âwija. Pp. 56. (2) Gâ'far Alsadiq, der Sechste Imam. Pp. 128. By Julius Ruska. Heidelberger Akten der von-Portheim-Stiftung. Arbeiten aus dem Institut für Geschichte der Naturwissenschaft. Heidelberg : Carl Winter's Universitäts-Buchhandlung in Heidelberg, 1924. Price (1) 3 marks, (2) 1·20 marks.

PRINCIPES GENERAUX DE L'ETIRAGE ET DU TRÉFILAGE. By G. Soliman. Pp. 235. Paris : Gauthier-Villars et Cie., 1924. Price 15 fr.

FOOD INVESTIGATION BOARD, SPECIAL REPORT No. 5, by the Engineering Committee of the Board. First Report on Heat Insulators, experiments by E. Griffiths, D.Sc. Revised edition. Department of Scientific and Industrial Research. Pp. iv+58 H.M. Stationery Office, 1924. Price 2s. net.

REPORT ON SOME ASPECTS OF BRITISH TRADE IN INDIA. By T. M. Ainscough, O.B.E. Department of Overseas Trade. Pp. 220. H.M. Stationery Office, 1924. Price 3s.

REPORT ON THE ECONOMIC CONDITIONS IN SOUTH AFRICA, JULY, 1924. By W. G. Wickham. Pp. 42. H.M. Stationery Office, 1924. Price 1s. 6d.

THE MINERAL INDUSTRY OF THE BRITIS[illegible]RE A[illegible] FOREIGN COUNTRIES, STATISTICS, 1920—1[illegible] MPER[illegible] MINERAL RESOURCES BUREAU, COPPER. Pp. v+60. H.M. Stationery Office, 1924. Price 2s. 6d.

REPORT ON THE ECONOMIC SITUATION IN THE BELGIAN CONGO, DATED JULY, 1924. By C. K. Ledger. Department of Overseas Trade. Pp. 50. H.M. Stationery Office, 1924. Price 1s. 6d.

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CHEMISTRY & INDUSTRY

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The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

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EDITORIAL

THIS week the University of Leeds is celebrating with fitting pride and ostentation the fiftieth anniversary of the founding of that small college from which it has developed. Quite recently we recalled in these columns the pioneer work of some of the early professors who laid the foundations of the teaching and research carried on to this day. The Yorkshire College began fifty years ago with three professors and one student and it is recorded that the then professor of physics and mathematics found his first duty was to teach the student how by Euclidean methods to construct an equilateral triangle. The creation of a college involved work quite apart from teaching: the organisation of local enthusiasm, the supply of funds, the acquisition of buildings and other such problems require much time and no little tact. Leeds was fortunate in having a number of public spirited men who put their shoulders to the wheel manfully. The progress of the college and the university has been as steady and as rapid as anyone could wish. When the Society of Chemical Industry meets in Leeds next summer the members will find a flourishing university with well-equipped chemical laboratories, several distinguished professors and lecturers on chemistry and many students. The dyeing department was, and perhaps still is, the best in the world; the department of agricultural chemistry and the experimental agricultural farm have made important contributions to knowledge. The Annual Meeting at Leeds is being well organised and the presence of a considerable body of American engineers will give it unusual interest and importance. Leeds is well suited for such a meeting; it stands on the edge of the industrial district so densely filled with coal-pits and forges that the birds have to fly backwards to keep the soot out of their eyes, and it also stands on the edge of one of the cleanest, most beautiful and picturesque parts of the North of England. Those who wish to visit works can find abundant opportunities; those who like the lonely hills, the bright streams or ruined abbeys and castles famous in history will find much to interest them. Those who know the Dales and have lived there, you would not persuade by all the wealth of Attalus, to trust their sensitive minds to dwell too long on the discordant features of Hunslet and Holbeck. For ourselves we shall worship the sweetly murmuring and sweetly smiling Wharfe!

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The student of history is familiar with the process, which seems invariably to occur after great wars, of taking stock. A prolonged and disastrous interruption of the ordinary course of affairs induces the need, when comparative tranquility is restored, for some general survey of present knowledge, for some indication of tendencies. In science, such phenomena occur as persistently as in political and economic relations. The dispute, unreal to many of the present generation, over the Darwinian theory, led to the reconsideration and revivification of the biological sciences, with results some of which are still to come. A similar state of affairs has harassed the chemist, and under the bombardment of radioactive particles his electrons begin to concern him greatly and questions of co-ordination begin to obtrude themselves with unavoidable persistence. So it has come about that chemistry is undergoing a kind of stocktaking. The private life and behaviour of the most retiring organic compounds are being ruthlessly exposed by our Lowrys and Lapworths. All sorts of fundamental questions, from crystallisation to works costs, are being considered by our chemical engineers. Some of the more daring spirits are trying to acquire new habits of thought in order to grasp the Einstein theory and wondering whether their mathematics will stand the strain. There are many research institutions at work throughout the land, investigating paint and plaster, glass and gelatin, and our energetic president and his predecessor have shown, each in his own way, what chemists must do if they are to be effective as a body. And, of course, many books have been published which add their tribute to the stream of

inquiry. Some of these questions, in fact, as many as time and space would allow, have been discussed in our editorial columns, and, though we are hampered by much modesty, we like to think that some, at least, of our words have not gone unheeded. It is of interest, in our survey, to observe what our regenerated cousins, the physicists, are thinking about, and those who wish to know cannot do better than obtain a little book, "Physics in Industry," which Humphrey Milford and the Oxford University Press publish for the Institute of Physics, at the modest price of three shillings. One of the three lectures given in the book discusses the applications of physics in the ceramic industries, and we cannot resist the temptation to quote: "Chemistry without physics would be a poor subject. Indeed . . . chemistry without physics would be purely descriptive, much like descriptive mineralogy. The invasion of physics has prevented chemistry from developing into an elaborate collection of recipes after the style of a cookery book. The points of contact are said to belong to physical chemistry; physics, or if you like, physical chemistry, is busy revolutionising inorganic and organic chemistry." These are hard words, and a chemist is responsible for them. The lecturer is Dr. Mellor, the author of a Treatise on Inorganic Chemistry which we should call monumental if such a word did not suggest a mason's yard rather than a well-thumbed book. What can be said in reply?

* * *

Prof. G. T. Morgan was in his own home and surrounded by his friends and neighbours, when he took the chair at Birmingham on the occasion of the joint dinner of the local sections of the Society and the Institute. He diffused a feeling of hospitality and friendliness, and his dual position as chairman of both sections emphasised the co-operation which has been gradually springing up during recent years. The Society exists primarily to promote the welfare of applied chemistry, the Institute primarily to promote the welfare of chemists. In these prime factors there is much that is common to both. The residual affinity of the two bodies is considerable, and capable of easy co-ordination. Their induced polarities may alternate and be capable of more than one interpretation, but there is beyond doubt a large sphere of influence outside the primary functions of these bodies, capable of being directed and used for the greater benefit of mankind. The existence of joint dinners, common committees and common chairmen is evidence of this. Mr. Woolcock in his address dwelt briefly on the benefits derived from the exhibition at Wembley. No-one is more competent than he to speak of Wembley. In London recently we have had no days, merely gloomy intervals between nights. It seems to us that our President has now no time in London, he has merely hurried intervals between journeys all over Great Britain. His faith in the Society and the progress it is making spur him from city to city and from section to section. We know that he has this faith and we know it is justified. Such faith must produce something; we know not what will come of it, but are prepared to wait and see.

MODERN ELECTROLYTIC CELLS

By Professor A. J. HALE

(Continued)

Diaphragm Cells. These occupy a prominent position to-day, and most of the large installations in this country, France, Italy and the United States are of this type. The earliest forms, some of which are still in use, were the Hargreaves-Bird (Fig. 20), the Griesheim Elektron, Billiter-Siemens, and the Outhenin-Chalandre cells.

The first has been worked from 1899 and is now in use at Middlewich (also in Austria) for the production of sodium carbonate or caustic soda and chlorine. It was one of the earliest cells and followed by a few years the installation of Elektron diaphragm cells which was started near Frankfurt in 1890.

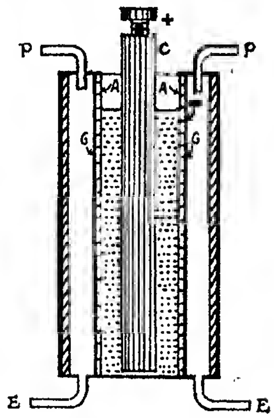

Fig. 20
Hargreaves-Bird Cell

Each Hargreaves cell consists of an iron tank lined with cement and about 10 ft. long, 5 ft. deep, and 2 ft. wide. It is divided longitudinally into three compartments by two asbestos sheet diaphragms, A, each of which is supported on the outer side by a perforated copper sheet which serves as cathode. The centre or anode compartment, which carries a row of graphite anodes, is supplied with brine. During the electrolysis this percolates through the diaphragms, and, as fast as caustic soda is formed on the cathode sheet, it is swept down to the bottom of the outer compartment by steam and carbon dioxide. Since this cell closely resembles recent cells such as the Allen-Moore and Nelson cells for producing caustic soda, there seems no reason why the more valuable product should not be made in the Hargreaves-Bird cell instead of sodium carbonate.

The Griesheim cell (Fig. 21) consists of a steam-jacketed tank, in which cement boxes, each of which contains a magnetite anode, alternate with sheet-iron cathodes. The wall of the tank acts also as a cathode, and therefore the cement boxes containing the anodes act as diaphragms.

The chief installation is at Bitterfeld, in Saxony, where the power, aggregating something like

30,000 h.p., is obtained from the combustion of lignite, which occurs in the locality.

The Billiter-Siemens cell resembles the Billiter-Leykam cell, already described, but a diaphragm constructed of asbestos and barium sulphate is fixed horizontally at the mouth of the bell. The cell was used in installations in Germany and America before 1914, and an improvement in the design was made in 1916 (E.P. 101,440).

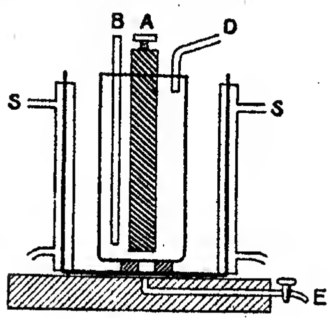

Fig. 21
Griesheim Elektron Cell

The Outhenin-Chalandre cell has been extensively used in France and Switzerland since about 1895, and was extensively used for the production of chlorine during the war. The cell (E.P. 15,906/93), shown in vertical section in Fig. 22, is of earthenware, and is divided into an inner anode and two outer cathode compartments by two vertical partitions, through which pass the porcelain tube diaphragms. The graphite anodes are attached to the positive terminals U, and are situated between the sloping unglazed porcelain tubes, which serve as diaphragms and within which the negative iron lugs project. The porcelain tubes are open at both ends, so that hydrogen passes up into the collecting cathode chamber formed by partition V, whilst the caustic soda liquor formed flows downward to the bottom of the cathode compartment and is drawn off through the pipe V.

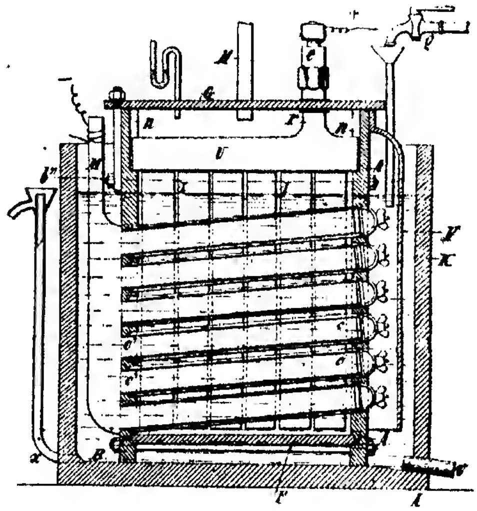

Fig. 22
Outhenin-Chalandre Cell

The more recent diaphragm cells include the Nelson, Allen-Moore, Wheeler, Vorce, and Gibbs cells, the last three of which are cylindrical. The Basle cell is rectangular, but is rather different in design from the rectangular cells already mentioned.

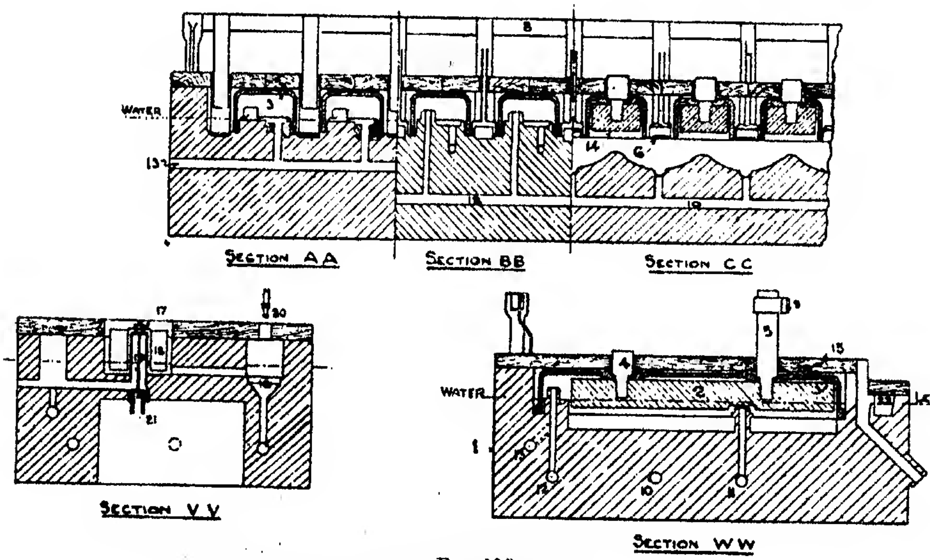

Fig. 19*
Jenkins Bell Cell
* cf. p. 1231 of previous issue for description

All are simple in design and have a high efficiency, and some of them in particular are displacing the older cells in all up-to-date installations.

In considering the merits of the different cells for chlorine and alkali, account must be taken of the facts which appear in the tabular statement given at the end of this section.

A diaphragm will need replacing after six to twelve months of service, its resistance will necessitate a slightly higher voltage than will be required by a bell cell of equal capacity, and the brine must be purified before admission to the cell, otherwise the diaphragm resistance will increase considerably, owing to clogging of the pores. Like bell cells, they give an alkali liquor containing much salt (14 per cent., approximately), which has to be removed during evaporation for solid caustic soda, whereas the caustic liquor obtained from mercury cells is practically free from salt.

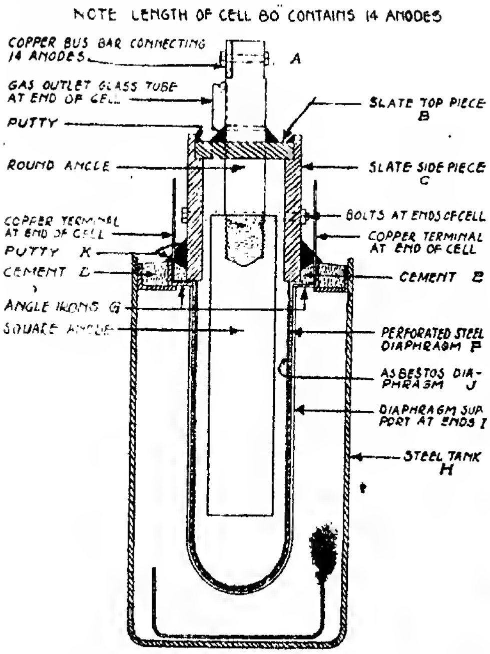

FIG. 23

Nelson Patent Electrolytic Cell

Although mercury cells can be worked at higher current densities (15-20 amperes per sq. dm.), and give more concentrated alkali which is practically free from salt, there are difficulties associated with the proper flow of the mercury in such cells, and the initial cost of mercury, amounting to some thousands of pounds for an average installation, may be reasonably regarded as an unnecessary expenditure.

No bell or gravity cell is as simple in structure as the more simple diaphragm cells, and generally they give a less concentrated caustic liquor. The Nelson cell (U.S.P. [illegible]0/15) is a development of the older MacDonald [illegible] and occupies less floor space than many cells. Each unit (Fig. 23) consists of a steel container in which a perforated U-shaped cathode of steel sheet is welded to supporting angle irons. The asbestos cloth diaphragm is fastened to the inside of the cathode, and internal to this is the anode compartment containing graphite anodes immersed in the brine and supported by a slate gas dome; the ends of the anode compartment are closed by blocks

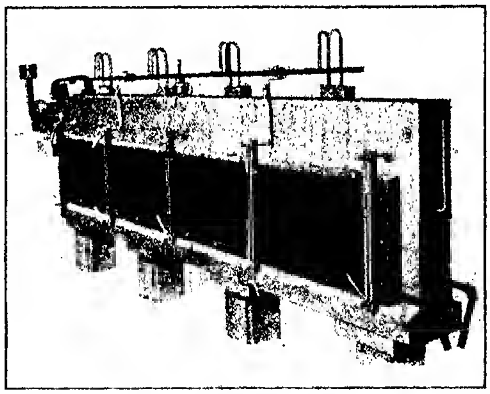

FIG. 24

Allen-Moore Cell

of cement. Steam admitted to the cathode spaces serves to remove the strong caustic soda formed on the electrode, and to maintain the temperature requisite for smooth working. Each cell is about 6 ft. in length and 10 ins. wide. During the European war an installation of Nelson cells at Edgewood Arsenal in America was producing 100 tons of chlorine and the same amount of caustic soda per day.

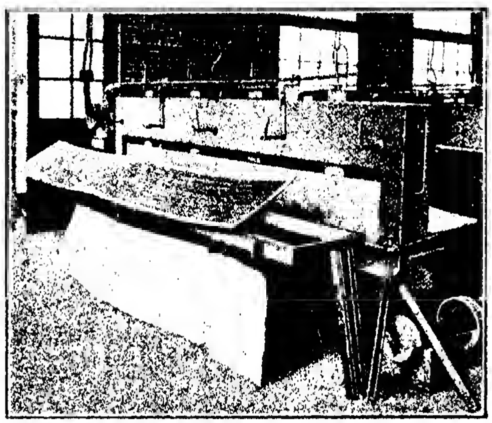

FIG. 25

Allen-Moore Cell

The Allen-Moore cell is similar to the last cell in many respects, and was first installed in America in 1912. It consists of a rectangular framework of reinforced concrete formed by a base, two ends and a top (Figs. 24 and 25). When the long rectangular openings in the side are closed by the diaphragms

and perforated cathode sheets, the interior forms the anode compartment.

The shallow iron side plates when clamped into position keep the cathodes and diaphragms in position, and form cathode spaces on either side of the anode compartment. Such arrangement greatly

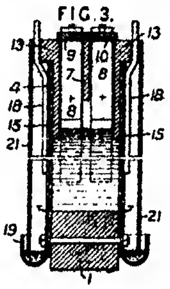

Fig. 26
Cranston and Le Bar Cell

facilitates the changing of diaphragms, when this is necessary, and renders the interior of the cell easily accessible. Brine is admitted to the anode compartment through a hard rubber float-valve, which automatically controls the level of the brine in the compartment, and the graphite anodes are connected to a positive bus bar running along the top of each cell. Caustic soda percolating through the cathodes is removed in an atmosphere of steam and hydrogen by

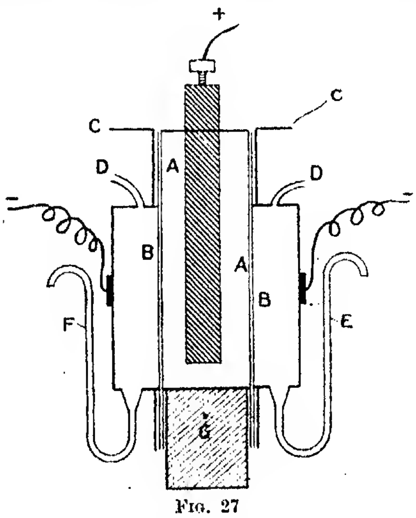

Fig. 27
Townsend Cell

flowing down the face of the cathode plate into the channel trough of the cathode box, whence it leaves by discharge pipes for the caustic soda store tank.

The Marsh cell (U.S.P. 1,443,797/23) is a rectangular diaphragm unit similar to the two just described, but the cathodes of perforated sheet steel are corrugated to conform to the surface of the horizontal graphite anodes, and asbestos paper diaphragms are clamped to the cathodes. Each cell is about 4 ft. long and 1 ft. wide.

A vertical section of a rectangular cell patented by J. Cranston and W. D. Le Bar (E.P. 194,428/21) is shown in Fig. 26. The body portion, 1, is made of slate or concrete in which are suspended graphite anodes, 8. A portion of each side of the body is cut away, and against this part is fixed the diaphragm of asbestos, 15, backed by a perforated metal sheet cathode, the lower end of which is turned up to form a trough, 19, for collecting the caustic liquor formed on the outside of the electrode. The sides, 4, of the upper portion of the cell body extend into the electrolyte to form a sealing wall between anode and cathode chambers, so that chlorine formed in the anode compartment is effectively separated. The

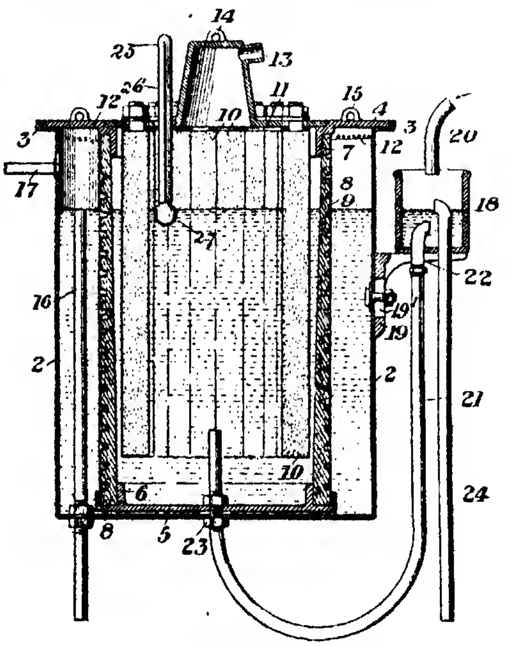

Fig. 28
Gibbs Cell

anodes are inserted through slots separated by partitions, 7, in the top of the body, and are mounted in sets upon metallic plates, 9, 10, forming a gas-tight connexion. A sheet of metal, 21, from the top of the body extends into the trough, 19, and thus forms a sealed chamber for collecting hydrogen. The terminal cathode bars are shown at 18.

The Townsend cell (Fig. 27) has been in use at Niagara since 1905. It resembles the Hargreaves-Bird cell in general structure, also the Allen-Moore cell, but the cathode compartments contain kerosene, which floats on the top of the caustic soda liquor, and the latter overflows through the swan necks, EF. The effect of the oil in contact with the cathode is to cause the caustic soda to form spherical drops, which are rapidly removed from it, thereby falling through the oil to the bottom of the compartment. Each cell is about 8 ft. long, the body consisting of bottom and ends made of cement or concrete, to the foot of which two strong iron plates, CC, forming the outer

containing walls, are clamped. Kerosene supply pipes are shown at DD.

The Gibbs cell (cylindrical diaphragm) is one of the most important of this type, which is the most convenient and most efficient type in use at the present time. Gibbs cell (Fig. 28) is installed at the works of the Pennsylvania Salt Company, United Alkali Company at Widnes, and the Canadian Salt Company, Ontario. The Vorce cell, introduced at about the same time (1907), and the Wheeler cell are similar in construction.

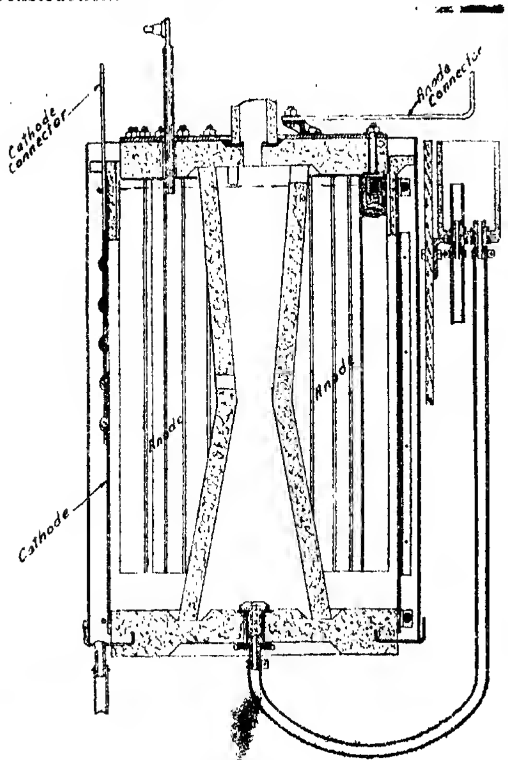

FIG. 29
Wheeler Cell

The outer body of the Gibbs cell is of iron, carbon anodes being fastened to the cover and dome, which form the top of the cell. The diaphragm, which is submerged on both sides, is fastened to a flat annular ring, at the top, which, like the cover, can be easily removed for cleaning and inspection. The cylindrical steel cathode supports the diaphragm, and is covered with a large number of projections which help to support the diaphragm and at the same time serve as points of electrical activity on which highly concentrated caustic soda is formed, and from which it is removed with considerable rapidity, thereby preventing any formation of hypochlorite or chlorate.

The brine feed-cup, 18, serves to maintain a correct level in the cell which is 28 ins. in diameter and 4 ft. high. Such a cell can take 800 amperes at 3·6 volts, and runs with an energy efficiency of 60—62 per cent., which is as high as that of the best cells.

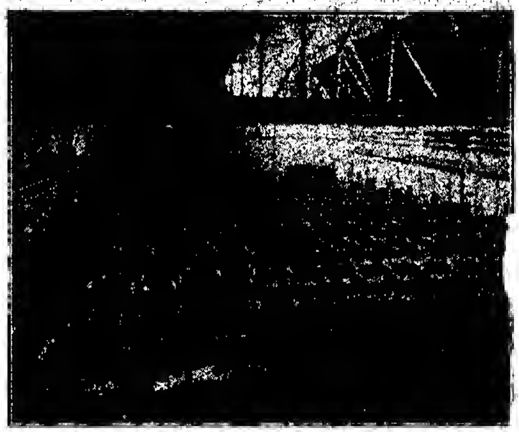

FIG. 30
Installation of Wheeler Cells

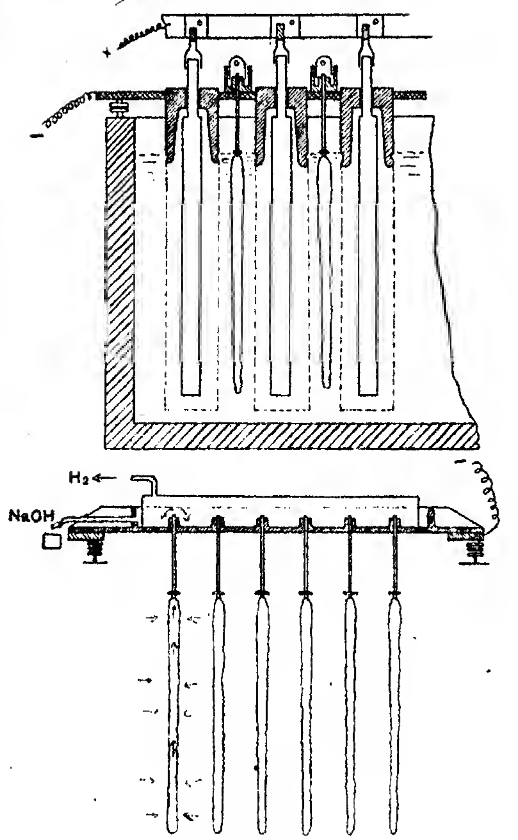

FIG. 31
Cell of the Society of Chemical Industry in Basle

The Vorce cell is cylindrical and is fitted with a circle of graphite anodes in a centre compartment, which is fed from beneath with saturated brine. A 1000-ampere unit is 26 ins. in diameter and 40 ins.

Comparison Table of Efficiencies

Cell	Capacity in amperes	Voltage	Current efficiency	Energy efficiency	Concentration of alkali, g. per litre	Kw.-hrs. per kg. NaOH
Castner mercury	560	4·2	94	50	200	3·4—4
Aussig bell	600	3·6	85	49	80	3·1
Billiter-Siemens	2000	3·1	92	68	120	2·4
Nelson	1000	3·7	90	60	120	2·5
Gibbs	800	3·6	94	60	—	2·5
Basle cell	up to 10,000	—	90	59	—	2·6

high, and the floor space required is approximately 15 sq. ft., as compared with 25 sq. ft. for a Nelson unit, or 60 sq. ft. for an Allen-Moore unit of the same capacity. Its output is 5 lb. of caustic soda per sq. ft. of floor space per day, compared with 2·7 lb. and 1·2 lb. for the Nelson and Allen-Moore cells, respectively.

Its weight is 600 lb., compared with 2500 lb. for the Allen-Moore cell, whilst the weight of graphite anodes are approximately :—Vorce, 214 lb. ; Nelson, 240 lb. ; Allen-Moore, 440 lb.

These figures quoted in favour of the Vorce cell also hold for the Gibbs and Wheeler cells.

The Wheeler cell (Fig. 29) is shown in vertical cross-section. Its similarity to the usual make of cylindrical cell is apparent, and the diaphragm is not submerged on the cathode side. The brine is admitted through the bottom to the centre of the cell and evenly distributed to all parts. Discs of dielectric material form the top and bottom of the cell, that at the bottom being reinforced with a steel trough, which also acts as a collector for the caustic liquor. The cell is stated to operate with a particularly thin asbestos diaphragm, which insures a high efficiency. An installation of Wheeler cells is shown in Fig. 30.

The last diaphragm cell to be described will be that of the Society of Chemical Industry in Basle, which is installed in France, Switzerland and Italy. A rectangular concrete tank (shown in longitudinal and transverse section, Fig. 31), having an area of 50 sq. ft., is filled with brine, whilst graphite anodes and self-propulsive cathodes of iron rod are submerged as indicated. Each cathode rod is encased in asbestos, which terminates at the top in an iron tube, through which a hydrogen and caustic-liquor foam passes to a covered iron channel. The propulsive effect produced by the rising bubbles of hydrogen causes a circulation inwards of the electrolyte, the speed of which depends on the current density at the cathodes. Several such cathodes screwed into a gutter form a cathode unit, the gutter itself being screwed on a frame, which serves as negative conductor. The anode unit consists of a narrow bell made of non-conducting material, into which the carbon anode is fixed, and which has an outlet for chlorine. To the bell an asbestos bag is attached. The anodes and their asbestos diaphragms last about three years. The electrolysers in use at Monthey, Switzerland, have a capacity up to 7000 amperes and produce 240 kg. of caustic soda per twenty-four hours.

(To be continued)

ACADÉMIE DES SCIENCES

On October 20, Prof. H. Le Chatelier read a paper on the variation of the viscosity of glass as a function of the temperature. Within a temperature difference of 500 to 1000° C., the viscosity may vary from 1 to 1 milliard. M. A. Lumière, who had announced in a previous paper that a normal human serum toxic for the guinea pig became harmless when exposed to a vacuum, advanced an explanation according to which the slight flocculation produced by the vacuum sufficed to prevent the toxic shock. M. Lindet presented a note by M. Guittonneau, showing that the Microsiphonaceæ of the soil assimilate with practically the same facility ammoniacal, nitrous and nitric nitrogen. The quantity of combined carbon available as a source of energy determined the utilisation of mineral nitrogen.

On October 27, amongst other papers, there was an interesting one by M. M. Stoklasa and Penkava, on the comparative radio-activity of the air in the potash mines of Alsace, in Vesuvius, and in the Solfatara, showing the influence of radio-activity on the growth of plants and the fixation of atmospheric nitrogen.

On November 17, the Académie heard the funeral oration to Sir Archibald Geikie, a foreign member of the Académie since 1917. A paper by L. Barrabé and P. Viénnot described a discovery of an oil field at Gabian (Hérault). A description was given of the technical and geological considerations which led the authors to select a site for the boring which passed through the upper trias into a region specially favourable for the accumulation of oil. M. Deslandres, discussing band and line spectra, deduced a simple law correlating the radiations of simple bodies. M. Béhal described the work of M. Freundler on the action of light on stannous iodide, showing that the association of iodine, tin and sodium which occurs in sea-water, plays a part in that "dissimilation" of iodine which the author had discovered in Laminariæ at certain periods. A paper by M. Lebeau described the transformation of the diamond into graphite, this change taking place progressively in a vacuum between 1500 and 2000° C. M. Chaussin described the cultivation of wheat with and without fertilisers, and showed that the higher yields obtained with fertilisers correspond (1) to a greater osmotic pressure in the leaf and stem ; and (2) to a much greater value for the ratio of the mineral matter to the total extract in the soluble part of the leaf.

COLLOIDAL PROTECTION*

By JEROME ALEXANDER

Intellectual inertia is, perhaps, the most appropriate term to apply to that attitude of mind which resists the acceptance of truths inconsistent, or apparently inconsistent, with previously-accepted or "classical" ideas of science. In most cases in industry, practical men are far more numerous than chemists and are continually in close contact with actual operating conditions; and in addition to the mere numerical advantage in opportunity for observation thus given, the practical man is usually not handicapped by prior knowledge of what he must see, and what it is unorthodox to observe.

It is for this reason that technical practice frequently is far in advance of theoretical or scientific knowledge. Another reason is that many teachers of chemistry look askance at experimental data which do not fit into the already sufficiently numerous and complicated laws and principles that they must make plain to the coming generation. And, finally, when non-conformist facts stubbornly press their way forward, the attempt is generally made to force them into compliance with existing theories. Thus the purple of Cassius was regarded by Berzelius to be a definite chemical compound, for on precipitation and re-solution it acted as a unit; and for many years it was so accepted. About twenty years ago, however, Zsigmondy proved it to be an adsorption compound by showing that it could be synthesised by simply mixing colloidal gold and colloidal stannic acid; and just recently A. Huber (*Physikal. Zeit.*, 25, 45 (1924)) confirmed Zsigmondy's proof by X-ray analysis, which showed that none of the gold is chemically combined with the tin.

The technical use of what we now call "protective colloids" goes back into the dim mists of antiquity. The Chinese used glue in the manufacture of their ink to deflocculate the lamp-black, just as they also used sheeps' thyroids to aid morons—both worked. And the ancient Egyptians used gum (probably acacia) in their inks for the same reason, and made their clay as workable as that of Babylonia by the use of infusions of straw. The alchemists of the Middle Ages produced their *aurum potabile* by reducing solutions of gold in the presence of stabilising ethereal oils; and at least as early as 1794 silk was dyed with colloidal gold. Berzelius, in his *Lehrbuch* (1844), gives recipes for producing several shades of colloidal gold, and long prior to this, isinglass, egg albumen, and starch were used for the same purpose.

In 1897, just before Zsigmondy (1898), unaware of Faraday's earlier (1856) work with "jelly" as a protector for colloidal gold, had independently rediscovered the phenomena, von Meyer and Lottermoser (*J. prak. Chem.*, 56, 241) recognised the protective action. They drew attention to the fact that albumin stabilises silver sols—a fact well known to practical photographers. In his book "Anorganische Kolloide," p. 50 (1901), Lottermoser said: "On the addition of very stable colloids, such as albumin, gelatin, agar, or gum arabic, to a silver sol, no precipitation is caused by electrolytes until the stable colloid is coagulated. The less stable silver sol is thus protected against the electrolyte by the more stable colloid; it becomes more like it in its behaviour."

To put it tersely, a protector is a substance that opposes the aggregation of molecules or particles into larger groups. It is natural to expect that substances will vary widely in their protective power, if, indeed, they show any protective action at all; and also that a substance which is a protector in one set of conditions, may, under other conditions, show a different degree of protective action, or none at all. To establish some measure of protective action, Zsigmondy determined the number of milligrams of protective substance which would just fail to prevent 10 c.c. of pure colloidal gold solution from changing its colour from red to violet upon the addition of 1 c.c. of 10 per cent. sodium chloride solution. These ruby-red gold sols contain 0·005—0·006 per cent. of gold, and are exceedingly sensitive to traces of electrolytes. The subjoined table gives such "gold numbers" for a variety of substances, taken from the results of Zsigmondy and of Schryver:—

Substance	Gold number
Gelatin	0·005 to 0·01
Russian glue	0·005 to 0·01
Isinglass	0·01 to 0·02
Casein (in ammonia)	0·01
Egg-globulin	0·02 to 0·05
Ovomucoid	0·04 to 0·08
Glycoprotein	0·05 to 0·1
Amorphous egg-albumin	0·03 to 0·06
Crystallised egg-albumin	2·0 to 8·0
Fresh egg-white	0·08 to 0·15
Gum arabic	0·5 to 4·0
Gum tragacanth	2·0±
Dextrin	6·0 to 20·0
Wheat starch	5·0±
Potato starch	25·0±
Sodium oleate	0·4 to 1·0
Sodium stearate at 100 degrees	0·01
Sodium stearate at 60 degrees	10·0
Deutero-albumose	∞
Cane sugar	∞
Urea	∞
Stannic acid sol (old)	∞

The results with sodium stearate indicate that the degree of dispersion of the protector is a very material factor in its action, just as it is in the detergent value of soap, and lends support to the generally-accepted view of Bechhold that protective action is consequent upon the adsorption of a layer of the protector at the interface between the dispersed and the dispersing phase. The thinness of the layer seems obvious from the fact that Zsigmondy could see no diminution of the Brownian motion caused by it, nor any ultramicroscopic evidence of its existence. Since protectors are substances having considerable attraction for water and, as a rule, a great swelling capacity, it is not unlikely that after ordinary desiccation they may swell enough to force the constituent particles of the protected substance far enough apart so that they are beyond the range of molecular attractive forces which is ordinarily estimated to be about 50 $\mu\mu$. But it is not intended

* Paper read before the American Section of the Society of Chemical Industry on May 16, 1924.

to go here into the maze of theoretical discussion—the experimental facts of protection are interesting and suggestive.

A capital instance of the effect of colloidal protection is seen in the case of milk, where the casein, an unstable colloid, is protected or stabilised by lactalbumin. In the older books this relation of the two proteins was obscured by the practice of reporting their sum as "total proteids"; but the [illegible]owing table, based on the averages of Koenig, once shows the great differences between milks, well as the importance of the casein-lactalbumin [illegible]o in determining these differences :—

Average Composition of Various Milks

Kind	Casein	Lactalbumin	Fat	Lactose
Cow	3·02	0·53	3·64	4·88
Woman	1·03	1·26	3·78	6·21
Goat	3·20	1·09	4·78	4·46
Ewe	4·97	1·55	6·86	4·91
Mare	1·24	0·75	1·21	5·67
Ass	0·67	1·55	1·64	5·99

[illegible]xperiment shows that cows' milk is much more [illegible]dily coagulated by acid and by rennin than is [illegible]hers' milk, and that the coagula of mothers' [illegible]k, if formed, are much finer. The addition of [illegible] protector-proteins like gelatin or albumin, [illegible]bohydrates like dextrin, Irish moss, or gum arabic, [illegible] even salts like sodium citrate—will make cows' [illegible]lk behave more like mothers' milk, and will make [illegible] more digestible for the infant. Regarding the [illegible]ghly protected asses milk, so eminent an authority [illegible] A. Jacobi stated as far back as 1888 that it is a [illegible]uge to which the physician flies when neither [illegible]ws' milk nor even mothers' milk is tolerated.

In this connexion it seems probable that any cause [illegible]ich decreases the proportion of lactalbumin to [illegible]ein in mothers' milk—such as nervous shock or [illegible]mia—will tend to register itself in a digestive [illegible]t in the nursing infant. This ratio undoubtedly [illegible]es with the period of lactation as well as in different [illegible], so that the milk of a herd is much more uniform [illegible] that of one cow.

Plural Protection

An outcome of these observations on milk was the [illegible]evelopment of the idea of *double or plural protection*. [illegible]he attempt to produce an imitation of casein by [illegible]rming a precipitate of calcium phosphate in the [illegible]esence of protectors (gelatin, gum arabic) was not [illegible]sful when the protector was added to the phosphate solution or to the calcium solution. On reflection, however, it was evident that in the organism, *both* the reacting solutions contain protectors, and on protecting both the sodium phosphate and the calcium chloride, there was obtained a colloidal calcium phosphate which could be precipitated by acid or by rennin. Olive oil was emulsified in this, and a stable imitation milk was obtained.

Several instances exist in the literature where this principle has been unwittingly used to produce ultra-fine dispersions. Thus in the *grainless* emulsion of Lippmann (so called because of the fact that it is transparent), the recipe calls for the addition of gelatin to each of the reacting solutions of potassium bromide and silver nitrate. Carey Lea produced some of his finest colloidal silver by adding the protective Rochelle salt to the silver nitrate and to the ferrous sulphate. Lobry de Bruyn (*Rec. trav. chim.*, **19**, 236, 1900) produced extremely fine precipitates or even colloidal solutions by adding gelatin to each of his reacting solutions.

The value of this principle in technology is obvious, and in medicine and in biochemistry it must be of exceedingly great importance, for in the organism all reacting solutions are protected. The work of Augusto Lumière and others has shown the disastrous consequences that follow the formation of floccules of sufficient size to cause nerve irritation, capillary embolism, and the wide variety of symptoms that may follow more or less directly or indirectly from the appearance in the blood stream of particles of unusual dimensions. In addition, protectors very generally lead to the formation of crypto-crystalline structures, obviating sharp crystalline deposits.

Autoprotection

Since every substance, in the course of aggregating from atomic or molecular dispersion into visible masses, must of necessity have in it at some time particles of colloidal dimensions, we must face the condition known as *iso-colloidism*, wherein the colloidal dispersion of the substance is in contact with a non-colloidal phase of the same substance. If the colloidal phase has the property of being adsorbed or of adsorbing, we may have *autoprotection*, where the substance delays or prevents its own crystallisation. The work of Quincke, O. Lehmann, and others indicates that crystal formation is preceded by the formation of tiny globulites; and by rapid evaporation of a film of a solution of sulphur in carbon disulphide containing a little Canada balsam to slow down the aggregation process, these globulites and their various stages of aggregation may be seen (J. Alexander, Colloid Symposium Monograph, Univ. of Wisconsin, 1923). An analogous adsorption seems to delay the transformation of γ-iron into α-iron (allocolloidism), and it is especially observable in ammonium salts and in soaps, *e.g.*, in oleates.

In the case of solutions, where the viscosity is not too great, the autoprotective stage is of limited life. Thus the gels formed by cooling solutions of 5-dimethylaminoanilino-3, 4-diphenylcyclo-1, 2-dione in organic solvents (W. B. Hardy, *Proc. Roy. Soc. Lond.*, 87A, 29, 1913); by dibenzoyl-1-cystine (Gortner and Hoffmann, *J. Am. Chem. Soc.*, **43**, 2199, 1921); by camphorylphenylthiosemicarbazide (Forster and Jackson, *J. Chem. Soc.*, **91**, 1881 (1909), dissolved in organic solvents—all become crystalline within a comparatively short time, which may run into weeks.

Cumulative Protection

Anything that changes the nature or degree of aggregation of a protector will influence the stability of the dispersion stabilised by it. This may be brought about by heat (albumin), coagulants (*e.g.*, ferric chloride, by flocculating gum arabic, "breaks" emulsions made with the gum), enzymes (rennin converts lactalbumin into a coagulant in addition to destroying its protective action in milk (J. Alex-

ander, 8th Inter. Cong. Appl. Chem., 1912). We may, therefore, have protectors for protectors, through a whole series.

This conception may lead us to understand some of the peculiar phenomena observed in mixtures. Thus the individual silicates in glass tend to crystallise, but in admixture they form a mutually protective chain, being so chosen by the glass technologist. If the mixture is not right, or if it has been allowed to remain too hot for too long a time, the chain breaks down, and the glass suffers devitrification. In alloys, especially in complex alloys, we may in this manner conceive how even small percentages of some of the constituents may exercise a potent influence.

In biological mixtures such as the gluten of wheat or rye flour the principle of cumulative protection is of consequence, and it may be that many of the proteins (albumin, gelatin, globulin, casein) may be adsorption complexes of simpler chemical compounds, which do not break up under the conditions to which they are ordinarily subjected. This view is consonant with the fact that, although some proteins are not definite chemical individuals, they are approximately uniform in composition.

RANCIDITY AND THE KREIS TEST

By T. W. JONES, B.Sc.

The rancidity induced in fats and oils by deterioration is important economically if for no other reason. Exactly what it is in the fat or oil that constitutes rancidity is still one of the numerous incognita of the chemistry of oils and fats; it is, therefore, a matter for some surprise that the literature upon the subject is not more extensive, for really very little attention appears to have been given to the problem. Several theories have been advanced to account for the phenomena, and a certain amount of work has been done upon the conditions giving rise to rancidity, with the result that, with reasonable care, the possibly heavy losses that would occur through deterioration of stored fats can be avoided. Exposure to light, heat and the atmosphere causes the rancidity of fats; moisture appears from recent work to be but a secondary factor, whilst bacteria thrive only when nitrogenous material is present, such as animal tissue and the marc of fruit remaining from crude methods of extraction.

It was at one time supposed that the acidity of oil was the same thing as its rancidity, but this was disposed of by experimental investigation, as was also the converse theory that rancidity could set in without the liberation of free fatty acids. It is now generally accepted that if an oil is rancid then it contains a fair proportion of fatty acids. Another theory that was quashed was that the aldehydic bodies always found in a rancid oil or fat were responsible for the rancidity; recent work, however, may have the effect of reviving this theory, as it appears that rancidity may be directly concerned with the presence of acrolein.

With this confusion regarding the nature of rancidity it is no wonder that a satisfactory test has not yet been evolved for its detection. Though rancidity can scarcely be ignored when well developed in any oil or fat, yet in its initial stages, especially if masked by a strong natural odour of the oil, its detection is sometimes a matter of difficulty, and on these occasions a positive chemical test is to be desired. It is not difficult to mix a slightly "off" oil with a fresh one that has a strong natural smell in such a way as to disguise its deterioration effectively for the comparatively short period it is on the market. It is to detect such adulterations that it is imperative to have a trustworthy test. Of those proposed the most successful so far and most generally used is the Kreis test, a modification of Bishop's test for sesamum oil. This test consists in shaking the suspected fat or oil with strong hydrochloric acid and then with an ethereal solution of phloroglucin. A rancid fat yields a red or pink colour. Kreis ascribes the reaction to the presence of aldehydes and ketones in the rancid fat, as a similar colour results when the test is applied to such compounds as vanillin, eugenol and so on.

This test has been widely used of recent years and consequently its value has been very thoroughly investigated. The result has been that a certain amount of doubt has arisen regarding its e[illegible]acy for the purpose of detecting rancidity. [illegible]l,[1] for example, objected to it on the grounds [illegible]) it is not specific and gives the same col[illegible] with aldehydes and ketones not found in [illegible]ils, (b) the colour is not proportional to the [illegible] cidity, and (c) lastly, the test is too d[illegible]cat[illegible] oils were to be condemned on the stren[illegible] reaction many that were perfectly fit [illegible] have to be discarded. A few years a[illegible] ton Meat Inspection Laboratory[2] m[illegible]0 to 20·0 study of the test which confirmed [illegible]5·0[illegible] and it was found, in addition, that certa[illegible] ticularly crude and freshly refined cotto[illegible] even when perfectly fresh and sweet, gave the co[illegible] reaction. The Laboratory did, however, find the test of value for confirmatory purposes and for samples where the natural odour masked that of rancidity; also it was concluded that its extreme sensitiveness was not wholly a drawback, as it was found to give evidence of an incipient rancidity which in every instance developed later. The test, therefore, is of use in giving warning of the onset of rancidity some time before the changes have progressed to such a point as to be evident to the senses. Similar conclusions were reached by J. F. Bevis[3]: "Under most conditions the interval of time between the first appearance of the Kreis test and the sensible appearance of rancidity is sufficient to permit the conservation of the product by immediate use."[3] The Kreis test as modified by Kerr[4] is carried out as follows:—

To 10 c.c. of the suspected oil or melted fat is added 10 c.c. of hydrochloric acid (sp. gr., 1·19) in a large test tube (8×1 in.). This is then stoppered and shaken vigorously for approximately 30 seconds. 10 c.c. of a 0·1 per cent. solution of phloroglucin in ether is then added, and the whole well shaken and

allowed to stand. A red or pink coloration in the acid layer indicates rancidity.

This test is given for comparison with the Powick test for acrolein and also because it shows the modi-ation used by Bevis[3] and Holm and Greenbank,[5,6] n their work. These workers tested the relationship etween the amount of oxygen absorbed by an oil or t and the intensity of the colour given by the re-lting oxygenated oil when the Kreis test was plied. This was done by bubbling pure oxygen ough the liquid dry fat at various temperatures at given rate and withdrawing samples at regular ervals for testing. All three found that there was proportionality between the rancidity and the th of colour produced by the test. According to m and Greenbank there is, however, a specific t proportion between the amount of oxygen orbed and the colour intensity; or "the amount fat necessary to give an equivalent colour with Kreis reagent is inversely proportional to the ount of oxygen absorbed, up to a certain limit." ey also found that in every experiment where an preciable oxidation had occurred the resulting fat ponded accordingly to the Kreis test, indepen-ntly of the degree of rancidity. These results point the invalidity of the Kreis test as a specific one for ncidity, a conclusion also reached by Bevis.

Whether any information can definitely be drawn om this work as to the nature of rancidity or not, ertain findings concerning the role played by oleic id are important, and it is possible that future quiry will ascribe the responsibility for this condi-n to the acid. Of the various fats and pure fatty ids examined by Holm and Greenbank, oleic acid as found to produce the greatest intensity of colour r an equivalent oxygen absorption, and further e induction period of autocatalytic oxidation was ortest with this acid. The induction period of re butter fat was also shorter than for lard, which ntains a far smaller percentage of oleic acid. In ddition, Bevis found that the presence of additional e oleic acid in a fat increases the rate of formation f the compounds causing the Kreis reaction.

Powick[7] in work on the rancidity of oils and fat as evolved a new test for acrolein, which is a modifi-ation of the Kreis test of Kerr:—

To 1 or 2 drops of diluted acrolein solution in a test-tube is added 1 drop of an approximately 3 per cent. solution of hydrogen peroxide. After about one minute, 5 c.c. of concentrated hydrochloric acid (sp. gr., 1·19) is added and the test-tube shaken. Finally 5 c.c. of an ethereal solution of phloroglucin is added and the whole shaken. A deep red colour is immediately imparted to the hydrochloric acid phase, which on spectroscopic examination shows a well-defined, fairly narrow absorption band in the yellow green region.

The modification thus consists in the use of hydrogen peroxide and the spectroscopic examination. In the absence of hydrogen peroxide the red colour is not obtained, and when an excess of acrolein is used the condensation product separates as a purple precipitate. Identical results are obtained with rancid fats, but *not* with such aldehydic substances as vanillin, eugenol, cinnamic aldehyde, and non-rancid cottonseed oil which also react with the Kreis reagent; with these the "spectra of the colours obtained show a general absorption throughout the green blue-violet part of the spectrum." Powick therefore concludes that the substance responsible for the Kreis test in rancid fats is the same as that formed by the action of hydrogen-peroxide on acrolein, and that this substance differs from the reactive substance in certain non-rancid cottonseed oils. Powick's results also point to the possibility that the free oleic acid in rancid fats is an active factor in the production of rancidity. It seems, however, from the results of Bevis and Holm and Greenbank that it is not the oleic acid molecule so much as its decomposition products that play the important part. One experiment given by Holm and Greenbank in another paper[8] is significant. Three small vessels containing equal amounts of fresh, dry butter fat are connected in series so that air may be blown through them. To the last vessel (No. 3) is connected an upright tube to act as a condenser. The three are then immersed in water at 100°C., and air is blown through them. It is found that No. 3 is the first to show signs of auto-oxidation, and No. 1 will resist oxidation the longest. This can be explained by the assumption that volatile oxidation products of Nos. 1 and 2 are carried over to No. 3, and catalytically hasten the oxidation of the fat there. It has long been known[9] that by blowing air through oleic acid volatile oxidised products are obtained; and the active substances carried to No. 3 are probably the decomposition products of the oleic acid in the butter fat, which has such a potent effect upon its reaction with the Kreis reagent.

That the oleic acid decomposition, or rather oxidation, product may possibly be identical with the acrolein-hydrogen peroxide complex is further indicated by the fact that acrolein-decomposition products, acrylic, acetic and formic acids are always found in fully rancid oils. The significance of the production of acrolein on heating all animal and vegetable fats needs no stressing. Further investigation of Powick's test will probably reveal this identity beyond doubt. Further investigation of the test is undoubtedly required before it can be finally accepted; but it appears to be the long-desired specific test for rancidity.

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The Société des Produits Azotés, at its recent meeting reported progress at its Bellegarde-Lannemezan and Martigny works, stating that the latter works, equipped for the production of calcium carbide with a supply of 50,000 to 60,000 k.w., was supplied with only 10,000 to 12,000 k.w., and it was decided to increase the supply of energy.

MINERAL OUTPUT IN THE UNITED STATES IN 1923

Figures showing the outputs that have been reported so far of various minerals in the United States in 1923 are as follows:—

	1923		22
Bismuth (metallic) ..	472,000 lb.	..	— lb.
Selenium	64,000 lb.	..	123,56[illegible]
Tellurium	1,000 lb.	..	—
Carbon black (produced from natural gas)	138,262,648 lb.	..	67,795,129 lb.
Clay	3,434,660 s.t.	..	2,647,700 s.t.
Fuel briquettes ..	696,810 n.t.	..	619,425 s.t.
Gypsum	4,753,448 s.t.	..	3,779,949 s.t.
Mica	9,086 s.t.	..	7,180 s.t.
Quicksilver	7,937 flasks		6,375 flasks.
Peat	61,355 s.t.	..	60,680 s.t.
Slate	726,800 s.t.	..	607,680 s.t.
Tin (metallic) ..	7,466 s.t.	..	9,108 s.t.

Nearly two-thirds of the 1923 output of bismuth was sold at $2·25 to $2·94 a pound, the smaller lots bringing the higher price. Ores containing appreciable amounts of bismuth were produced in 1923 from mines in Arizona, Idaho, Montana, Nevada, and Utah. The United States is believed to have been the largest producer of bismuth in 1923.

Only two companies reported the production of selenium in 1923, and most of the supply was in demand by the glass and ceramic industries, though a little was used in experiments. The output of tellurium and its compounds in the United States is very small, but the copper refineries ... annually between 100,000 and ... element should uses be found ... of clay products ... United States, and there

Clay available for the ... is widely distributed in every State in the Union. ... are clay-working ... 1923 increased by 30,703 short ... Imports of ... cent. in quantity, and $266,348, or 8 ... tons, or 9 ... value compared with 1922. The quantity ... per ... exported increased by 37,219 tons, or 78 per cent., and the value increased $195,295, or 45 per cent. compared with 1922.

Production in the fuel briquette industry has tended steadily upward during the last sixteen years with but four interruptions. The outstanding feature of 1923 was an increase of 48 per cent. in production at plants in the Eastern States. The combined output in Wisconsin and Pennsylvania constituted more than 67 per cent. of the total amount for the country. Of the 14 briquetting plants that were in operation in 1922, 13 were active in 1923, and the plant of the Virginia Fuel Corporation at Portsmouth, Va., commenced operations. The estimated world production of fuel briquettes in 1923 was approximately 37,500,000 m. t., a decrease of about 14 per cent. compared with the output in 1922.

In 1923 for the first time the quantity of gypsum mined in the United States exceeded 4,000,000 s. t., showing an increase of 26 per cent. over that of 1922.

From figures available from North and South America and Africa, the world's output of mica for 1923 appears to be only 10,929 m. t., but figures from other countries are not yet reported. Mica imported into the United States in 1923 amounted to 7,330,853 lb., and the total value of mica exported was $182,162, against $129,186 in 1922.

The condition of the mercury-mining industry in 1923 was somewhat better than in 1922. There was an increase of nearly 14 per cent. in the average price at San Francisco and an increase of nearly 25 per cent. in the production. If the new mercury boiler should prove as successful in practice as is believed by its sponsors, an increased demand for quicksilver will undoubtedly arise, but this demand is not likely to be great in the immediate future. Should it eventually become so a large part of the quicksilver to satisfy it will have to be sought in foreign countries. Italy continued to be the world's largest producer of quicksilver in 1922 and 1923, the output in 1922 being nearly 44 per cent. above that of 1921, though it had not yet reached the amount which the deposits now in Italian possession showed themselves capable of yielding before the war. In 1923 there was a smaller increase in production of mercury. The output of Spain in 1922 was more than double that of 1921 and was greater than that of any other year since 1911. In 1923, however, there was a distinct decrease ... amount ... purt ... number of producing mines in the United States ... from 10 in 1922 to 14 in 1923.

The ... it on ... the ... found ...

FORTHCOMING EVENTS

Dec. 19. SOCIETY OF CHEMICAL INDUSTRY, South Wales *Section*. Joint Meeting with the ... Institute of Chemistry, the Chamber of Commerce, Exchange Buildings, Swansea, at 6.30 p.m. "Fire Damp Explosions," by Prof. R. V. Wheeler, D.Sc.

Dec. 19. SOCIETY OF DYERS AND COLOURISTS, *Scottish Section*, "Gelatine Colours and their Application," by J. W. Wilson.

Dec. 19. SOCIETY OF DYERS AND COLOURISTS, *Midlands Section*, "Destruction of Wool by the Action of the Atmosphere," by S. R. Trotman and R. W. Sutton.

Alteration.—The January meeting of the Manchester Section of the Society of Chemical Industry which had been arranged for January 2 is now arranged for January 9. In this meeting it is hoped that in addition to the paper by Messrs. Simpkin and Sinnatt, the Section will have the honour of welcoming and hearing a paper by Prof. Hugh S. Taylor of Princeton University, U.S.A., the title of his address to be "The Properties of a Catalytic Surface."

USES OF COBALT

At a recent meeting of the Société des Ingénieurs Civils, M. L. Guillet read a paper on recent applications of cobalt. After describing the well-known utilisation of cobalt as a compound, the speaker pointed out the harmful effect of cobalt in brasses and aluminium bronzes, and said that cobalt did not offer much possibility of use for improving the properties of metals, but was of interest for the manufacture of permanent magnets, high-speed steels, and for electro-plating.

SOCIETY OF CHEMICAL INDUSTRY

SUSPENSION OF ENTRANCE FEE

As an inducement to Chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Society in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 4, June 13 and 27, July 4 and 25, September 19, or October 3 and 17, 1924, that they are willing to dispose of to the Society.

LIBRARY OF THE CHEMICAL SOCIETY

The Library of the Chemical Society will be closed for the Christmas Holidays at 1 p.m. on Tuesday, December 23, and will re-open at 10 a.m. on Monday, December 29.

LIST OF MEMBERS ELECTED, December 12, 1924

Askew, H. O., "Fairlawn," 643, Fulham Road, London, S.W. 6
Bain, William, Ashbourne House, Whitechapel Road, Cleckheaton, Yorkshire. Analytical Chemist.
Balns, Leslie, 5, Carlton Road, Stroud Green, London, N. 4. Chemist.
Bührig, William H., The Fleischmann Laboratories, 158th Street and Mott Avenue, New York, N.Y., U.S.A. Chemist.
Burman, Henry, "Dunaverty," Provanmill, Millerston, Glasgow. Analytical Chemist.
Burns, A. C., 6, Oakbank Avenue, Chorlton-cum-Hardy, Manchester. Chemist.
Chevassieu, Henri, Société de la Soie Artificielle d'Izieux, Izieux, Loire, France. Director.
Cheshire, Arthur, 21, Cavendish Drive, Rock Ferry, Birkenhead. Chemist.
De Ganahl, Carl, Isle of Grain, Kent. Oil Refiner.
Donovan, W., Dominion Laboratory, Wellington, New Zealand. Assistant Dominion Analyst.
Frost, Granville B., Dept. of Chemistry, Queen's University, Kingston, Ontario, Canada. Lecturer.
Gibson, Reginald O., 41, Peak Hill, Sydenham, London, S.E. 26. Research Chemist (Industrial).
Godber, Joseph, 30, Frant Road, Tunbridge Wells, Kent. Director.
Hess, Eric H., c/o Adolph Hess & Bro., Ltd., Kirkstall Road, Leeds. Managing Director.
Hossack, James, 679, Echo Drive, Ottawa, Canada. Chemist.
Katsuyama, Katsujiro, c/o Mitsubishi Shogi Kaisha, Ltd., 117, Fenchurch Street, London, E.C. 3. Chemical Engineer.
Kearns, W. E., Cowpe Mills, Waterfoot, near Manchester. Cotton Yarn Dyer.
Lewis, Philip S., The Muspratt Laboratory, The University, Liverpool. Research Student.
Light, Alfred K., Dept. of Public Works, Ottawa, Ontario, Canada. Chemist.
Long, William L., 537, Brinton Street, Germantown, Philadelphia, Pa. U.S.A. Chemist.
Lunt, Clifford, 66, York Street, Runcorn, Cheshire. Chemist.
Marson, Cecil B., Fuel and Metallurgy Dept., The University, Leeds. Gas Research Fellow.
Martin, Frank A., 56, Windsor Terrace, Gosforth, Newcastle-on-Tyne. Works Chemist.
Mitchell, Helen G., The Horticultural College, Swanley, Kent. Lecturer.
Mitchell, Thomas C., Templehall Buildings, 168, Quarry Street, Hamilton, Scotland. Research Assistant.
Monk, Harold E., 27, Kenwyn Road, Wallasey, Cheshire. Assistant to City Analyst.
Moth, Leonard Alfred, 24, Holborn Viaduct, London, E.C. 1. Analytical Chemist.
Parrish, Eric, 157, Cheetham Hill Road, Manchester. Research Student.
Parrish, John, 155, Hertford Road, Waltham Cross, Herts. Technical Chemist.
Roberts, Thomas J., Ingleside, Huyton, near Liverpool. Lecturer.
Scruton, Harold A., 192, Victoria Avenue, Hull, Yorkshire. Research Chemist.
Simpson, Louis, 172, O'Connor Street, Ottawa, Ontario, Canada. Consulting Engineer.
Slater, Victor W., 139, Ashburnham Road, Luton, Beds. Industrial Chemist.
Smart, Thomas F. M., The Clayton Aniline Co., Ltd., 68½, Upper Thames Street, London, E.C. 4. Manager.
Southall, Colin L., Suva, Fiji Islands. Analytical Chemist.
Steed, Walter A., 72, St. John's Road, Isleworth, Middlesex. Analytical Chemist.
Stoton, Percy F., 20, Mill Street, Wincanton, Somerset. Chemist.
Streather, Alec T., 3, Wellington Road, Watford, Herts. Works Chemist.
Swint, Wendell R., c/o E. I. du Pont de Nemours and Co., 54, New Broad Street, London, E.C. 2. Chemical Engineer.
Sword, James, 14, Percy Street, North Kelvinside, Glasgow. Assistant to Professor of Chemistry.
Taylor, George, 17, Great Tower Street, London E.C. 3. Analytical Chemist.
Taylor, L. R., c/o The Lautaro Nitrate Co., Ltd., Oficina Santa Luisa, Taltal, Chile.
Thwaites, John A. C., 14, Holly Avenue, Whitley Bay. Chemist.
Thompson, Joseph, Altorf, Holywood Road, Belfast. Miller and Manufacturer.
Tunstall-Behrens, Brian, 36, Meadway, Golders Green, London, N.W. Analytical Chemist.
Voge, Cecil I. B., 4, Cluny Avenue, Edinburgh. Student.
Walton, Milton, c/o Messrs. I. Brown and Co., Ltd., Manufacturing Chemists, Savile Town, Dewsbury. Chemist.
Whitmore, Richard D., Food and Drug Laboratories, Health Dept., 317, Queen Street, Ottawa, Ontario, Canada. Chemist.

NOTTINGHAM SECTION

A joint meeting with the Society of Dyers and Colourists was held on November 27, Mr. S. H. Pentecost presiding. The Society recorded its sorrow at the loss of Mr. J. T. Wood and its sympathy with Mrs. Wood.

Mr. G. H. Ellis then read a paper on "The Dyeing of Acetate Silk." Mr. Ellis stated that artificial yarns produced by the earlier methods differed materially from those produced by the Dreyfus process (which is responsible for the present day Celanese); the difference shows itself chiefly in the degree of impermeability. Although in comparison with other textile fibres the present Celanese is relatively impermeable, it is much less so than the earlier fibres, and it has also low conductivity and different optical properties. It is claimed therefore that garments made from Celanese are

relatively cool in summer and warm in winter. The yarns are also extensively used for insulating purposes. The tensile strength of the yarns particularly when wet has been increased and this together with a considerable elasticity renders it possible to process with facility. Cellulose-acetate as represented by Celanese is a very stable fibre as is shown by long ageing tests.

The earliest cellulose-acetate fibres of a number of years ago would only take up basic colours substantively after drastic treatment to swell the fibre. In the early days of Celanese (which is the registered trade mark of British Celanese, Ltd.) unsuccessful attempts were made to use ordinary dyestuffs such as direct cotton colours. In England the method of saponification or hydrolysis was elaborated, whilst in Switzerland the dyeing was done with simple basic colours without mordants, using inorganic salts, *e.g.*, magnesium chloride, for heavier shades. The saponification method was difficult to control, as faults were not apparent until the material was dyed and were then beyond correction. A very large percentage of the saponification was completed in the first five minutes, which meant an extremely sensitive process, which, on account of its rapidity, resulted in irregularity. Unevenness became greatly accentuated, since any portion of the surface first attacked by alkali subsequently absorbed more and became further hydrolysed in preference to the remainder. Further, there was a substantial loss in weight and some effect on the lustre, resistance to abrasion and so on; hence the saponification method was unsuccessful.

The ultimate solution of the problem lay in the synthesis of colours especially for cellulose-acetate which theoretical deduction showed would have to be molecularly simple, generally basic in nature but certainly not strongly acidic or salt-forming. It appeared certain that such colours would be insoluble in water, and it became necessary therefore first to devise a method of "solubilising" such insoluble compounds. The possibility of achieving physical or colloidal dispersion of water insoluble colouring matters was conceived. Many colouring matters answering to the above conditions would be oil soluble and considerable promise seemed to lie in the use of sulphoricinoleic acid which has the properties of an oil, but has miscibility with water, and in the form of its alkali salts is a very powerful protective colloid in aqueous dispersion systems. Thus simple colours were dissolved in hot sulphoricinoleic acid and the solution diluted down to suitable dyebath strengths. The method was next extended to cover unsulphonated fatty acids, neutralisation being first necessary to produce salts miscible with water. Subsequently the methods were greatly elaborated and numerous new discoveries made; the principle throughout was to obtain a high degree of solution in pre-treatment and to prevent subsequent aggregation or coalescence in the aqueous dyebaths.

The result of much research has produced what are known as "S.R.A." colours. Dyed samples were shown in which the dye was used in the form of a paste embodying the colouring matter compounded with agents or media colloidal solubilisation and subseq ... of dyebath conditions. The ... ct which produced properties of the "S.R.A." colou... ituent preservation good. The special compoundin... val general fastness for these colours as now mar...rs were exceedingly they are no more trouble in diss... method employed colours of commerce. Besides th...keted is such that gether the "S.R.A." colours may ...lving than the usual direct cotton colours and appli...ing miscible to baths, and as they do not dye cott... also be mixed with silks, mixed goods may therefo... in the same dye various effects, such as solid shade... or other artificial or bi-colour effects. Substantiall... be dyed with do not dye animal fibres cit... two-tone effects, effects may also be produced, ... "S.R.A." colours mixed fabrics of cotton-Celanese ... thus tri-colour Celanese and silk. In conclusion ... as for example in eated the application of "S.R... and wool, or cotton printing. ... the author indi... A." colours to

In the discussion Mr. Pentecost pointed out that the process involved was entirely novel in that it achieved the dyeing with insoluble dyes in a very fine degree of dispersion, instead of in true solution. It should be noted that there was a whole series of these dyes, covering the entire range of the spectrum. Mr. Pentecost said he had noticed that with some materials the cotton constituent had become coloured even when temperatures of only 160°—170° had been used and no carbonated alkali, and he wondered whether a trace of alkali in the softened water was responsible. Another speaker enquired if it was possible to prepare a material in marketable condition in which the Celanese fibre was dyed and the rest left white. Another speaker enquired whether "S.R.A." dyes could be used for calico printing. In reply, Mr. Ellis said that the points to be attended to were (*a*) the temperature must be strictly governed, (*b*) avoidance of saponification, (*c*) mechanical occlusion. He did not think that the amount of alkali present in softened water would cause irregularities. Prevention of mechanical occlusion required very careful scouring. A hard twist would resist much better than a soft one. Some causes of unsatisfactory results were those alluded to above and it must also be remembered that a number of the dyes were oil soluble and consequently all the fabric must be freed from oily matter. In calico printing nothing more was needed than direct printing on with a suitable material such as gum tragacanth or British gum. After printing, the usual drying was carried out and ageing preferably with dry steam. The material would then stand soaping much better than cotton printed with ordinary cotton colours, in fact, the results nearly approached those obtained by mordant colours.

The fifth meeting was held on December 3, Mr. Pentecost presiding. Prof. W. E. S. Turner, D.Sc., read a paper entitled :—"A Study of Recent Attempts to Produce High Resistance Glasses."

The stability of glass was indicated by the fact that specimens are in existence which were made more than 3000 years ago. Glass made up to the sixteenth—seventeenth century was mainly of the soda-lime-silicate type. In the seventeenth century

appeared a new glass in which oxides of lead and potassium were extensively used in place of lime and sodium oxide. This glass was still in use for the best table glass. Glass chemical apparatus up to 1850 was mainly of the soda-lime-silica type. Glass rich in sodium oxide was appreciably attacked by water and acids and was therefore unsuitable for accurate quantitative experiments. Stass found that a glass of the composition SiO_2 77 per cent., CaO 10·3 per cent., K_2O, 7·7 per cent, and Na_2O, 5·0 per cent., resisted chemical action, and in 1860—1870 glass of this type was made by the Bohemians.

Starting with sodium silicate ($Na_2O.3SiO_2$), the substitution of CaO for Na_2O increased the stability. Glass containing less than 2 per cent. CaO was rapidly attacked by water, and as the amount of lime increased beyond 3 per cent. the corrosion rapidly diminished. The substitution of Na_2O by other alkaline earths or aluminium oxide gave similar results. The substitution of magnesia for lime gave a slightly more durable glass, whilst for zirconia and titanium oxide the results were intermediate between those for lime and magnesia.

The material extracted from the glass by corrosion varied with the type of the glass, but the alkali constituents were always in excess in the solution. The stability of high resistance glass was in general indicated by the actual solubility of the several oxides which compose the glass. The order of solubility of the commoner oxides used was as follows: K_2O, Na_2O, B_2O_3—BaO, CaO, MgO, PbO, ZnO—Al_2O_3, SiO_2, hence the more SiO_2 which can be melted into a glass, the greater the durability to water and acids. Boron trioxide, although relatively fairly soluble, behaved as an exception to the above rule since, up to a limiting value of about 12 per cent. B_2O_3, it not only increased the durability but reduced the coefficient of thermal expansion and gave the glass valuable optical properties; above 12 per cent. B_2O_3 the durability diminishes. In 1893, high resistance borosilicate glass was made at Jena, and since that time the use of B_2O_3 associated with high silica content had been extensively developed.

The resistance of a glass increased with the silica content, but the fusion point was correspondingly raised, hence the limiting silica content was mainly determined by the ability to bring the materials to a state of fusion in operations on a commercial scale.

In the discussion, Mr. Pentecost asked whether it would be possible to make dye-baths of glass that would not be stained by the dye. Dr. Firth asked if a glass which was initially readily attacked by water or acids became more resistant after several treatments with water or acid, also why it was impossible to work glass which had been subjected to the action of steam for some time, also the cause of opalescence after heating of combustion glass, and transparent silica ware. Dr. Prideaux enquired whether the use of manganese dioxide by the Romans was intentional or routine, the value of zinc oxide as a constituent of glass and also whether dust hastened devitrification. In reply, Prof. Turner stated that glass could not be used as lining for metal baths, owing to the difference of thermal expansion of metal and glass. Glass improved appreciably after repeated treatment with water and acids, the amount of glass dissolved diminished, particularly in soda-lime and the commoner glasses. Glass may be regarded as a colloid, and rapidly adsorbed gases and water vapour; this was greatest in glasses of high alkali content in which adsorption was followed successively by absorption, hydration, hydrolysis of silicates with the production of silica possibly as gel, and the corresponding production of alkali. On heating glass containing absorbed gases or more particularly water vapour the gas or water vapour was rapidly expelled under fracture of the glass. With glass of high silica content high temperatures caused the excess silica to separate as fine crystals; at 1140° amorphous silica was slowly converted into tridymite. The use of manganese dioxide was known to the Romans not only as a colouring agent, but also as a decolorising agent. The use of zinc oxide increased the refractivity and durability and lowered the thermal expansion. Dust favoured devitrification in so far as the particles were centres for the condensation of moisture and hence the glass was acted on intensively at these points. Therefore optical glass and the like should be kept dust free.

BIRMINGHAM AND MIDLAND SECTION

Dr. Twiss presided at the second meeting on December 9. Mr. D. R. Nanji and Mr. W. S. Shaw (Department of Fermentation and Brewing, University of Birmingham) submitted a paper on "The Role of Silica in Plant Growth: its Assimilation and Physiological Relation to Phosphoric Acid."

During the eighty-five years which have elapsed since Liebig first brought forward his theory, our views on the artificial fertilisation of land have undergone considerable modification, more especially when viewed from the standpoint of the colloidal and the biological conditions existing in the soil. We have come to regard elements such as nitrogen, phosphorus, potassium, calcium, magnesium, sodium, sulphur and iron as requisite for perfect growth, and it is now held that certain elements such as boron, fluorine, iodine, silicon, aluminium, manganese and zinc, which had been known to exert a toxic effect towards plants when present in concentrations above a certain limit, had, in fact, when present in very minute amounts, not only a stimulating and beneficial effect, but might even be essential in some cases. It had been held that silica fulfilled ecological functions in that plants grown in the presence of silica are able to withstand parasites and moulds to a greater degree than plants grown without silica. Recent investigations have shown that silica is capable of increasing growth, and this beneficial effect is particularly marked in soils deficient in phosphorus. Silica fulfilled an important function in plant metabolism, and the realisation of this fact should prove of immense service to agriculturists in combating plant pests and diseases. The great significance of this problem to the cotton and similar industries which suffer heavy losses annually in their inability to cope with disease, can readily be realised. Such a study would also reveal the influence of silica in modifying the physical nature of the plant tissues. Before such investigation can yield fruitful results it will be necessary to dispose of

methods for examining and estimating the forms in which a given constituent may be present in the plant tissue. By this means alone can we gain an accurate impression of the equilibrium between the different combinations of the same element found generally in plant tissues. Much work still remains to be done by the agricultural chemist on the mineral physiology of plants, and being specially interested in the physiology of the element silicon and its relationship to phosphorus, studies have been commenced by the authors with such plant tissues as the straws of various types which are known to be highly siliceous.

A paper on 3 : 3 - Diethylpentane was presented by Prof. G. T. Morgan, Mr. Sydney Raymond Carter, and Mr. Albert Edward Duck. 3 : 3 - Diethylpentane or tetraethylmethane, $C(C_2H_5)_4$, a tertiary paraffin, is of especial interest as having the most symmetrical structure of all the theoretically possible nonanes. From the general inorganic viewpoint this hydrocarbon acquired additional significance, because it may also be regarded as the initial member required to complete the following periodic series :

$$C(C_2H_5)_4,\ Si(C_2H_5)_4,\ Ge(C_2H_5)_4,\ Sn(C_2H_5)_4,\ Pb(C_2H_5)_4.$$

This paraffin had now been synthesised from diethylketone by the application of the Grignard and Frankland reactions, as summarised in the following scheme :

$$(C_2H_5)_2CO \rightarrow (C_2H_5)_3C{\cdot}OH \rightarrow (C_2H_5)_3C{\cdot}I \rightarrow C(C_2H_5)_4.$$

The hydrocarbon is a colourless liquid with a characteristic camphoraceous odour, having a melting point $-41° \pm 1°$ and boiling point $139{\cdot}2°/760$ mm. In its chemical properties diethylpentane exhibits the inertness which characterises a paraffin hydrocarbon. It does not decolorise bromine water or alkaline permanganate, neither is it attacked by concentrated sulphuric or nitric acids. Its physical properties, including the vapour density, liquid density, molecular volume, surface tension and refractive index, have been determined. A comparison of these properties with those of other hydrocarbons demonstrates the monomolecular character of 3 : 3 - diethylpentane. Moreover, they accord with the compactness and perfect symmetry which would be associated with the structural formula of tetraethylmethane.

A joint dinner with the local section of the Institute of Chemistry was held at the Queen's Hotel, Birmingham, on December 13, and Prof. G. T. Morgan, the chairman of the local sections, presided.

The toast, "Chemistry and Industry" was proposed by Professor F. W. Burstall, Dean of the Faculty of Science in the University of Birmingham, who stated that in his professional life as an engineer he had been greatly impressed by the developments in the chemical world. The developments in the production of synthetic drugs and artificial silk had been particularly marked and the chemist might now well direct his attention to the application of science to the home, and to the production of foods that would be available for immediate use merely by heating and which would to a large extent prevent the colossal waste that now took place. The toast was acknowledged by Mr. W. J. U. Woolcock, C.B.E., president of the Society of Chemical Industry, who insisted that there was practically no industry which did not owe much of its development to the work of the chemist. There was much to be done in inculcating in the public mind the precise function of the chemist and the great part he was playing in the life of the country. In the direction of propaganda a valuable work had been done by the displays in the chemical section of British industry at Wembley. The cost involved of over £100,000 was worth it, because it answered the question—Germany or this country? Formerly, the mass of our people, when they heard the word "chemicals" were apt to think only of Germany. This was no longer the case. To-day, it was recognised that British chemicals and the British Chemical Industry had an established place. The Wembley exhibition had brought home to the Britisher not only the great industrial developments that had taken place within the domain of chemistry, but the patient, plodding, and very often unrewarded research work that was going on; this was an absolute guarantee for the continued progress of the British Chemical Industry.

Mr. J. T. Bell, President of the Birmingham Pharmaceutical Association proposed the toast, "The Institute of Chemistry," and remarked that the institute had always had a peculiarly close relationship to Birmingham from the time when Sir William Tilden was Chemistry Professor at Mason College, and President of the Institute from 1891 to 1894. He gave an interesting historical sketch of the foundation of the various chemical organisations and bore tribute to the invaluable work done by the Institute in maintaining the high professional status of its members. Prof. G. G. Henderson, President of the Institute, in his reply, urged that the primary function of the Institute was to promote the welfare of the profession. It had a direct and personal interest in all its members and was anxious to provide them with information and advice. The foundation of the Society of Chemical Industry had a great influence for good in raising the status of the chemist. The men who laid the foundations of that Society, determined that it should be built up of self-governing sections, each independent within limits, but all linked together by a central body, upon the Council of which each section was represented. Thus, chemists from all parts of the country came together with a common aim and purpose, and in this way obtained a better understanding of one another's position. But he felt that the principal influence in promoting the development of the profession of the chemist was the steady, unceasing work which had been carried on by the Institute of Chemistry for 50 years. Several generations of chemists, representing every branch of the profession, had devoted time, thought and labour, for the benefit of their successors; and he thought it was incumbent upon all chemists to become members of the Institute. Not until every chemist in the country was a member would they be able to speak, if necessary, with one voice upon matters of national importance. Chemistry and other scientific work must become of increasing importance to this country and, indeed, to every country; and if the mass of the people was to realise

the significance and importance of the work of the chemist, the aid of the press would have to be invoked.

The toast of "The Guests" was proposed by Prof. G. T. Morgan, who said that the unemployment list of the Institute would not have been confined to its present modest proportions but for the Safeguarding of Industries and the Dyestuffs Acts. Prof. J. G. Smith replied.

SOCIETY OF DYERS AND COLOURISTS

A meeting of the Manchester Section was held on December 12, Mr. J. Huebner, M.Sc., presiding.

A paper entitled, "Recent Experiments on the behaviour of Aluminium Hydroxide towards Dyestuffs and Salts," by J. K. Wood, D.Sc., and A. Wooller, M.Sc., was read by the first-named author.

Mr. Wood said that the behaviour of titanic acid and of stannic acid towards dyestuffs was influenced by the mode of preparation of the compounds in question. This influence of the mode of preparation was attributed to the amphoteric character of the substances, which made it possible for them to adsorb either acid or alkali from the solution in which they were being produced, so that, according to the condition of the solution, there was either acetate on one occasion or alkali on another, thus giving rise to products capable of taking up acid dyes or basic dyes, respectively. Similar results might be obtained with other amphoteric substances, and it might be said that a hydroxide like aluminium hydroxide could either have the adsorption of an alkali or the adsorption of an acid, according to the condition of the solution in which it was being made, and that would lead to a difference, according to the mode of preparation, in behaviour towards dyestuffs. The paper described experiments on the behaviour of what had been termed hydrated aluminium oxide or hydrated alumina, because the amount of water was variable and there was no very definite compound.

There was some difficulty in preparing hydrated alumina free from impurity, and the behaviour of the product towards dyestuffs was often influenced by the impurity present. Hydrated alumina had more affinity for acid than for basic dyes, and evidence was adduced to show that with basic dyes the fixation of the colour involved an exchange between the acidic impurity in the hydrated oxide and the acid of the dyestuff.

A second paper, "On Alkali Cellulose," by Prof. E. Knecht, Ph.D., M.Sc., and J. H. Platt, B.Sc., was read by Prof. Knecht, who said that it was now more than eighty years since Mercer, in 1844, when filtering a solution of caustic soda of 60° Tw. through a filter, composed of a six-fold layer of cambric, noticed that the filtrate had been reduced in strength to 53°. The experiment led to the discovery of the mercerising process. During further investigations of his "sodaised" cotton, Mercer was led to conclude that on treating cotton with caustic soda of roughly 45° Tw., a definite compound was formed, represented, according to the present way of writing it, as one of cellulose to one of caustic soda. Later, Dr. Gladstone showed that the amount of alkali taken up was one-half of that assumed by Mercer, and that definite compounds, represented by the formula of two of cellulose to one of caustic soda or potash, had been formed. Since then, and especially within the last twenty-five years, the question of the composition of alkali-cellulose occupied the attention of numerous investigators, some of whom had confirmed the views held by Mercer and by Gladstone, whereas others had maintained that the amount of alkali taken up by the cotton fibre was a variable quantity depending upon the constitution of the caustic alkali. "Alkali cellulose" was the product which resulted when cotton was subjected to the action of strong caustic soda or potash. Beyond 40° Tw. the compound formed by caustic soda possessed a constant composition which corresponded to that obtained in another way by Dr. Gladstone. The same was found to hold good for caustic potash beyond a strength of 70° Tw.

BIOCHEMICAL SOCIETY

A meeting was held on December 8, when six papers were read.

I "Magnesium in Human Serum," by E. Watchorn. A series of nine normal individuals gave values ranging from 2·23 to 2·50 mg. per cent., except in one case whose serum contained on one occasion only 2·09 mg. per cent. Thirty-two pathological cases were investigated, of which only six had a normal magnesium content of the serum, the remainder having increased values, ranging from 10 to 40 per cent. Magnesium chloride ingestion caused an increase of 21 per cent. During and immediately preceding menstruation the magnesium was found to be considerably decreased (sometimes by 40 per cent.) in four cases where the function was accompanied by marked physiological disturbance, but increased in one case investigated where there was no such disturbance.

II "The Oxidation of Amino Acids by Fungus Tyrosinase," by M. E. Robinson and R. A. McCance. A study has been made of the oxidative deamination of glycine, alanine and leucine by a tyrosinase from *Lactarius Vellereus*, in the presence of *p*-cresol, resorcinol and catechol. The oxygen uptake, the change in amino nitrogen and the liberation of ammonia have been estimated.

III "The Effect of Gelatin Feeding on the Thyroid Gland," by G. M. Findlay. When gelatin is fed to rats as the sole source of protein in an otherwise complete diet death invariably occurs in from two to four weeks. The only constant pathological finding is an atrophic condition of the thyroid gland, characterised by the disappearance of all colloid material and the collapse of the walls of the vesicles. The addition of cystine and tyrosine to the gelatin does not prevent this change in the thyroid.

The following papers were also communicated :—

"The Isolation of a Hydrolysis Product of the Proteins, hitherto undescribed," by H. W. Buston, H. N. Mukherjee, and S. B. Schryver. "Some Transformations of Casein," by H. Mastin and S. B. Schryver. "The Separation of the Proteins of Egg-white in an Electric Field," by Dorothy Griffiths and S. B. Schryver.

CORRESPONDENCE

WHAT IS THE THEORY OF INDUCED POLARITIES ?

Sir,—I recently took exception (this vol., p. 1109) to the following statement made during the course of a discussion on a paper of Prof. Pyman's: "The theory assumed that when oxygen and nitrogen are both present, the former is the negative key-atom." As Prof. Pyman had merely been applying, to his own observations, the "principle of induced alternate polarities" (which is not based on any theory, but is essentially a restatement in generalised terms of experimental observations) I naturally assumed that Dr. Flürscheim's remark was not a disingenuous attempt to confuse the principle with a variety of attempts which have since been made to explain its theoretical significance.

I preferred to assume that Dr. Flürscheim spoke in ignorance or forgetfulness, and although his reply to my protest suggests that his remark should be interpreted otherwise (this vol., p. 1160), I should be sorry to accept that suggestion.

In the circumstances, however, I, as one of several who have made tentative efforts to discover a sound theoretical basis for the "principle" in question, have good reason to wonder how Dr. Flürscheim justifies the application of the description: "the theory of alternate polarities" to certain views expressed conjointly by Robinson and Kermack rather than to others expressed by Sir Joseph Thomson, by Dr. Henstock, by Prof. Lowry or by myself.

This multiplicity of theories makes Dr. Flürscheim's offer all the more sporting, of course, unless he himself again assumes the responsibility of deciding which of the five or six brands of "theory" is to be tested and when its postulates fail. As to Dr. Flürscheim's own theory, I have expressed my own *opinion* of it in my last letter to you. I long ago signified my concurrence with some of his postulates, and my dissent from that based on Werner's carboxylic acid theory in the Annual Reports for 1909 (vi., pp. 58—61).—I am, Sir, etc.,

The University, Manchester A. Lapworth

THEORY OF SUBSTITUTION IN AROMATIC COMPOUNDS

Sir,—In your issue of November 21, p. 1161, Dr. Flürscheim replies to certain points raised by Prof. Lapworth by quoting some excerpts from publications in part by me, and in regard to which Prof. Lapworth cannot be assumed to have accepted any responsibility. For my own part, I am ready to defend all the postulates quoted by Dr. Flürscheim, but suggest that their application has been misunderstood. It is true that the tendency of the oxygen atom to acquire a negative charge and a stable octet is greater than that of the nitrogen atom, but whether this tendency can become effective or not will certainly depend on the circumstances of the case, and especially on the structure of the molecule and the mechanism of the particular reaction considered. To take the analogy of a game of chess, the queen is potentially the most powerful piece on the board and in simple cases will, with the best play, always overpower a weaker hostile piece, whilst in complex positions even a pawn may sometimes prove a more efficient instrument. Similarly, in complex molecules an oxygen atom may meritoriously succeed in stabilising its octet, and yet the process proves to be futile because it has no relation to the changes which can occur in the molecule under the particular conditions of experiment.

A sovereign has a higher purchasing power than a penny, but this cannot be proved by a test with an automatic machine. Again, in readily reversible reactions the final point of attachment of a group, where more than one possibility exists, will chiefly depend on the stability of the product. In such cases electro-valencies tend to be replaced by co-valencies, and the result anticipated from the elementary process of sign-labelling is reversed.

Absolute rules are rare in organic chemistry, yet in connexion with aromatic substitution there are several to which no exceptions exist. For example, it appears to be always true that the existence of free electrons (lone pairs) in the octet of an atom directly attached to the nucleus connotes strong *o-p*-directive effect. This is easy to understand on the electronic theory of conjugation, because the levelling out of valency, which is one of the prime factors affecting the direction of chemical change, can occur with the aid of free electrons with the minimum of disturbance. In this case the electronic theory is useful both for classification and explanation. What is the equivalent in other theories of valency? In order to avoid misunderstanding it should be stated that the above proposition cannot be reversed; *o-p*-orientation does not always depend on the existence of free electrons.

The whole subject cannot be adequately discussed in correspondence columns, but I do wish to assert that the criticism which has recently been directed against the applications of the electronic theory of valency to organic chemistry has not resulted in the production of a single definite case to which these theories are inapplicable. Prof. Ingold has made very interesting observations on the addition of nitrosobenzene to unsaturated compounds, and it is significant that, on his interpretation of what polarity theories predict, everything goes the wrong way. This indicates order at least, but as in every other case the meaning of the results cannot be discussed until the mechanism of the reactions is elucidated. It is impossible to accept without question the constitutions assigned to the substances formed in the additive processes when the only method of analysis is by thermal decomposition.

The University, Manchester R. Robinson

PERSONAL AND OTHER ITEMS

Mr. George Eastman, founder of the Eastman Kodak Co., who has already given away half his holding of stock in that company, has given the remaining half, roughly, $15,000,000, to various institutions of learning. About $8,500,000 will go to the University of Rochester, and $4,500,000 to the Massachusetts Institute of Technology, both institutions which have previously received large gifts from Mr. Eastman.

Sir John Cadman has returned to London from Persia, where he has been for over two months.

Mr. H. J. Turner, head of Messrs. Charles Turner and Sons, Ltd., colour, varnish and japan manufacturers, London, died recently, aged 93.

Mr. L. E. Hinkel has been awarded the D.Sc. degree of the London University, for a thesis entitled "Reactions in the Hydro-aromatic Series, resulting in the Formation of Aromatic Compounds."

The Royal Society

At tho 262nd anniversary meeting of the Royal Society, the president, Sir Charles Sherrington, announced that Prof. O. W. Richardson, noted for his work on thermionics, has been appointed to the third Research Professorship which has been provided from the munificent gift of Sir Alfred Yarrow. The Society's medals were awarded as follows: The Copley Medal to Sir E. Sharpey Schafer for his physiological researches; the Rumford medal to Prof. C. V. Boys for his services in producing apparatus for accurate physical measurements; a Royal medal to Sir D. Clerk for his work on the internal-combustion engine; a Royal medal to Dr. H. H. Dale for his researches on the action of ergot; the Davy Medal to Prof. A. G. Perkin for researches on the natural organic colouring matters; and the Darwin Medal to Prof. T. Hunt Morgan for his researches into the theory of organic evolution.

The following officers and members of council were elected: President, Sir Charles Sherrington; Treasurer, Sir David Prain; Secretaries, Mr. W. B. Hardy and Mr. J. H. Jeans; Foreign Secretary, Sir Richard Glazebrook; other members of council, Sir Frederick Andrewes, Prof. J. H. Ashworth, Dr. F. W. Aston, Sir William Bragg, Professor S. Chapman, Sir Dugald Clerk, Dr. H. H. Dale, Prof. F. G. Donnan, Prof. A. S. Eddington, Prof. E. S. Goodrich, Sir Thomas Holland, Prof. J. B. Leathes, Prof. T. R. Merton, Dr. G. C. Simpson, Prof. J. F. Thorpe, and Prof. F. E. Weiss.

Cast Iron Research Association

In the unavoidable absence of Lord Weir, Mr. H. B. Weeks presided at the Third Annual Meeting of the Cast Iron Research Association in London on November 19. The Chairman laid stress on the great progress made during the year, and summarised the main developments, particularly the extended research programme, and the establishment of a laboratory. The report and accounts were adopted, these showing a considerable improvement.

Sir John Dewrance, K.B.E., was elected President for the period 1924–26, and the following were elected Vice-Presidents:—Mr. G. Pate, O.B.E., J.P. (Falkirk), Mr. S. Hunter, C.B.E., M.Inst.C.E. (Wallsend-on-Tyne), Mr. F. W. Firth (Sheffield), Mr. C. E. Lloyd, O.B.E., M.P. (Dudley), and Mr. W. B. M. Jackson (Chesterfield). Commander C. W. Craven, O.B.E., R.N., and Prof. T. Turner were re-elected Vice-Presidents for a further year. A great tribute was paid to the services rendered to the Association by the retiring President, the Rt. Hon. Lord Weir of Eastwood, P.C., who was elected an Honorary Member, and retiring Vice-Presidents, Mr. M. Deacon, Vice-Admiral Sir George Goodwin, Mr. A. Laing, C.B.E., Mr. P. W. Petter, J.P., and Mr. Douglas Vickers.

Mr. A. J. Burn, Mr. F. J. Cook, Mr. T. Donaldson, Mr. N. B. Ellington, Mr. J. Haigh, Major C. Howl and Mr. M. Riddell were re-elected to the Council. Dr. W. Rosenhain, F.R.S., and Prof. T. Turner were elected Honorary Members, and Dr. Rosenhain suitably responded, expressing the hope that there would be even greater co-operation in future between the Association and the Ferrous Alloys Research Committee. Delegates nominated by tho leading technical institutions were elected, and thanks expressed to the professors and scientists who assist in the work of the Association.

The French Coal and Iron Industry

Production for the month amounted to 3,837,378 tons, an increase on the August output which was 3,691,153 t., the daily production being 147,591 t., compared with 144,680 t. in January, and 136,147 t. in January, 1913. Developments in the Nord and tho Pas de Calais increased the daily production from 60,239 t. in January, 1923, to 85,539 t. in September, 1924, daily. In the Central and Southern districts the amount of coal extracted during the month was 5569 t. daily. The total daily production of the mines situated along the old frontiers was only 5569 t. less than that in 1913. The production of metallurgical coke in France rose in September to 223,810 t. Of coal and lignite 2,083,499 t. was imported of which 1,026,808 t. came from Great Britain, and 227,896 t. were exported. Imports of coke amounted to 417,610 t., of which 368,274 t. came from Germany, and 45,108 t. were exported.

During the first nine months of 1924, 34,215 t. of cast-iron was imported, and 549,933 t. exported; 7534 t. of ferro-alloys was imported, and 14,436 t. exported. Exports of iron and steel amounted to 1,675,575 m. t., and imports to 537,861 m.t.; 38,613 m.t. slag was exported, and 56,888 m. t. imported.

Sugar Beet Subsidy

It is announced that the Government has decided to carry out the proposals made by the late Government for the grant of a subsidy for a period of ten years on a diminishing scale to sugar manufactured in this country from home-grown beet, coupled with a minimum price to the growers in the initial years.

The proposed subsidy, which will apply to sugar manufactured during the current season, will be at the rate of 19s. 6d. per cwt for the four years from 1924-25 to 1927-28 inclusive; at the rate of 13s. per cwt. for the three following years; and at the rato of 6s. 6d. per cwt. for the three final years. These rates will apply to sugar of a polarisation exceeding 98 deg.; for sugar of lower polarisations the rates will be reduced according to scale. The subsidy has been fixed at a rate which will enable the sugar factories to pay excise duty at the preferential rate, which at present is 9s. 8⅔d. per cwt., and the industry would not be adversely affected in future by any reduction in the Customs duty on imported

sugar, since the Excise duty would be proportionately reduced at the same time. It will be a condition of payment of the subsidy that the sugar manufacturers should pay during the first four years a minimum price of 44s. per ton of beet of 15½ per cent. sugar content, with an addition or deduction of 3d. per ton in respect of each one-tenth per cent. of sugar content above or below 15½ per cent.

The Government proposes also that in the case of any new sugar factories it shall be a condition of the payment of the subsidy that not less than 75 per cent. of the value of the machinery and plant shall be of British manufacture, unless the Minister of Agriculture for any special reason dispenses with this condition.

The necessary measures have been prepared and will be presented to Parliament when it meets for business. It will not be possible to complete the stages before Christmas, but it is the intention of the Government to secure their passage into law without any avoidable delay.

Adulteration of Food

Mr. J. F. Liverseege, F.I.C., city analyst of Birmingham, gave an address on "The Adulteration of Foods" before the members of the Biochemical Society of the University of Birmingham, on December 4, Prof. A. R. Ling presiding.

Mr. Liverseege said that 5000 samples of drugs and food were taken in Birmingham annually, or about 530 samples per 100,000 of the population, and about 5 per cent. was adulterated. From 1897 to 1901 9·3 per cent. of the milk samples contained boric acid or formic aldehyde; but to-day less than one in a thousand samples was adulterated in that way.

During the war, when bread was dear, a curious preparation which claimed to prevent bread losing moisture and to impart flavour and colour was put upon the market, but it was useless as it consisted of starch, Epsom salt and calcium phosphate. At one time boric acid was largely used as a preservative in sponge cakes, and it was used during the war period in imported liquid eggs for making sponge cakes. He had found Gorgonzola cheese adulterated on the outside by a paste of barium sulphate and tallow, sometimes coloured with oxide of iron, whilst rice had been adulterated with French chalk, used, it was said, to protect it against the weevil. Glucose had been used in making sweets, and then as the glucose picked up moisture, a coating was given of paraffin wax. There were instances many years ago of vinegar having been adulterated with sulphuric acid, and he had found samples containing boric acid and salicylic acid. One recent sample consisted of jam marked, "Prepared from refined sugar," but which contained glucose syrup. Adulteration was not common in Birmingham, and the large proportion of traders did their best to supply the public with the article they required and paid for.

Answering questions, Mr. Liverseege stated that dried milks now had to be labelled in accordance with their composition. Under the new labelling regulations the sale of dried skimmed milk as dried milk should be stopped. The word "adulteration" did not come in under the Food and Drugs Act, but such products, including medicine, should be in accordance with the nature, quality and substance demanded by the purchaser. Various products sold under proprietary names could not be defined by the public analyst. There was no standard, so that the public analyst was without power to support a prosecution, unless, of course, such proprietary article was injurious to health. A difficult question like that of the use of saccharin in jam ought to be dealt with not only by a local authority, but by the Ministry of Health. He had on one occasion found golden syrup adulterated by solid glucose.

Prof. Ling said if the manufacturer mixed his food products upon proper lines preservatives should be unnecessary. He condemned the use of glucose in golden syrup as an adulteration.

Power Alcohol from Beet

An influential deputation formed by the British Power Alcohol Association has, according to *The Times*, asked the Minister of Agriculture to extend the proposed subsidy of 19s. 6d. per cwt. on sugar produced from beet to the sugar content of beets used for making power alcohol. Some of the chief points mentioned were the agricultural importance of the beet crop and the serious need of an alternative motor fuel to petrol. The value of sugar beet as a cleaning crop in the rotation and its effect in increasing the following crop of cereals was emphasised, whilst the additional farm labour required and the value of by-products of beet as food for stock were also pointed out. It was urged that if these arguments were strong in the case of sugar they were stronger as regards power alcohol, because central factories were much cheaper to construct, used larger quantities of beet and worked continuously throughout the year. The need of producing power alcohol, in view of the growing consumption and the rapidly diminishing sources of it, had been impressed on the country by various Government Committees, and the deputation strongly urged that it was essential for economic and strategic reasons that we should not be dependent on foreign sources for our motor fuel supplies. If the subsidy were granted, the comparative cheapness of an alcohol factory would prove a guarantee against the creation of monopolies, as it was the aim of the British Power Alcohol Association to encourage the establishment of central factories on a co-operative basis, the farmer supplying the beet to have participation in the profits, and a first claim on a portion of the product. Large sums were lost annually because our main supplies of liquid fuel were drawn from the United States, in consequence of the adverse exchange conditions. Foreign countries, including the United States, where were the largest supplies of petrol, were entertaining large schemes for the development of power alcohol. The main object of a subsidy being to place an infant industry in a position to stand on its own feet, it was important to know whether at the end of the proposed subsidy, namely 10 years, power alcohol could be made in this country to compete with petrol. Leading experts who have examined this question on behalf of the Association were satisfied that at a cost for beet which

could make the sugar industry just pay its way if present prices for sugar were maintained, power alcohol could compete easily with petrol, even if the average post-war petrol price were not to be exceeded, a supposition which seemed unlikely. For the safety of the country against economic or military attack, it was essential that the power alcohol industry should be established here, and the amount of the subsidy would probably be more than compensated for by reduction of the dole and saving in exchange on purchases of American motor spirit.

Whilst addressing the Rotary Club at Wolverhampton, Mr. Alfred Wood said that the British Sugar Beet Society, which represented all interests in this new industry, undertook to make every effort to comply with the condition of the subsidy, which was to secure such economies arising from education, experience and efficient organisation as to enable it to become self-supporting in the period of ten years covered by the Beet Subsidy Bill. Four of the six promised factories at Ely, Kidderminster, Spalding and Ipswich were expected to be ready for the 1925 crop of beet, and the farmers, through the National Farmers' Union, were co-operating with the manufacturers in every possible way. Prof. A. R. Ling, of Birmingham University, Mr. T. H. P. Heriot, of the Royal Technical College, Glasgow, and Dr. A. Wijnberg, formerly principal for twenty-five years of the school for the sugar industry of Holland, were engaged upon the consideration of a scheme put forward by the Society, in which universities and beet sugar factories would be invited to co-operate,

Mineral output of Canada in 1923 and 1924

According to revised statistics received from the Dominion Bureau of Statistics, the Canadian mineral output in 1923 was as follows :—

	Quantity	Value $
Asbestos	231,482 tons	7,522,506
Copper	86,881,537 lb.	12,529,186
Lead	111,234,466 lb.	7,985,522
Nickel	62,453,843 lb.	18,332,077
Salt	206,985 tons	1,713,516
Silver	18,601,744 f. oz.	12,067,509
Zinc	60,416,240 lb.	3,991,701

Finally, revised figures for gold production in 1923 show 1,243,341 fine ounces, valued at $25,702,139.

The total value of metallic production during the first six months of 1924 amounted to $47,496,000 as compared with $39,581,000 during the same period in 1923. The value of gold produced was $14,475,000, an increase of $3,511,000 and the silver production amounted to $5,881,000, an increase of $74,000. The value of nickel showed an increase of $1,789,000, whilst that of lead was $6,278,000, an increase of $2,700,000.

Physics and Chemistry of Paints and Varnish

The study of the fundamental principles at the basis of any manufacture has always proved valuable in helping progress in the industry. Organised consideration of the scientific basis of paint and varnish technology has not been conspicuous, however, in this country, though, in the United States, the U.S. Paint Manufacturers' Association has established an energetic and prolific research department. It is, therefore, of interest to call attention to the course of lectures on the above subject (which also includes synthetic resins), which are to be given at the Battersea Polytechnic by Mr. A. A. Drummond, M.Sc. The Principal of the Polytechnic, Dr. R. H. Pickard, D.Sc., F.R.S., states that the lectures are designed to indicate the lines along which scientific development is being made and the many openings for further investigation. Such a course is well worth attention by young technologists engaged in the industry and should provide a valuable stimulus to progress.

The Action of Light on the Photographic Plate

Dr. T. Slater Price, O.B.E., F.R.S., addressed the Chemistry Section of the Leicester Literary and Philosophical Society, on December 3, at the Museum, Leicester. He gave a brief account of the main principles of the "Action of Light upon the Photographic Plate," illustrated by experiments and lantern slides, and then proceeded to describe the recent work of his own Research Association and of others. Mr. Hubert Pooley, M.Inst.C.E., presided. A short discussion followed.

Research in Cotton

On December 3 the foundation stone of the Technological Research Laboratory at Bombay was laid, and the Viceroy also opened the spinning-plant of the Indian Central Cotton Committee. This function marks an important development in the Indian cotton industry and it is difficult to over-estimate the value of the new laboratory to India. Properly controlled spinning tests will be undertaken for the Agricultural Departments, and the laboratory will also arrange for full-scale mill-trials before new cottons are brought into general cultivation The Research Laboratory thus formed will be the only one in the world concentrating on the improvement of raw material and the investigation of the growers' needs.

Knecht Testimonial Fund

In view of the great service rendered by Prof. E. Knecht, Ph.D., M.Sc., to the Society of Dyers and Colourists over the long period of forty-two years, for forty of which he was Foreign Editor of that Society's Journal, it has been decided that a testimonial should be presented to him. Those desirous of taking part should send their donations to the "Knecht Testimonal Fund," addressed to the Secretary of the Society of Dyers and Colourists, 30, Pearl Assurance Buildings, Bradford.

"Rayon" the New Name for Artificial Silk

The Council of the Silk Association of Great Britain and Ireland has approved the adoption of the word "Rayon" in place of the name, "Artificial Silk." The object is to eliminate the word "silk," and ensure the use of "Rayon" as a descriptive term for all classes of artificial silk, so that "Rayon Silk" would be incorrect. The word "Rayon" has already been largely adopted in the United States by representative organisations in the trade.

REVIEWS

The Extra Pharmacopœia. Vol. I. By W. Harrison Martindale, Ph.D., F.C.S., and W. Wynn Westcott, M.B., D.P.H. 18th Edition. Pp. xxxviii+1163. London: H. K. Lewis and Co., Ltd, 1924. Price 27s. 6d. net.

For the most recent information on drugs and medicinal preparations the pharmacist and the medical man have for many years found "The Extra Pharmacopœia" a safe and reliable book of reference, and the latest edition fully maintains its reputation. It is four years since the previous edition was published, and during that time much important work has been done in medical science. New methods of treatment are described under such headings as Colloidal Metals, Endocrinology, Insulin, Accessory Food Factors, Vaccines, etc. The information supplied is concise, thoroughly up-to-date, and includes a very large number of recent medical references which form one of the features of the book.

To the analyst concerned in the examination of foods and drugs, and to the consulting chemist when confronted with problems connected with pharmaceutical chemistry, this volume is especially valuable. It contains a vast amount of practical information based on the authors' own experiences and research, not only on processes of manufacture of medicinal substances, but also on clinical tests—the excellent summary of the Poisons Regulations and the intricacies of the Dangerous Drugs Acts constitutes an authoritative guide to the pharmacist. Every preparation which falls within the Poison Schedule or is classified as a "dangerous drug" is marked with a special sign throughout the book.

A few of the important new features deserve special comment. The authors have conducted a series of experiments on the preparation of tinctures and spirits of official drugs using isopropyl alcohol in place of ethylic alcohol, and have come to the conclusion that isopropyl alcohol is equally suitable for the extraction of such drugs as belladonna, benzoin, calumba, capsicum, cinchona, henbane and nux vomica. Although isopropyl alcohol is more toxic than ethylic alcohol, its use for medicinal tinctures, the dose for which is comparatively small and usually well diluted, is well worth consideration. For hair lotions, skin lotions and toilet preparations for which methylated spirit is unsuitable, isopropyl alcohol has been proved to be eminently satisfactory.

Activated alkaloids, in which the addition of an alkali is found to produce enhanced physiological effects, form the subject of a new chapter. Alkaloidal periodides have also received experimental treatment, both chemically and physiologically, at the hands of the authors, and their results are published exclusively in this addition. Arsenobenzol, the British equivalent of salvarsan, and the newest methods of administration are fully described, and many recent medical references are given.

Cocain and synthetic substitutes for local anæsthesia are fully dealt with, and details of their application are included. Under colloidal metals, the newest additions are described, with recent reports on the use of colloidal gold in neurasthenia, alcoholism and the morphia habit.

Emetine and its compounds, now largely employed in amœbic dysentery, have been given due prominence. In the chapter on nutriments, the accumulated knowledge derived from many original contributions on accessory food factors has been carefully abstracted and condensed. The effects of aeration, oxidation, pasteurisation and excessive heat on food products are clearly shown.

The subject of insulin, which has been prominently before the public during the last few years, is dealt with in about eight pages, its manufacture, distribution in nature, technique of injection, chemical examination, effects of excessive dose, etc., being fully discussed.

Under Endocrinology, new methods of treatment with animal substances, notably pituitary, thyroid, parathyroid and suprarenal glands are commented on, accompanied by notes on the manufacture and standardisation of their active principles and their physiological effects.

The section on vaccines and antitoxins occupies some seventy-five pages, illustrating the growing importance of this realm of medical treatment, notably in asthma, bronchitis, cholera, diphtheria, d[illegible] tuberculosis, typhoid and small-pox.

The enormous variety of drugs and pre[illegible] referred to in this minature pocket volum[illegible] to impress upon the reader the immens[illegible] ties of the present-day pharmacist. [illegible] tindale" is of incalculable value as a [illegible] and a veritable mine of information [illegible] the preface remind the physician "t[illegible] take exception to a chemist commun[illegible] on matters of doubt relating to presc[illegible] like. Therapy to-day is so extremel[illegible] complex that it is only by careful co-ope[illegible]on and mutual good will that mistakes can be c[illegible]ed and dire consequences be prevented." They plead also to the practitioner to help forward British industry, and ask medical men to assist the English chemical worker to their utmost. The compilers are to be congratulated on the production of a work well abreast of the times and meriting the highest praise.

C. T. Bennett

A System of Physical Chemistry. By W. C. McC. Lewis. Vol. III. The Quantum Theory. Pp. x+407. London: Longmans, Green and Co., 1924. Third edition. Price 15s.

During the last few years many books have been published on the quantum theory. This does not, however, make the third edition of Prof. Lewis's work less acceptable. The book contains a large amount of matter and gives quite clearly and definitely the principles of the application of the quantum theory to many phenomena.

The theory is introduced through a discussion of the problem of radiation in thermodynamic equilibrium. It is shown that classical statistical mechanics leads to a result not in agreement with experiment. Planck's conception of energy-quanta is then given, and the correct law deduced.

An account is given of the application of quantum principles to various problems, such as the energy

content of solids and of gases, thermionics, contact potential, the photoelectric effects, photochemical reaction and Nernst's heat-theorem. A long chapter (Chapter V) deals with the various theories of the structure of the atom, especially the theories of Bohr and Langmuir, which are given in some detail. The application of the Quantum Theory to matter in bulk is discussed in Chapter VIII, which deals with the theory of the ionic lattice and the molecular lattice. The volume has eight appendices, by various writers. These consist in general of a formal development of points in the theory which could not conveniently be treated in the text.

Whilst being mainly theoretical, the book contains an account of the principles of the fundamental experimental work, such as that of Nernst on the specific heat of solids, and the classical determination of Planck's constant by Millikan.

Altogether the book may be considered as a very useful addition to the literature on the subject. The theory is not yet by any means complete; quantum principles have been successfully applied, either partially or wholly, to a large number of problems, but progress is slow in the absence of precise ideas as to the true significance of the discontinuities involved. Each partial application meets with striking successes, and difficulties no less striking, and each reveals a separate aspect of the central problem, which itself remains unsolved. It is this difficulty which the author has had to encounter; he has tried to give as ordered an account as possible of the theory in its present incomplete state, and he may be congratulated on having achieved so much.

There are a few misprints in the book, but these are of a trivial nature, and the book is otherwise well printed and appears to be free from any serious errors. Diagrams are inserted wherever necessary, and these are invariably clearly drawn and of sufficient size.

The writer has no hesitation in saying that the work should prove of great value to all serious students of chemistry and physics. As a volume of a system of physical chemistry, it is written from a chemical point of view, but this should not make it less valuable to physicists. G. ERIC BELL

PHYSICAL AND PHYSICO-CHEMICAL PROBLEMS RELATING TO TEXTILE FIBRES. Reprinted from the Transactions of the Faraday Society. No. 59, vol. 20. Part II, 1924. Price 7s. 6d.

This is an account of a general discussion held by the Faraday Society and the Textile Institute at Wembley in June. The first impression one gets in perusing this volume is that the textile industry is now receiving the full searchlight of science. Previously it was mentioned that all branches of the industry were founded on what is generally called "rule of thumb" or "empiricism," and that these methods held sway until quite recent times. But this statement is difficult to maintain, for a century ago some quite distinguished scientists were engaged in the industry, and at all times textiles seem to have attracted as many men versed in scientific methods as other industries have. It is true that the results of scientific investigations in the industry have not always found publication, for the simple reason that nothing was to be gained by the broadcasting of information of industrial importance. But now we are living in another age, and many old business men are wondering what is to be the outcome of the spreading of this information. Certainly an enormous amount of work is being done, and those engaged in industry find it difficult to assimilate all the information and apply it to industrial use.

The introductory address at the Conference was given by Dr. W. L. Balls, in which he surveyed the field of research. He regards physics as the pivotal subject for industrial research in the textile industries during the next half-century. Most of the faults in cotton yarns to-day were faults intrinsic in the physical properties of the raw materials. When an industry was changing its technique, as the electrical industry always was, and the textile industry was now beginning to do, the scientist's place was very different from what it was in a stable industry, and the main reason why a scientist could be useful to an unstable industry was that the practical man took a very long time to get the answer in experimental work. Dr. Alexander Scott showed some slides of linen used in the shroud of Tut-ankh-Amen, and Dr. S. A. Shorter read a paper on the physical properties of textile fibres in relation to technical processes, emphasising the importance of the absorption of moisture by fibres and their elastic properties. He discussed some observations in the light of the theory of the colloid structure of fibres. Dr. T. Barratt gave measurements of the transparency of a fabric and of the lustre produced during mercerisation. The transparency of a fabric may be increased 30 per cent. by mercerisation, and the amount of light reflected from a mercerised cloth is less than from the unmercerised. A careful examination of a well-mercerised fabric will show a distribution of very bright and very dull points, the amount of reflected light being usually rather less than from the more uniformly lighted surface of an unmercerised fabric. This latter fact is due to the greater transparency of the mercerised fabric and the consequent loss of reflected light.

Some structural characters of the flax fibre were discussed by C. R. Nodder and properties of the silk fibre by Dr. W. S. Denham. Other papers are "The Fibre Balance," by Dr. T. Barratt; "The Action of Light on Textiles," by Dr. G. Barr; "Aircraft Fabrics," by Dr. J. E. Ramsbottom; "Recent Advances in the Experimental Study of Warp Dyeing," by F. D. Farrow; "A review of work on the Absorption and Desorption of moisture by Textile Materials," by A. K. Urquhart and A. M. Williams; and "The Function of Water in the Web Spinning of Flax," by Dr. W. H. Gibson. In some cases the papers were résumés of work previously published and abstracted in this Journal. A full account of the discussions which took place on the papers is given. The Faraday Society is performing very useful work in publishing such reports of its discussions.

COMPANY NEWS

CASSEL CYANIDE CO., LTD.

Colonel Sir Edward A. Brotherton, chairman of Brotherton and Co., Ltd., who has been elected chairman of the Cassel Cyanide Co., Ltd., in place of the late Sir George Beilby, presided over the ordinary general meeting, held in Glasgow, on December 10. The chairman referred to the death of Sir George Beilby, whose connexion with the company extended over thirty-two years, during which he rendered incalculable service to the company and to the cyanide industry, as well as to science and education generally. In moving approval of the annual report (*cf. Chem and Ind.*, Dec. 5, p. 1216), the chairman said that the demand for cyanide during the year was fairly satisfactory, and sales were well maintained in spite of active competition. Selling prices, however, suffered a further reduction, and they could look for no stability in this direction until a lower level was reached, although their product was already selling at less than pre-war prices. The company had been working during the past year on new processes of manufacture with a view to lowering production costs. Patents had now been issued and published, and covered quite a revolutionary process for the manufacture of metallic sodium, which was the base for the production of high-grade sodium cyanide. Their chief chemist, Dr. Ewan, was the inventor. The report was adopted.

POWER-GAS CORPORATION, LTD.

The twenty-fourth ordinary general meeting was held on December 10, Mr. E. Lloyd Pease (chairman) presiding. Although adverse conditions of trade still continued, important orders from all parts of the world had been received for the Corporation's specialities for the production of gas for heating and power, water gas and town gas, and the number of orders booked during the past financial year were considerably in excess of those of previous years. All the plants had given great satisfaction, and it was expected that a growing market would be found for these specialities. The Corporation owned all the shares in Ashmore Benson Pease and Co., Ltd., established about fifty years ago, at Stockton-on-Tees, for the manufacture of gasworks plant and general engineering work, but during the past year had derived no profits from this company, as, although it had secured a larger volume of orders, the prices obtained were unprofitable. After allocating £2000 to the reserve fund from the total profit of £23,267 (which included £11,070 brought forward), there was a balance of £21,267, which it was proposed to carry forward. It was considered that the interests of the company would not be served by making a distribution of profits this year, although it would be the first time for fourteen years that no dividend had been paid.

GENERAL PETROLEUM COMPANY OF TRINIDAD

In order to provide further working capital, the directors have decided to recommend the reconstruction of the company. They propose to form a new company with a capital of £400,000 in 2,000,000 shares of 4s., which will take over the whole of the assets of the present company in consideration for the payment of the liabilities of the present company and the allotment of 1,682,045 shares credited 2s. paid. Each "A" shareholder will be entitled to one share for every "A" share held, and each "B" shareholder one share for every two held, the new shares to be payable 6d. per share on application and the balance by instalments of 6d. per share, payable in March, May and July. The issue of the 1,682,045 shares will provide £168,204, and the subscription has been guaranteed in consideration of an underwriting commission of 7½ per cent. and an overriding commission of 2½ per cent.

BRITISH BURMAH PETROLEUM CO.

The report for the year ended July 31 showed a balance from revenue account of £195,079 (£224,253 last year), and a total credit of £219,273 including interest, dividends, etc. (£250,282 last year). After deducting expenditure, interest on debenture stocks and depreciation, there is a net surplus of £52,098 (£73,530). After adding £2916 balance brought in, £5810 surplus on realisations of investments, and £16,760 refund in respect of taxes, a total credit of £77,585 is shown (£152,849). The directors state that the reduction in profits is mainly due to the continued fall in the prices received for benzine, and do not consider that the profit earned is sufficient for the payment of a dividend. A more satisfactory result is anticipated this year, owing to higher extraction of products at the refinery, combined with further substantial reductions in working costs.

BRUNNER, MOND AND CO., LTD.

The shareholders of this company have been invited by the directors to subscribe to an unadvertised issue of 175,000 7½ per cent. cumulative preference shares at par in the Madeley Collieries, formed to acquire for £350,000 a certain colliery and brick works situated near Madeley, Staffordshire. Half the ordinary shares of the Madeley Co. are held by Brunner Mond and Co. The purchase price is to be paid half in cash and half in ordinary shares.

BRITISH PLATINUM AND GOLD CORPORATION

The accounts for the year ended July 31, 1924, show a net profit of £49,985, compared with £33,385 for the previous year, the amount to be carried forward being £51,583, as against £18,198. The directors have recommended a final dividend of 6d. per share, less tax, making 1s. 6d. per share for the year.

RUTHS STEAM ACCUMULATOR CO., LTD.

The controlling interest in the Ruths Steam Accumulator Co., Ltd., has been acquired by the Fairfield Shipbuilding and Engineering Co., Ltd., and James Howden and Co., Ltd., of Glasgow. The company was formed in April last for the purpose of marketing in the British Empire the steam accumulator invented by Dr. J. Ruths of Stockholm. A great deal of interest has been shown by technical firms in this country in the application of the accumulator in industrial plants, as it has been found that very large economies, together with increased production, are secured when the plant is installed in technical works.

By the terms of the licence all plants will be made in this country, and it is anticipated that considerable output will be secured. Three directors of each of the above companies will be on the board of the company, and Sir Alexander Kennedy, chairman of the Fairfield Shipbuilding and Engineering Co., Ltd., will be chairman.

BOOTS PURE DRUG CO.

An interim dividend has been declared on the ordinary shares for the quarter ending December 31, 1924, at the rate of 9 per cent., less tax.

UNITED INDIGO AND CHEMICAL CO.

An interim dividend has been declared at the rate of 5 per cent. per annum on the ordinary shares, less tax, payable December 31.

REPORT

Report of Test by the Director of Fuel Research on Parker Low-Temperature Carbonisation Plant installed at Barugh, Barnsley, at the Works of Low-Temperature Carbonisation, Ltd. Department of Scientific and Industrial Research. Pp. iv+24. H.M. Stationery Office, 1924. Price 9d.

This report describes a test carried out from July 22 24, 1924. The installation consisted of two settings of 32 retorts each, each setting being designed to carbonise 50 tons of coal per 24 hours. After briefly describing the plant and its operation, the report deals with the arrangements for and the conditions of the test. The coal used was Dalton Main, a medium caking coal, in the form of washed breeze up to half-inch pieces. The coal was clean, and of uniform quality. A weight balance was found to show a loss of 0·48 per cent., and this, in conjunction with the thermal balance loss of 5·2 per cent., is considered satisfactory. A complete examination of the products of carbonisation was carried out at the Research Station, details of which are included in the Report. The yields of products per ton of coal were as follows: Coke, 13·92 cwt.; gas, 5620 cb. ft. or 39·6 therms.; tar, 18·62 galls.; liquor, 26·00 galls.; crude spirit, 1·78 galls.; and ammonium sulphate, 13·55 lb.

The coke or smokeless fuel was of good quality, and the yields of tar, gas, and ammonia were high; the ammonia liquor was dilute (under 6 oz. strength), and the advisability of recovery is questioned. Spirit obtained by scrubbing the coal gas amounted to 1·78 galls. per ton of coal.

Details are also given of the working operations, of the labour and power required and of a variety of points in the handling of the setting. The temperature of carbonisation was not uniform throughout the setting, varying from 600° C. to as high as 800° C. Suggestions are given for the improvement of temperature control, as the 83·5 therms consumed per hour could be reduced considerably.

In an appendix the conditions are set out under which official tests are made of plants for the low-temperature carbonisation of coal.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£21 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder..	£47 per ton.
Acid Hydrochloric ..	3s. 6d.–6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali.. ..	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 10s. per ton, packages extra.
Borax, Commercial—	
Crystal..	£25 per ton.
Powder..	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride (Solid)..	£5 12s. 6d. to £5 17s. 6d. per ton, carriage paid.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate	} £38 per ton d/d. Normal business.
Nickel Ammon. Sulphate	}
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¾d. per lb.
Potass. Chlorate.. ..	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake..	£3 10s. per ton d/d.
Soda Caustic, solid ..	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5–£5 5s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate (refined)	£10 10s. per ton, carr. paid.
Sod. Bichromate.. ..	4¼d. per lb.
Sod. Bisulphite Powder 60/62%..	£17–£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. solid 60/65	About £15 per ton d/d.
Sod. Sulphide cryst. ..	£9 5s. per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	6½d.—1s. 2d. per lb., according to quality.

Antimony sulphide—	
Crimson	1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes White and Dark	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P.	£50—£65 per ton, according to quantity.
Sulphur Chloride	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£11 5s. per ton, and upwards.
Grey	£14 10s.—£15 per ton. Firmer.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand brisker in many localities.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 9d. per gall. 60% O.P.
Solvent	5s.—5s. 3d. per gall. 40% O.P. Firmer.
Wood Tar	£4 10s.—£5 10s. per ton. Demand slack and stocks being held.
Brown Sugar of Lead	£42 per ton. Steady market.

TAR PRODUCTS

Acid Carbolic—	
Crystals	5¾d. per lb. Quiet.
Crude 60's	1s. 7d.—1s. 9d. per gall. Market quiet.
Acid Cresylic, 97/99	1s. 11d.—2s. 1d. per gall. Fair business.
Pale 95%	1s. 8d.—1s. 11d. per gall. Not much business.
Dark	1s. 7d.—1s. 9d. per gall. Market dull.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6½d.—7½d. per gall. Small demand
Unstrained	6d.—6½d. per gall.
Benzole—	Prices advanced; supplies very scarce.
Crude 65's	9d.—11½d. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 9½d.—1s. 11d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d.—1s. 7d. per gall. More inquiry.
Toluole—Pure	1s. 7½d.—1s. 9d. per gall. Steady demand.
Xylol—Coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	8d.—8½d. per gall. Not much business.
Middle Oil / Heavy Oil / Standard Specification	5¼d.—6½d. per gall., according to quality and district. Market firmer. Steady demand.
Naphtha—	
Solvent 90/160	1s. 3d.—1s. 6d. per gall. Demand good. Market very firm.
Solvent 90/190	1s.—1s. 1d. per gall. Few inquiries.
Naphthalene Crude—	Cheaper in Yorkshire than Lancashire. Demand rather better.
Drained Creosote Salts	£3—£5 per ton. Steady but quiet.
Whizzed or hot pressed	£6—£9 per ton. No business.
Naphthalene—	
Crystals and Flaked	£12—£15 per ton, according to district.
Pitch, medium soft	50s.—60s. per ton, according to district. Plenty of inquiry for prompt and forward. Market very steady.
Pyridine—90/160	18s. 6d.—19s. per gall. Few inquiries.
Heavy	11s. 6d.—12s. per gall. Rather flat.

INTERMEDIATES AND DYES

Business in dyestuffs has been maintained but without further improvement.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb. naked.
Acid H.	3s. 10d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid, Salicylic, tech.	1s. 0½d.—1s. 1d. per lb.
Acid Sulphanilic	9d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	10d. per lb. d/d.
Aniline Oil	8d. per lb. naked at works.
Aniline Salts	8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	3s. 10d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chloraniline	3s. per lb. 100% basis.
p-Chlorphenol	4s. 3d. per lb. d/d.
o-Cresol 29/31° C.	3½d.—4d. per lb. Fair demand.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	2s. 3d. per lb.
Dichloraniline S. Acid	2s. 3d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 3d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 2½d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
G. Salt.	2s. 3d. per lb. 100% basis d/d.
Monochlorbenzol	£63 per ton.
α-Naphthol	2s. 4d. per lb. d/d.
β-Naphthol	1s. per lb. d/d.
α- Naphthylamine	1s. 3½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.

m-Nitraniline	4s. 2½d. per lb. d/d.
p-Nitraniline	2s. 2½d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. 3d. per lb d/d.
Nitronaphthalene	10d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	4s.. per lb. d/d.
p-Phenylene Diamine	10s. per lb. 100% basis d/d.
R. Salt	2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 2d. per lb. 100% basis d/d.
o-Toluidine	10d. per lb. naked at works.
p-Toluidine	2s. 10d. per lb. naked at works.
m-Toluylene Diamine	4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£45 per ton, ex wharf London, in glass containers.
Acid, Acetyl Salicylic	3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P.	2s. 6d. per lb.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 4½d. per lb. Increased demand.
Acid, Gallic	2s. 9d. per lb. for pure crystal in cwt. lots. Easier.
Acid, Pyrogallic, Cryst.	7s. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	1s. 6d.—1s. 8d. per lb., according to quantity.
Acid, Tannic B.P.	2s. 10d. per lb. Quiet steady demand.
Acid, Tartaric	1s. 1d. per lb., less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	1s. 10d.—2s. per lb. More enquiry.
Amidopyrin	14s. 6d. per lb.
Ammon. Benzoate	3s. 3d.—3s. 9d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	13s. 9d. per lb. Slightly lower. Quiet steady demand.
Benzonaphthol	5s. 3d. per lb. spot.
Bismuth Carbonate	8s. 6d.—10s. 6d. per lb.
„ Citrate	8s. 6d.—10s. 6d. „
„ Salicylate	8s. 0d.—10s. 0d. „
„ Subnitrate	7s. 7d.—9s. 7d. „ According to quantity. Prices recently reduced.
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Market less firm. Prices uncertain.
Ammonium	2s. 1d. per lb.
Potassium	1s. 10d. per lb.
Sodium	1s. 11d. per lb.
Calcium Lactate	1s. 6d.—1s. 8d. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate	4s. per lb.
Chloroform	2s. 6d. per lb. for cwt. lots.
Formaldehyde	£48—£49 per ton in barrels, ex wharf London. Supplies exceed demand.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	7s. per lb.
Iron	8s. 9d. per lb.
Glycerophosphates—	
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. „
Guaiacol Carbonate	9s. per lb. Reduced in price.
Hexamine	3s. per lb. for bold crystal. Powder slightly less.
Homatropine Hydrobromide	25s.—30s. per oz.
Hydrastine hydrochlor	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. „
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb. Price recently reduced.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Light, pure	£46 per ton.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£25 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	57s. per lb. for December delivery.
Synthetic	26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials	Market very quiet. Mercury slightly firmer.
Red oxide	5s. 2d.—5s. 4d. per lb.
Corrosive sublimate	3s. 5d.—3s. 7d. „
White precip.	4s. 6d.—4s. 8d. „
Calomel	3s. 10d.—4s. „
Methyl Salicylate	1s. 9d.—2s. per lb.
Methyl Sulphonal	22s. per lb. Slightly weaker.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 8d. per lb. for B.P. quality.
Paraldehyde	1s. 2d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin	5s. 6d. per lb.
Phenazone	6s. per lb.
Phenolphthalein	5s. 3d. per lb. for cwt. lots. Again lower in absence of active buying.
Potass. Bitartrate— 99/100% (Cream of Tartar)	86s. per cwt., less 2½% for ton lots.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Ferricyanide	1s. 9d. per lb. Quiet.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	7½d. per lb. spot. Forward prices higher.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. per lb. in fair quantities. Supplies exceed demand.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. per lb. for cwt. lots. Slightly lower. Limited demand.
Silver Proteinate	9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P.	2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite— Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.

Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash. according to quantity.	
Sod. Nitroprusside ..	16s. per lb.	
Sod. Potass. Tartrate (Rochelle Salt) ..	75s.—82s. 6d. per cwt., according to quantity.	Quiet market.
Sod. Salicylate	Powder 2s. 1d.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 4d. per lb. Flake 2s. 6d. per lb.	Strong demand. Market firm.
Sod. Sulphide—		
Pure recryst.	10d.—1s. 2d. per lb.	
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.	
Sulphonal..	14s. 6d. per lb.	Little demand.
Thymol	18s. per lb.	

PERFUMERY CHEMICALS

Acetophenone	11s.	per lb.	Cheaper.
Aubepine	12s. 6d.	per lb.	Cheaper.
Amyl Acetate	3s.	,,	
Amyl Butyrate	6s. 6d.	,,	
Amyl Salicylate	3s. 3d.	,,	
Anethol (M.P. 21/22° C.)	4s. 6d.	,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d.	,,	
Benzyl Alcohol free from Chlorine	2s. 9d.	,,	
Benzaldehyde free from Chlorine	3s. 3d.	,,	
Benzyl Benzoate.. ..	3s. 6d.	,,	
Cinnamic Aldehyde— Natural..	18s. 6d.	,,	
Coumarin	17s. 3d.	,,	Again cheaper.
Citonellol	20s.	,,	
Citral	9s.	,,	Dearer.
Ethyl Cinnamate ..	12s. 6d.	,,	
Ethyl Phthalate	3s.	,,	
Eugenol	10s. 6d.	,,	
Geraniol (Palmarosa) ..	33s. 6d.	,,	
Geraniol	12s. 6d.—20s.	per lb.	
Heliotropine	6s. 9d.	per lb.	
Iso Eugenol	16s.	,,	
Linalol ex Bois de Rose..	26s.	,,	
Linalyl Acetate	26s.	,,	
Methyl Anthranilate ..	10s.	,,	
Methyl Benzoate.. ..	5s.	,,	
Musk Ambrette	50s.	,,	
Musk Xylol	14s.	,,	
Nerolin	4s. 6d.	,,	
Phenyl Ethyl Acetate ..	15s. 6d.	,,	
Phenyl Ethyl Alcohol ..	15s.	,,	Cheaper.
Rhodinol	50s.	,,	
Safrol	1s. 10d.	,,	
Terpineol	2s. 4d.	,,	
Vanillin	25s.—25s. 6d.	per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	
Anise Oil	2s. 10d. per lb.	
Bergamot Oil	15s. per lb.	Cheaper.
Bourbon Geranium Oil ..	30s. per lb.	
Camphor Oil	65s. per cwt.	
Cananga Oil Java ..	11s. 3d. per lb.	
Cassia Oil, 80/85% ..	9s. 3d. per lb.	Cheaper.
Cinnamon Oil, Leaf ..	6½d. per oz.	
Citronella Oil—		
Java 85/90%	7s. per lb.	
Ceylon	3s. 4d. per lb.	
Clove Oil	8s. 3d. per lb.	
Eucalyptus Oil 70/75% ..	2s. 2d. per lb.	
Lavender Oil—		
French 38/40% Esters	38s. per lb.	
Lemon Oil	3s. 4d. per lb.	Dearer.
Lemongrass Oil	5s. 9d. per lb.	
Orange Oil, Sweet ..	11s. per lb.	
Otto of Rose Oil—		
Bulgarian	42s. 6d. per oz.	
Anatolian	28s. per oz.	
Palma Rosa Oil	17s. per lb.	
Peppermint Oil—		
Wayne County ..	45s. per lb.	
Japanese	23s. 6d. per lb.	
Petitgrain Oil	9s. 9d. per lb.	
Sandal Wood Oil—		
Mysore	26s. 7d. per lb	
Australian	18s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before February 10th, 1925: they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on December 24th.

I.—Applications

Fothergill. Evaporators. 28,792. Dec. 1.

General Electric Co., Ltd., and Goldsmith. Filters. 29,348. Dec. 6.

Imray (Victoria Falls and Transvaal Power Co. and Andrews). Removal of calcium sulphate scale from condenser tubes etc. 28,801. Dec. 1.

McIntyre. Crushing or mixing machines. 28,701. Dec. 1.

Pennell. Filtering-apparatus. 28,800. Dec. 1.

Spangenberg. Separating particles from fluid streams. 28,810. Dec. 1.

Waring. Pulverising or grinding machines. 28,946. Dec. 3.

I.—Complete Specifications Accepted

13,891 (1923). Sauer. Treatment of liquids. (198,373.)

21,496 (1923). Fothergill. Evaporators. (225,271.)

30,282 (1923). Blantyre Engineering Co., Ltd., and Rogerson. *See* II.

31,767 (1923). McEntire. Centrifugal separator. (225,396.)

6394 (1924). Deutsche Ton- und Steinzeugwerke Akt.-Ges. Fine-grinding mills. (212,922.)

II.—Applications

Artificial Coal Co. (Hamon Process), Ltd., and Hamon. Manufacture of decolorising carbon from peat. 28,873. Dec. 2.

Beaudequin. Manufacture of combustible briquettes. 28,908. Dec. 2. (Belgium, 3.12.24.)

Bregeat. Manufacture of highly active carbon etc. 29,294. Dec. 6.

Crozier. Purifying oils. 29,013. Dec. 3.

Thoumyre Fils. Manufacture of combustible agglomerates. 29,100. Dec. 4. (France, 12.3.24.)

Wollaston. Gas-retorts. 28,717. Dec. 1.

II.—Complete Specifications Accepted

23,345 (1923). Bergh. Retort furnaces for treating bituminous materials. (204,067.)

25,854 (1923). Duplan. Furnaces for distillation and carbonisation. (225,337.)

29,940 (1923). Toogood, and Dempster and Sons, Ltd. Heating of horizontal retorts for gas production. (225,377.)

30,282 (1923). Blantyre Engineering Co., Ltd., and Rogerson. Plant for dehydrating coal, sludge, pulp, and the like. (225,379.)

2267 (1924). Brikettharz-Ges. Manufacture of combustible briquettes. (210,458.)

III.—Application

Murphy. 28 974. *See* IX.

III.—Complete Specification Accepted

29,312 (1923). Weil, and Chem. Fabr. in Billwarder. Manufacturing pure carbazol. (225,369.)

IV.—Applications

Farbenfabriken vorm. F. Bayer und Co. Manufacture of monoazo dyes. 29,133. Dec. 4. (Ger., 5.12.23.)

Soc. of Chemical Industry in Basle. Manufacture of dyestuffs. 28,905. Dec. 2. (Switz., 28.12.23.)

V.—Applications

Cross, and Viscose Development Co. Manufacture of cellulose products. 29,328. Dec. 6.

Ingham. Waterproofing paper. 29,079. Dec. 4.

Levy. Apparatus for manufacture of artificial filaments. 29,135. Dec. 4.

Plinatus. Gelatinisation of nitrocellulose etc. 29,110. Dec. 4.

Plinatus. Manufacture of films etc. 29,113. Dec. 4.

Plinatus. Process for dissolving and gelatinising nitrocellulose etc. 29,113, 29,232. Dec. 4 and 5.

V.—Complete Specifications Accepted

19,028 (1923). Lilienfeld. Treatment of textile products containing cotton. (216,477.)

4678 (1924). Jackson (Tubize Artificial Silk Co. of America). Manufacture of artificial silk. (211,889.)

VI.—Application

Testrup and Thomson. Bleaching etc. 29,331. Dec. 6.

VI.—Complete Specification Accepted

15,278 (1924). Schlumpf. Dyeing and washing textile material. (218,296.)

VII.—Applications

Carpmael (Farbenfabriken vorm F. Bayer und Co.). Manufacture of sulphuric acid. 29,247. Dec. 5.

Du Faur. Recovery of hydrated oxides of iron and calcium sulphate from sulphate solutions etc. 28,993. Dec. 3. (Australia, 21.1.24.)

General Chemical Co. Manufacture of contact sulphuric acid. 28,887. Dec. 2. (U.S., 21.12.23.)

Haglund. Treatment of raw materials containing highly refractory oxide. 29,035. Dec. 3. (Austria, 17.4.24.)

Phillips. Production of diamonds from amorphous carbon. 28,830. Dec. 2.

Plauson (née Hildenbrandt). Manufacture of nitrogen compounds. 28,734, 28,735, 28,736. Dec. 1.

Soc L'Air Liquide. Extraction of krypton and xenon from the air. 28,759. Dec. 1. (Fr., 19.1.24.)

VII.—Complete Specifications Accepted

21,008 (1923). Redfern (Pintsch Akt.-Ges.). Process for obtaining nitric oxide. (225,263.)

29,774 (1923). Pipereaut and Helbronner. Manufacture of titanic and zinc compounds. (207,555.)

31,634 (1923). Kidd. Production of soda crystals. (225,393.)

874 (1924). Deutsche Celluloid Fabrik. Recovering nitric acid from weak nitric acid liquors. (217,546.)

13,925 (1924). Soc. Anon. D'Eclairage et D'Applications Electriques. Extracting krypton and xenon from the atmosphere. (218,266.)

VIII.—Application

Deutsch-Luxemburgische Bergwerks- und Hütten Akt.-Ges. Manufacture of magnesite blocks. 29,234. Dec. 5. (Ger., 16.1.24.)

X.—Applications

Bureau d'Organisation Economique and Soc. des Ciments Français. Manufacture of fused cement. 29,048. Dec. 4. (Fr., 4.12.23.)

Murphy. Soluble tar etc. compound for roads etc. 28,974. Dec. 3.

Plinatus. Cement or adhesive compositions. 29,111. Dec. 4.

Plinatus. Packing and insulating materials. 29,112. Dec. 4.

Rigby. Manufacture of cement. 28,934, 29,148. Dec. 3 and 5.

X.—Applications

Allen. Treating metal surfaces. 29,070. Dec. 4.

Barrott Co. Treating non-ferrous metals. 29,312. Dec. 6. (U.S., 7.12.23.)

Cachemaille (Westinghouse Lamp Co.). Manufacture of refractory metals. 28,785. Dec. 1.

Curtius und Co. Treatment of cupriferous pyrites. 29,011. Dec. 3. (Ger., 10.3.24.)

Haglund. 29,035. *See* VII.

Speck. Annealing etc. furnaces. 29,057. Dec. 4.

Talbot. Metallurgical furnaces. 29,215, 29,216. Dec. 5.

Western Electric Co., Ltd. (Western Electric Co., Inc.). Metallic materials. 29,031, 29,032. Dec. 3.

X.—Complete Specifications Accepted

21,927 (1923). Constant and Bruzac. Reduction of metal oxides. (225,295.)

2205 (1924). Sankey and Sons, Ltd., and Martin. Pickling stainless iron and steel. (225,416.)

18,185 (1924). Lawson. Soldering-metal. (225,484.)

XI—Applications

Automatic Telephone Manufacturing Co., Ltd., and Hudd. Electrolytic cells. 29,106. Dec. 4.

Lewis. Electric accumulators. 28,850. Dec. 2.

Oldham, and Oldham and Son, Ltd. Accumulator plates etc. 28,784. Dec. 1.

Plinatus. 29,112. *See* IX.

Vignon. Dry cells etc. 29,016. Dec. 3.

XI.—Complete Specifications Accepted

25,716 (1923). Oldham and Son, Ltd., and Wilde. Galvanic batteries. (225,334.)

463 (1924). Weissman. Bipolar agglomerate for electric cells. (225,407.)

10,456 (1924). Soc. D'Etudes et de Constructions Metallurgiques. Electric arc furnaces. (225,458.)

XII.—Applications

Crozier. 29,013. *See* II.

Fulton and Hutton. Manufacture of detergents. 29,301, 29,302. Dec. 6.

Spearing. Soaps. 29,146. Dec. 5.

XIII.—Application

British Cyanides Co., Ltd., and Rossiter. Manufacture of artificial resins. 29,246. Dec. 5.

XIV.—Applications

Clarke. Rubber preservative. 28,740. Dec. 1.

Smith. Vulcanisation of rubber. 29,219. Dec. 5. (Italy, 6.12.23.)

XV.—Complete Specification Accepted

11,064 (1924). Schmid and Luttig. Treatment of hides and skins. (225,460.)

XVII.—Complete Specification Accepted

8901 (1924). Burmat. Treatment of bagasse. (225,449.)

XVIII.—Complete Specification Accepted

14,050 (1923). Jensen (Fleischmann Co.). Manufacture of yeast. (225,252.)

XIX.—Applications

Crosfield and Sons, Ltd , Hilditch, and Wheaton. Purifying or softening water etc. 28,773. Dec. 1.

Hartley. Purification of sewage. 28,696. Dec. 1.

Hartley. Purification of sewage. 28,842. Dec. 2.

XIX.—Complete Specifications Accepted

19,829 (1923). British Dyestuffs Corp., Ltd., and Lefebure. Insecticides and the like. (225,262.)

25,321 (1923). Hart. Purification of semolina middlings and other milling products of wheat. (225,331.)

XX.—Applications

British Cyanides Co., Ltd., and Rossiter. Preparation of thiocarbamide. 29,245. Dec. 5.

Farbwerke vorm Meister, Lucius, und Bruning. Manufacture of complex gold compounds. 29,329. Dec. 6. (Ger., 7.12.23.)

Ikeda. Manufacture of glutamic acid and salts thereof. 28,990. Dec. 3.

Rheinische Kampfer Fabrik Ges. Production of inactive menthol. 28,811. Dec. 1. (Ger., 4.4.24.)

XXII.—Applications

Plinatus. 29,110. *See* V.
Plinatus. 29,232. *See* V.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*Austria*: Hardware, tinplate (604); *China, Japan and Siam*: Chemicals, oils, photographic materials (626); *Egypt*: Palm oil soap (Inspecting Engineer, Egyptian Government, Queen Anne's Chambers, London, S.W. 1) (Muh., 1924/74/6); *Mexico*: Paints (B.X./1378); *Netherland East Indies*: Oils, soap, perfumery, paint, varnish, glass, enamelware (628); *New Zealand*: Steel (599); *Norway*: Galvanised corrugated sheets (616); *Sweden*: Copper, tin, lead, zinc (619); *Switzerland*: Oils (622); *Turkey*: Paint (625).

Output and Consumption of Coal in India, 1923

The total production of coal in 1923 amounted to 19,658,000 tons, which is 647,000 t. or 3·4 per cent. more than in 1922, but about 3,000,000 t. less than the record output in 1919. To this may be added some 393,000 t. estimated to have been taken out from mines by miners for their own use, making the total production in 1923, 20,051,000 t. There was an increase in the output of coal in all the provinces except the Central Provinces, Assam, Baluchistan, the Punjab and Rajputana, and for the first time the Talcher coalfield in Bihar and Orissa during the year under review turned out 4800 t., of good steam coal. Of the coal supplies of India, 98 per cent. are obtained from the Gondwana coalfields and 2 per cent. from Tertiary beds. The total estimated value of the output in 1923 was Rs. 14,61 lakhs. Owing to the fact that the coal in India which is now being worked is comparatively near the surface, and labour comparatively cheaper, Indian coal has a lower value at the pit's mouth than that of any other country except South Africa. In 1923, 200,918 persons were employed in the mining industry in India, a figure practically the same as in the preceding year. Imports of coal during the year fell to 625,000 t., compared with 1,221,000 t. the previous year, and the exports, 88 per cent. of which went to Ceylon and 11 per cent. to the Strait Settlements, amounted to 136,600 t. as against 77,100 t., in 1922, and 275,600 t. in 1921. The estimated consumption of Indian and foreign coal in 1923 was 20,100,000 t.

British Petrol

A new refinery for the production of B.P. motor spirit has been established at Grangemouth by Scottish Oils, Ltd. For the last five years the Scottish industry has supplemented its supplies of crude shale oil by refining crude petroleum imported from Persia, and this operation is at present being carried on very successfully in one of the shale-oil refineries set free for the purpose, and also in the large new refinery at Grangemouth.

Foreign Company News

The manufacture of phosphazote by the Société des produits chimiques de l'Artois has begun, and the Société des produits Azotés has formed, with this company and the Société Malétra, an association for the study of nitrogen and its derivatives. Next spring, the Artois and Malétra companies will absorb 15,000 metric tons of cyanamide, and will produce roughly double the quantity of phosphazote.

The group formed by the Viscose and the Kuhlmann Companies is studying the manufacture of artificial wool, the object being to treat cotton so as to give it some of the qualities of wool. When the process has been perfected, the group will probably form a company to work it.

Notes on Plant and Products

Messrs. Vickers and International Combustion Engineering have received the following orders:—A complete boiler-house equipment, to include two water-tube boilers fired with pulverised fuel, this being the first section of a plant which will eventually be six times the size; pulverised fuel plant for St. Pancras for firing two boilers of the Vickers Spearing type with Lopulco equipment; and pulverised coal equipment for the new cement-manufacturing plant at Holborough, in Kent.

PUBLICATIONS RECEIVED

Cane Sugar and Its Manufacture. By H. C. Prinsen Geerligs, Ph.D. Second revised edition. Pp. ix+342. London: Norman Rodger, 1924. Price 20s.

The Electrolytic Theory of Corrosion. By Wilder D. Bancroft. Pp. 785-871. Reprinted from The Journal of Physical Chemistry, Vol. xxviii. August, 1924.

The Influence of the Ingestion of Potassium Chlorate, Sodium Chloride and Water on the Oxygen Capacity of the Blood. By Victor Ross. Pp. 2. Reprinted from the Proceedings of the Society for Experimental Biology and Medicine, 1924. XXI. Pp. 182-184.

Stickstoffindustrie. By Dr. B. Wasser. Technische Fortschrittsberichte, Fortschritte der Chem. Technologie in Einzeldarstellungen. Edited by Prof. B. Rassow. Pp. 128. Dresden und Leipzig: Theodor Steinkopff, 1924. Price 4 marks.

Gmelins Handbuch der anorganischen Chemie, Part 8. Edited by the Deutschen Chemischen Gesellschaft. System-Number 32. Zink. Pp. xxii+329. Leipzig and Berlin: Verlag Chemie G.m.b.H., 1924.

Publications of the United States Geological Survey, Department of the Interior, Mineral Resources of the United States. Washington: Government Printing Office, 1924:—

Carbon Black Produced from Natural Gas in 1923. By G. B. Richardson. Pp. 89–90. No. II: 11.

Coal in 1922. By F. G. Tryon and S. A. Hale. Pp. 439–669. No. II: 33.

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

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EDITORIAL

THE year is nearly at an end; the year is dying, let him die. He may have been good and kind to us, but we expect his successor to be better and kinder. Has it not been said that time is like a fashionable host, that slightly shakes his parting guest by the hand; and with his arms outstretched, as he would fly, grasps in the comer? Towards the end of the eighteenth century a writer of good repute—there were such in those days—after contemplating for some interval of time, wrote, "I saw the skirts of the departing year." He subsequently altered this to "I saw the train of the departing year." This imagery is no longer appropriate; trains have disappeared, skirts have become fine by degrees and beautifully less, and the trim ankle whose occasional appearance poets were wont to praise is now succeeded by that which recalls the story of the Prodigal Son. The year, whose departure we are seeing in our mind's eye, has been a year of quiet, uncertain and slow progress. This is as true of chemistry as of other spheres of human activity. No brilliant development, no spectacular theory comes into our mind, marking the year 1924 as a vintage year.

* * *

Nevertheless there is comfort to be derived from a close examination of our profit and loss account, our trading and manufacturing for the year under review. The Society's meeting in Liverpool was the largest, most important and best organised meeting of its kind. Dr. E. F. Armstrong terminated his successful years of office in a manner which was neither common nor mean. If we were the chairman of the company we should dilate on this, but we are merely the auditors. Why should a man be described as an auditor who in the driest words possible certifies the accuracy of accounts after freeing himself from responsibility by mentioning that the stocks have been valued by the company's officials? Everyone knows that whether you make a loss or a profit depends in most manufacturing businesses on how you value your stocks. Auditor, we suppose, means listener; when they have listened long enough they become directors. Every chartered accountant should have framed over his bed the opening words of Juvenal: "*Semper ego auditor tantum?*" Shall I always be merely an auditor? The next item which requires attention is the meeting of the Union Internationale at Copenhagen. This was one of the happiest and brightest of the meetings of that body. We are glad to mention that discussion has recently taken place in Paris on the revision of its statutes, and the committee appointed at Copenhagen will shortly be able to report progress. Wembley: when we think of Wembley we are almost inclined to re-write the earlier notes we have written. It is not wise,to yield too much to your inclinations; what we have writ is writ—would it were worthier! Wembley certainly is an achievement on which your chairman, Mr. Woolcock, is entitled to dilate in glowing periods and terms. The chemical exhibit at Wembley and the book "Chemistry in the XX Century" do stand high in the annals of British chemistry.

* * *

In the science of chemistry we are not competent to enumerate the most significant discoveries in their due order of magnitude. Dr. Aston has continued to investigate the anatomy of the atom, the division of the indivisible, and the explanation of the incredible; the manufacture of insulin has been made more economical, more scientific and more beneficial to mankind; the properties of hafnium are being gradually found out in Copenhagen; the manufacture of synthetic ammonia proceeds apace at Billingham; this country has agreed with Germany to continue the system of encouraging our own dyestuff industry by refusing to import foreign dyes unless a good case can be made out for an exception to that rule. Schemes for the graphic representation of polarities, valencies and chelate bodies adorn our pages at frequent intervals, and twice a month a small crowd assembles outside the Chemical Society's rooms in Piccadilly listening to Profs. La . . . ., Lo . . . ., Ro . . . ., and Si . . . . with some others, as they emerge into the street maintaining with no little heat their various opinions. There is, we fully believe, only one graphic representation of co-ordination, only one way in which this can be made manifest by any symbol visible to the

majority of chemists. It involves both plus and minus signs: these will be always equal in number; the time will have to come when the organic and the inorganic chemist, the organised manufacturer and the disorganised recipient of the benefits of chemistry, will agree upon a scheme for reduction of certain figures in a banker's book to a minus quantity and the insertion of a multitude of positive quantities into another account to be held on trust for chemistry generally. It is a mere case of induced polarity, of stereo-chemistry such as that celebrated recently in Holland and more recently in France.

* * *

Our relations with foreign Powers continue to be friendly: the recent election here and the recent elections in America and Germany have not produced a feeling of European dismay: the Dawes agreement will probably help us to secure a peaceable feeling in this distracted continent. The efforts of the radio-active people in Russia to produce a revolution here have not so far been successful, and are not likely to be successful. This is not a good country for an experiment of that sort: we are "not yet enslaved nor wholly vile, O Albion . . . social quiet loved thy shore, nor ever proud invader's rage or sacked thy towers or stained thy fields with gore." In this journal we cannot help reflecting to some extent the feelings of those we meet from week to week. Our chemical friends do not always talk to us in praise of dimethoxybenzaldehyde. Our literary pursuits sometimes take us far away from the substituted arylpyrazolones. Old Moore's Almanac is almost the last survivor of that combination of modern science and ancient astrology which distinguished the alchemist. This direct descendant of Paracelsus in his issue for the year 1924 predicted an important medical discovery as a leading feature in the brilliance of 1924; he was right, and in the Almanac for 1925 there appear two items, a full-page advertisement of that universal panacea "Yadil" and a note that their previous year's prophecy has been proved to be correct by the benefits conferred by that mixture upon suffering humanity. We trust that the next year's Almanac will prophesy the result of the libel action brought by the proprietors of Yadil against the *Daily Mail*, Sir William Pope and Professor Dixon. Unless some steps are taken to overcome the inertia of our courts and our litigants, we shall learn the decision in no other way. We digress; we must digress; unless we stray sometimes from our path we fear lest we find all individual dignity and power engulphed in Courts, Committees, Institutions, Associations and Societies, a vain speech-making, speech-reporting guild. We fear also lest we might in time, unless we strayed, fall into that error which Faraday condemned, that of accepting theories and usages as established merely because they have gradually become familiar. We ask our readers to forget us until the New Year and to think of us then as being as young, as innocent, as free from guile and as irresponsible as the year is young. Later, we may again become stately. God rest you, merry Gentlemen, let nothing you dismay!

DEVELOPMENTS IN THE BRITISH CHEMICAL INDUSTRIES DURING 1924

By REX FURNESS

The great wave of optimism which usually sweeps through industry with the advent of a New Year is often broken, all too soon, upon the rock of economic conditions into a dazzling but unsubstantial spray. From the commercial point of view, however, the year 1924 has not been too dismal, and the excess of exports of chemicals, dyestuffs and drugs over imports has been practically the same as in 1923, a year during a considerable portion of which trade was artificially stimulated by the Ruhr occupation. The chemical industries are so necessary to general industry that to supply home requirements would be satisfactory in itself, but, with the realisation of more stable conditions at home and abroad, it is possible to hope for an increase in our exports as well as in the home trade. It has been held in some quarters that the incidence of the Dawes scheme would react prejudicially against the chemical industries, for their voice was not heard in the discussions, but it may be pointed out that Germany is feeling palpitations in her chemical heart, if the statements of Dr. Duisberg of the Interessen-Gemeinschaft be taken at their face value. It is probable that individual hardships will be more than balanced by the general benefits which will come as a result of greater stability.

Wembley

Nineteen hundred and twenty-four has seen the realisation of the greatest scheme of advertisement for the chemical industries that has ever been attempted, and the display of the chemical section at Wembley is the seed from which a whole crop of trade will develop, provided adequate fertilisation be afforded in the shape of judicious advertisement in the chemical and trade press. Kinematograph films have been used more during 1924 for advertisement and propaganda purposes in the chemical world.

Synthetic Ammonia

The most outstanding development in the chemical industries has been the commencement of the manufacture of synthetic ammonia on a large scale at Billingham. Fixed nitrogen preparedness has become a dogma in the political and economic faith of modern nations in recent times, and it is thanks to the splendid work of Brunner, Mond and Co. that this country is able to depend upon "air-" fixed nitrogen supplies from the works of Synthetic Ammonia and Nitrates, Ltd., From 100 to 120 tons of ammonium sulphate per day have been manufactured throughout the year so that this company is already the largest individual producer within the ranks of the Sulphate of Ammonia Federation. Details of the process have not been made known, but it is considered to be a much improved type of the Haber-Bosch system both in respect of catalyst, hydrogen production, speed of ammonia formation and general plant equipment and control. Much of the ammonia solution resulting from the removal

of ammonia from the circulating gas stream by means of water, is converted into ammonium carbonate by means of carbon dioxide, produced within the main process. Reaction with calcium sulphate mined in the vicinity of the ammonia plant leads to ammonium sulphate formation, whilst there is a market for the precipitated calcium carbonate.

No praise can be too warm for all responsible for this great achievement, for the Billingham installation is the finest synthetic ammonia plant in the world, with the possible exception of the new German installation at Merseburg.

It is of interest to note that the production of sulphate of ammonia in this country has now overtaken the 1913 figure, but there is a large market available both at home and abroad.

Heavy Chemicals

General progress is evident in our heavy chemical industry, and the recent optimism in the cotton industry has reacted upon the former, so that home demands may be expected to increase. Exports during 1924 have risen above the very satisfactory 1923 figures, and to-day, in spite of heavily protected heavy chemical industries abroad, we are exporting more soda ash, bicarbonate, crystals and caustic soda than at any time. It is true that salt exports are not yet back at pre-war rates, but a steady improvement has been in evidence in 1924. Bleaching powder has again suffered due to the disappearance of the American, Canadian and Swedish markets, but India still calls for supplies, and more and more is wanted in Persia as the application of the hypochlorite refining process for petroleum products is being extended. This may be countered by the policy of home refining of Persian oils, now successfully established and increasing largely in dimensions. Any diminution of bleaching powder consumption in this country will be compensated for by increases in the consumption of liquid chlorine, and this product is now available in cylinders and tank cars. English makers of liquid chlorine are engaged upon intensive research and propaganda in respect of the use of their product.

Acids

Turning now to acid production, it must be recorded that synthetic nitric acid is now being made, in small quantities, by the catalytic oxidation of ammonia by Synthetic Ammonia and Nitrates, Ltd. Hydrochloric acid, no longer a by-product of the Leblanc process since the passing of this honourable method of alkali production after a century of service in 1923, is made specially by the action of sulphuric acid upon salt, whilst small amounts are made synthetically from chlorine and hydrogen.

Sulphuric acid, the life blood of industry, has been produced during 1924 almost at pre-war rates, although, on account of large plant additions during the war years, the percentage of plant in operation has not yet reached the 1913 figure of 85 per cent. A welcome decrease in the price of the acid has been observed, and manufacturers of sulphate of ammonia, and of superphosphate are amongst those most prominently affected by the favourable change.

It is impracticable to review the position of every chemical produced in this country, but special mention may be made of hydrosulphites and related compounds, the manufacture of which for the dye industry is now upon a secure basis. The value of home-produced bichromates has been more apparent in the 1924 returns, and cyanides and related compounds are regaining some of the ground lost by the inception of the process for making calcium cyanide from cyanamide at Niagara. It is to be regretted, however, that the efforts of the British Cyanides Co. to fix atmospheric nitrogen in the form of cyanide by the barium process have not been brought to full technical fruition during the year. Anyone who has experienced the trials of bringing in a new technical process will sympathise with the company, whose efforts have been unrelaxing and experimentally sound for years past. As a *quid pro quo*, however, a new product of value in rubber vulcanisation acceleration and in other directions has been produced by the British Cyanides Co. from gas works sulphocyanides, and successful marketing is announced.

A word must be accorded to the soap and glycerin industries, although little of absolute novelty has appeared during 1924. Messrs. Lever Bros. and their associated companies still pursue a policy of expansion, and factories in Scandinavia and Denmark have been opened this year. Efforts have not been without reward in the sale of British glycerin.

Artificial Silk

The production of artificial silk is definitely a chemical or chemical engineering process, and considerable developments are to be recorded. The viscose process is being further extended, and Messrs. Courtaulds have commenced the erection of a factory at Bushbury, Wolverhampton. It will cost a million and a half, and employ four thousand workers. Probably for the first time, the outside critic is able to look upon the progress of Celanese silk with satisfaction. Not only in production but in application in yarns, mixtures and specialities, and also in the important matter of dyeing has considerable progress been made. It is no secret that the inadequacy or inconvenience—or both—of the dyeing processes for acetate silk was responsible for the commercial difficulties experienced in earlier years. Nineteen hundred and twenty-four has seen the development of a new series of dyestuffs, which will supplement or, perhaps, entirely displace the famous Ionamines, those special acetate silk dyes discovered and produced by the British Dyestuffs Corporation. It has been found that a full range of dyestuffs, fulfilling many demands of fastness, resistance to washing, etc., can be readily applied to Celanese silk by the ordinary direct dyeing process if the dye particles have been sufficiently dispersed.

In the "S.R.A." series of dyestuffs, made by the silk manufacturers, a standard dyestuff itself is incorporated with a solubilising or dispersing agent. Sulphoricinoleic acid was the first dispersing agent used with success and has given its name to the series of colours—S.R.A. Available in the form of 10 per cent. pastes, they may be used without preparation and without change in dyeing method.

Dyes

This matter naturally leads to a thought regarding the dye industry itself. The British dye industry, of which the British Dyestuffs Corporation is an important part—but only a part—has shown its worth by steady chemical progress and the idea that Englishmen had not the temperament for the game should now be counted out. New and special dyes for artificial silk, new bacteriological stains, photo-sensitising dyes and so forth represent forward moves, and the whole progress of the dye industry is not that of an inconsequential plagiarist. On the commercial side, however, there are still difficulties and the reconstruction of the B.D.C. with alterations in the directorate are being significantly discussed. We may well wait the event without comment, but the negation of the policy of agreement with the Interessen Gemeinschaft must be noted. It is probable that the veto exercised by the British Government in this matter will meet with almost universal approval in this country. It has been shown that British research is of high standard and capable of supporting the super-structure of an industry, and it is difficult to see how such research could have continued had agreement with the I.G. materialised. The abandonment of research in this industry, with its reaction in many directions need not therefore be contemplated as a result of the workings of Anno Domini 1924.

The completion of the Colour Index in the early part of the year has given us a record of nearly 1500 dyestuffs and pigments, both natural and synthetic, which is invaluable. It is even more complete and correct than the Schultz Farbstoff Tabellen, and both the Society of Dyers and Colourists and Dr. Rowe, the editor of the work, merit the highest praise.

Fine Chemicals

The fine chemical industry, related so nearly to the dyestuffs industry, has witnessed progress in the manufacture of drugs, pharmaceuticals, photographic chemicals, perfume synthetics and so forth, but pride of place must be given to the successful production of insulin upon a large commercial scale. Insulin, from the pancreas of the ox, is unstable in the presence of alkali and at relatively low temperatures. It is very easily destroyed by tryptic fermentation and its isolation in a relatively pure state in technical quantities was a problem demanding high ability in its solution. The efforts of British chemists and manufacturers have brought down the cost of insulin treatment during the last year or so from pounds to shillings per week. Insulin is now available to all who require it and the achievement is illustrative of the progress which our fine-chemical industries have made.

The predictions of King in the matter of the constitution of the celebrated Bayer 205 for sleeping sickness treatment have been substantiated this year by the discovery in France of Fourneau 309, and when the material has been fully tested, it will undoubtedly be made in English laboratories.

Beet Sugar

The foundations of a home beet sugar industry seem now to be well laid, for, in addition to the factories already producing at Kelham, Cantley and Colwick, six new works are to be erected and subsidised by the State. The work of survey, preparation and building has already commenced in several instances, and production during the 1925 season seems assured in at least one factory. During 1924, the area of land under beet cultivation has been largely increased, and work has been actively continued upon the question of the commercial production of the best type of seed.

Absorbent Carbon: Inorganic Gels

Active decolorising charcoals have been made in this country this year, and the quality is claimed to equal that of Dutch, German or American chars. These substances will find application, not only in sugar refining, but also in the decolorising of oils and fats and other materials, whilst they have a future as absorbents for solvent vapours from air or gas. Thus, benzol may be extracted from coal gas or coke-oven gas more economically than by the old oil-scrubbing processes, and solvent recovery in the rubber, and explosives and other industries is cheapened. In this connexion the inorganic gels, such as silica gel, etc., claim equal attention, and silica gel and an aluminosilicate gel are now made in this country. The latter, "Doucil," also possesses high base exchanging properties, and its use in water softening is spreading, as its superior powers are realised. Silica gel has been used in this country in refining petroleum products, following its success in the States.

Smoke Abatement

Smoke abatement is a matter which concerns the chemical industry directly and indirectly, and much propaganda work has been carried through during 1924, so that both public and manufacturers are beginning to take a greater practical interest in methods for its realisation. Smokeless fuel production has increased and newer processes show further development. Corporations such as those of Glasgow and Nottingham have become producers of smokeless fuel, and it is likely that this move will continue, for such bodies are ideally placed for disposing of by-products in the shape of rich gas and complex tars. The value of low-temperature tar has, however, not been definitely assessed either scientifically or commercially, and much work remains to be done. The burning of powdered fuel under boilers generates less smoke than when ordinary stoking practice is employed, and it is gratifying to note that the undoubted economies of the process have led several executives to put down installations this year. The Birmingham municipality, a Metropolitan electric power supply company, and the Synthetic and Nitrates Ammonia Co. may be cited as important instances.*

* A large and important series of papers upon fuel and kindred problems has been given at the 1924 World Power Conference, and is now available in print.

Chemical Engineering

Britain has often been charged with neglecting the manufacture of efficient chemical plant and the training of capable chemical engineers. The activities of our various societies during the year should clear away the latter taunt, whilst the fundamental research work upon production and standardisation of plant demonstrates that the manufacturer of apparatus for the various unit processes of chemical engineering practice is alive to realities. Production of excellent plant is well maintained, and it is of interest to note that British chemical plant has actually been exported to Germany in 1924, the contract being, in at least one instance, a "repeat" order.

It is perhaps invidious to particularise, but mention may be permitted of the Premier mill or colloidal mill, the stream line filter of Hele Shaw, jacketed pans, stills, filtering and crystallising apparatus and evaporators. In addition, British oil extraction and expression apparatus is second to none.

The Societies

The activities of our many societies and organisations have been well maintained, and the distinct signs of greater co-operation and ultimate fusion in some way are encouraging. The exhibit of the industry and science of chemistry at Wembley, organised and arranged largely as a result of the activities of the senior Societies and The Association of British Chemical Manufacturers, may be paid the compliment of mere mention here, for its value, interest and comprehensive character are surely stamped upon the memory of every reader. "Chemistry in the Twentieth Century," and the series of popular pamphlets have had a gratifying reception, and mark a forward move in the essential matter of placing the science and industry in their rightful perspective in the eye of the educated public.

Organised Research

Although no epoch-making discovery is directly foreshadowed in the reports of the various Boards under the Department of Scientific and Industrial Research, there is much evidence of solid progress in fuel, oils and fats, food preservation, cotton, leather, glass, etc. problems. The whole scheme of collective research has been criticised as being unsuited to the English temperament which is essentially individualistic, but there is no doubt that much useful work has been accomplished. Advocates of the idea of team work have not been wanting, and the address of Sir John Russell at the Toronto B.A. Meeting presents an eloquent defence of the system.

Other Matters

The final report of the Committee on the question of preservatives and colouring matters in foodstuffs is so definitive as to foreshadow immediate legislation.

Finally, a few points of interest—possibly selected arbitrarily or tinged with personal prejudices—may be noted. The year has seen the celebration of the centenary of the discovery of cement by Joseph Aspden, of Leeds, and American and English manufacturers of cement have fittingly paid tribute to the discoverer. Rubber latex has been increasingly exported from British dependencies, but relatively small amounts have been worked up in this country. New and improved accelerators of vulcanisation have been put upon the market, and general progress in the rubber industry is evident.

Agricultural research continues to examine the problems of soil fertility, fertiliser and insecticide production, the microbiology of the soil, artificial farmyard manure manufacture, soil conditioning and plant physiology, and propaganda work amongst farmers is being pursued with greater intensity.

The hydrogenation of oils upon a technical scale has temporarily disappeared, but the plants in being provide an effective economic safeguard against unwarrantable rises in price of solid fats. Research into problems of oil and fat chemistry—"a neglected chapter"—was foreshadowed by the remarks of the late President of the Society of Chemical industry at the annual meeting.

Power alcohol has been made upon a larger scale as the result in part of the operation of the new factory on the Humber, which is fermenting molasses.

The year as a whole has been one of steady untheatrical progress within the various branches of the chemical industry, and the part which chemistry plays in the social and economic progress of the community has perhaps never been so widely realised as in the closing months of 1924

SYNTHETIC AMMONIA IN ITALY

Nitrogen fixation continues to develop in Italy, and it is estimated that by 1926 the total capacity of the Italian factories will reach 12,000 metric tons of nitrogen annually. Details of the plants now working or to be completed are as follows:—The Societa Italiana Ammoniaca Sintetica, which uses the Casale process, is producing 3 m.t. of ammonia daily at Terni. and is building a plant at Nera Montoro, which will shortly be producing 7 to 8 t. of ammonia daily. The old Fauser plant of the Società Elettrochimica Novarese at Novara, with an output of 1 t. ammonia daily. has been replaced by a plant to produce 15 t. ammonia daily. and the new Fauser plant of the Montecatini company at Sedico Bribano (Belluno) will produce 2 t. ammonia daily. Plants are under construction at Bussi by the Società Azogeno (Claude process, 7 t. ammonia daily), at Coghinas in Sardinia by the Società Sarda Ammonia e Prodotti Nitrici (10 t. ammonia daily), at Marlengo, near Merano, by the Società Alto Adige Ammonia (50 t. ammonia) daily, and a large plant at Cotrone will begin work in 1926.

The Casale process has been adopted in France, Spain, Germany, Belgium, the United States and Japan, whilst the Fauser process is to be used in a new plant at Luz in the Pyrenees, and it is understood that a new process developed by Carrara and Zorzi at Milan is to be applied on an industrial scale.—(*G. Chim. Ind. ed App.*, October, 1924).

THE CHEMICAL INDUSTRY IN 1924

The world has not yet recovered from the extreme poverty caused by the enormous waste of the Great War and during the past year Chemical Industry, in common with most other industries, has suffered from this cause. It cannot be denied, however, that a slow but steady recovery is taking place and the past year does not compare unfavourably with its predecessor in the amount of business which has been transacted The demand for, and consumption of chemical products depends to a great extent on the amount of activity prevailing in other industries, among which the textile, and iron and steel trades are of the utmost importance. The depression which has prevailed in these two typical industries for the greater part of the year has naturally affected the home market for chemicals. Latterly, however, the prospects of cheaper cotton, the adoption of longer working hours in the cotton trade, together with renewed activity in the iron and steel industry and the establishment of more settled political conditions have given rise to a feeling that the future is much more hopeful than it was. The industry has not been affected by strikes as much as in previous years and the number of working days lost has been little more than half those lost during the previous year. In the autumn the unemployed male workers in the industry amounted to rather less than 10 per cent. of the total. During the summer some 22,000 workers in the heavy chemical industry received an advance in wages which was estimated to cost the industry about £300,000 per annum.

The production of sulphuric acid provides a very good index of the state of the chemical industry as it does, indeed, of trade in general. Calculated as 70 per cent. H_2SO_4 the output for the year ending June 30, 1924, amounted to 1,272,000 tons, corresponding with 63 per cent. of the plant capacity used. This shows a slight increase over the output for the previous year, but is still nearly a quarter of a million tons less than in pre-war times. Prices have ranged from 70 per cent. to 100 per cent. above pre-war although costs of production have been relatively much higher, probably at least 150 per cent. above pre-war. Production has been adversely affected by the depression in the superphosphate industry which, together with the manufacture of sulphate of ammonia, normally consumes half the output. A study of the statistics relating to the raw material used in the production of sulphuric acid during the past year and in pre-war times is very interesting. The figures are as follows :

Raw materials used	1913 tons	1923–24 tons
Pyrites	800,000 ..	350,000
Spent oxide	110,000 ..	148,000
Sulphur	3000 ..	66,000

The increased use of brimstone for high quality acid is very noticeable, about 22 per cent. of the acid produced during the past year having been made from this raw material compared with only 1 per cent. in 1913. An increasing quantity is also being made from the sulphurous fumes resulting from the smelting of zinc.

British heavy chemicals have always been predominant in the world's markets and a steady export business has been going on continuously throughout the year. On the whole prices have kept very steady indeed, although there have been a few fluctuations. Salt cake, for instance, which at the beginning of the year was valued at £4 10s. per ton was reduced to £3 10s. in the early summer and has maintained that figure ever since. Lead products have been particularly erratic owing to the fluctuations in the price of the metal. In the early part of the year, the price of brown sugar of lead for instance advanced from £42 to £47 per ton and afterwards declined again to the old figure. Latterly, the more important non-ferrous metals have been advancing in price, and products made from these have followed suit. White arsenic has been conspicuous for its steady decline in price throughout the year from about £70 per ton in January to £35 in December. This fall has been due both to the smallness of the demand, particularly from America, and to the very keen competition of the Japanese product.

Bleaching powder has been one of the quietest of the heavy chemicals due, no doubt, to the slackness in the textile industry. The price, however, has been fairly well maintained at about £10—£11 per ton. An interesting development has been the export of considerable quantities to Persia for use in the refining of petroleum by the hypochlorite process.

Steady business has been done in borax and boric acid, and the price of the latter was reduced in the summer by about £3 per ton for all grades. Cyanide products have suffered from American competition during the year, and sodium prussiate, for instance, has declined from 7d. to 4d. per lb. An encouraging feature has been the resumption of the manufacture of formaldehyde in this country, although the market has not been a very active one.

The market for wood-distillation products began the year very well with a good demand for acetates in particular. As the year went on, however, the industry began to suffer from American competition, and grey acetate of lime, for instance, declined from £22 per ton to about £14. Latterly, however, conditions have improved and a stiffening tendency has been in evidence.

As mentioned above, the superphosphate industry has been depressed, mainly owing to competition from Continental products produced with cheap labour, low taxation costs and helped by depreciated exchanges. Temporary relief was afforded during the spring by the improvement in French and Belgian francs which resulted in a decrease of imports at very low prices. Nevertheless, the consumption has been only 75 per cent. of the pre-war figure, and the industry is only slowly recovering the markets lost during the years following the war when exports were prohibited. The trade has been free to export for two years now and conditions generally are more favourable. The stabilisation of foreign exchanges, however, is vital to this industry.

The year has been a prosperous one for the sulphate of ammonia manufacturers, the production for the year amounting to over 400,000 tons, of which 65 per cent. was exported. The average

price for all deliveries both for home and export was £13 5s. 11d., compared with £15 0s. last year. The manufacture of the synthetic product is now firmly established in this country by Synthetic Ammonia and Nitrates, Ltd., who are now the largest individual makers of ammonium sulphate in this country.

With regard to tar products, the year on the whole has been very quiet and rather disappointing in spite of the restriction of output due to the small demand for coke by the iron and steel industry and the consequent closing down of some of the coke ovens. Cresylic acid has been the steadiest feature in the section, and the price has remained substantially unaltered at 2s. 1d. per gallon. Pyridine has been conspicuous because of its demand for methylating purposes, but the price has been erratic, varying between 24s. and 14s. per gallon. Heavy pyridine gradually increased in value throughout the year from 8s. to 12s. per gallon. Carbolic acid has been most disappointing, and has met with very little demand. The crude acid has declined from 2s. 9d. to 1s. 8d. per gallon, and the crystals from 1s. to less than 6d. per lb. Benzole, as might be expected, has generally followed the market for petrol, and was advanced in price in the spring and reduced in September. Recently the price has again been advanced, while the benzole mixture for motor purposes has been kept at the same price to compete with petrol although modified slightly in composition. Supplies of benzole have been none too plentiful. Solvent naphtha has also fluctuated considerably, rising to over 1s. 6d. per gallon in the spring, falling to about 11d. in the autumn, and again recovering to about 1s. 6d. during the past few weeks. Perhaps the most important feature among tar products has been the great fall in the price of pitch, which has been almost continuous throughout the year from about 100s. per ton in January to about 40s. in November. A reduced export demand and considerable imports of American pitch for patent fuel manufacture in South Wales have no doubt contributed to this decline in value.

THE BRITISH DYESTUFF INDUSTRY IN 1924

In spite of the continued depression in colour consuming industries, and consequent curtailed demands for dyestuffs, there is no evidence of diminished effort on the part of the dye makers. On the contrary, increased internal competition has been apparent, with the result that the general level of prices has been constantly, if gradually, lowered.

Keen competition must inevitably result in increased efficiency in production, which implies not only improved yields but also purer and better products, and during the year marked improvement has manifested itself in already existing products, in the direction of brilliancy of shade, solubility, fine paste products for textile printing, and so on.

Perfection of existing dyestuffs, in preference to the making of new ones, has not infrequently been urged as sound policy by consumers. In addition to progress on these lines many dyes not hitherto made in this country—some twenty-five, at least, distinct and essential types belonging to various categories—have been put on the market during the last twelve months, in quality equal to that of the foreign products which they have replaced.

It is not easy to form, at any given moment, a reliable estimate of the value of research in progress, but the indications are that this important branch of work is being prosecuted with no little vigour. Howbeit much criticism has been provoked by the drastic curtailment of research staffs in certain sections of the industry. Considerable work has been expended upon dyestuffs for cellulose acetate silk, and the problem of successful commercial dyeing of this material is much nearer solution than it was a year ago. This country has probably contributed more to the world's achievements in this direction than any other, though Germany and Switzerland have been by no means inactive. Following upon the greater understanding of the nature of the dyeing process in relation to the new fibre, the evolution of a more or less general method has taken the line of presenting insoluble colouring matters of widely diverse chemical constitution in such a form as to be assimilated by the cellulose acetate. Thus the omega sulphonic acid and bisulphite compound processes have been succeeded by the more generally applicable colloid dispersal method whereby insoluble dyestuffs are incorporated with sulphoricinoleic acid, or other disperse colloid, which renders them readily "accessible" to the cellulose acetate fibre. Doubtless this new method as yet only marks the beginning of another era in textile dyeing.

As a general rule the quality of the dyestuffs manufactured in Great Britain is admittedly good. The mind of the consumer is, however, much occupied with the question of prices ruling, and is actively directed towards effecting reductions.

The negotiations reported to have been taking place between the national company and the German Interessen Gemeinschaft have not fructified, the President of the Board of Trade having announced a few months ago that he would be compelled to withhold his sanction from the proposed agreement.

THE BRITISH FINE CHEMICAL INDUSTRY IN 1924

For those engaged in the Fine Chemical Industry in this country the year now closing has been one of great interest. Unusually frequent changes of Government have not tended to stabilise trade conditions, and many of the confident hopes expressed twelve months ago of greater business internationally and within the Empire have failed to materialise; but quiet, steady progress in several branches of the industry has undoubtedly been achieved. New buildings have been erected, departments extended, processes devised or revised, labour and output increased, and in consequence the industry is more firmly and broadly established than ever before, and more adequately equipped to tackle new problems, or greatly increase demand, as occasion arises.

Wembley

Every visitor to the Chemical Hall in the Palace of Industry at Wembley learned in varying degrees to appreciate the importance to the nation and to the individual of a strong and flourishing chemical industry. Professors and teachers discovered, sometimes to their evident surprise, that analytical reagents and microscopic stains of unimpeachable purity could be obtained from British manufacturers. Students and traders were obviously deeply interested in the displays of organic and inorganic chemicals, and even the members of the public wending their way from the water-tap suspended in mid-air, to the fountain composed of "real soap-suds," gained some fleeting impression of medicinal and pharmaceutical chemicals produced in home factories.

Output

The manufacture of well-established chemicals in general demand continues to make satisfactory progress. Alkaloids and their salts, such as atropine, pilocarpine, and cocaine have been placed on the market at competitive prices. Salicylic acid, sodium salicylate, and aspirin are being produced equal in quality and appearance to any imported consignments. Formaldehyde, paraformaldehyde, and paraldehyde, all of British origin, are now available in ample quantities. Acetanilide, chloral hydrate, and vanillin have attained a steadily increasing output. Calcium lactate, barium sulphate (for X-ray examinations), and sodium benzoate, each of a higher degree of purity than any produced elsewhere, are being readily purchased by discriminating buyers. Staple lines, such as sodium sulphate, magnesium sulphate, and calcium phosphate, have been manufactured on a scale exceeding any previous record.

Prices

Increased production here, coupled with higher costs of manufacture abroad and the general gradual return to more normal rates of exchange, have resulted in greater uniformity of prices, and less fluctuation in values. In this connexion it is interesting to compare quotations for a dozen typical fine chemicals in 1914, during the period of the war and to-day.

	1914		War period		1924	
	lb.		lb.		lb.	
	s.	d.	s.	d.	s.	d.
Acetanilide		10	8	9	1	11
Acid salicylic ..		11	20	0	1	5
Aspirin	1	11	48	6	3	0
	oz.		oz.		oz.	
Atropine sulphate ..	21	9	120	0	12	6
	lb.		lb.		lb.	
Caffeine	15	0	50	0	11	0
Chloral hydrate ..	3	0	14	0	4	0
Chloroform	1	6	4	3	2	6
Paraldehyde ..	1	5	10	0	1	2
Potassium permanganate		5	14	6		7
Potassium bromide ..	1	6	10	0	1	6
Sodium salicylate ..	1	2	6	3	2	0
Vanillin	14	0	80	0	24	0

The figures demonstrate that the value of many chemicals has reached a reasonable economic level when increased taxation, cost of labour and transport charges are taken into account.

The Future

Faith has been defined as "a capacity for believin something which you know cannot possibly be true, but with a Government in power, backed by th largest majority of modern times, the fine chemic manufacturers of the country would appear to hav a sound and solid basis for faith in the industry an to be in a position to develop trade and decreas unemployment, provided that it is found possibl to effect a settlement in the matter of inter-Allie war debts, and that the Safeguarding of Industrie Act can be rendered more elastic and adaptable t prevailing conditions. In such circumstances event may justify all concerned in looking to the comin year as likely to yield a period of progress an prosperity.

CHEMICAL ENGINEERING DURING 1924

By S. G. URE, M.A., B.Sc., M.I.Chem.E.

The year which is now closing has many interesting features for the chemical engineer and chemical plant manufacturer. On the educational side one welcomes most heartily the opening of the new Chemical Engineering Laboratories in London, at the University College. The new laboratory, which forms an important addition to the existing laboratories in this country in which the subject is taught, is part of the memorial to the late Sir William Ramsay, at one time Professor of Chemistry in University College. Those who are responsible for the venture are to be congratulated on deciding on this form of memorial and on having obtained the support and co-operation of a number of firms well known in chemical industry. Also of an educational character, and also of very great importance to industry, was the World Power Conference held during the summer at the British Empire Exhibition. Representatives and delegates from over thirty countries were present, and papers were read which covered a very wide field, including subjects of special interest to chemical manufacturers, such as power in electrochemistry and electrometallurgy. The question of cheap power is of vital importance to all industries, and the work which was done in this connexion at the Conference should prove of the greatest value. Whilst dealing with the subject of power production, mention may be made of the inauguration, towards the close of the year, by the British Aluminium Co., of their Lochaber Hydro-Electric Power scheme. The magnitude of this undertaking may be realised when it is stated that it will take from five to six years to complete the work, which includes harnessing the waters of Lochs Treig and Laggan, as well as the Rivers Spean, Treig, and Spey. This is the largest hydro-electric power scheme so far undertaken in this country, and will have cost on completion about £5,000,000.

Many power stations and factories in different parts of the country are adopting the pulverised system of boiler firing and are erecting plants suitable for this purpose. The pulverising of the fuel is usually effected by mills of the Raymond or Fuller-Lehigh types. Gas firing of boilers has also received some attention, and new plants are being erected in fac-

tories to produce gas for this purpose. Another method of firing which is receiving attention is that adopted in the Brunler internal-combustion boiler, in which the fuel is burned under the surface of the water, the products of combustion passing over with the steam generated. For this type of boiler a very high efficiency is claimed. Articles on the steam accumulator, an important adjunct for boiler plants in chemical industry, have also appeared in the technical press during the year. Important extensions are being made at various gas works and collieries, in some cases with the object of producing smokeless fuel, and in others simply with a view to increasing the capacity of the works for gas production.

The lessons impressed on the world by the shortage of nitrates during the war have resulted in considerable attention being directed towards nitrogen fixation, and developments have taken place in this province during the year. At Billingham-on-Tees the Synthetic Ammonia and Nitrates, Ltd., have started up their new factory, which is the only plant outside of Germany in which the Haber process has, so far, been worked with success. Nearly all the great countries in Europe and North America have been developing nitrogen fixation during the year. In Italy, for example, plants are being designed, or are in course of erection, which will raise the annual production to 20,000 tons of fixed nitrogen in the form of ammonium sulphate, an amount which is more than double the internal consumption of that country. The Casale process, using hydrogen produced by Fauser electrolysers, seems to be the favourite method adopted in Italy, although some plants are being erected in which the Claude process will be used.

As the result of the protection afforded by the late Government, and continued by the present, in the form of a subsidy to the beet sugar industry, considerable developments are taking place. Already several new companies have been formed, and no time has been lost in acquiring sites and getting ahead with the erection of the factories, which cost between £200,000 and £300,000 each. One of the conditions under which this subsidy is granted is that at least 75 per cent. of the plant and machinery shall be of British manufacture. This should ensure that a considerable part of the costs of each factory should go in the form of orders to our engineering and allied trades. In passing, mention may be made of the erection at Belfast of a new oxygen plant, the property of the Irish Oxygen Co., which is closely associated with the Liquid Air Co. of London. This factory is conveniently situated to the great shipyards of the town, and will give employment to between two and three hundred men. A new plant, in which for the first time in this country silica gel has been used in oil refining, has been brought into operation during the year, and seems to have given every satisfaction to its owners, the Medway Oil Refinery Co. An interesting new material is "Proderite," a pitch concrete formed of vertical retort tar and silicious material, which can be cast into pipes or moulded and may be reinforced like ferro-concrete. It is capable of resisting the action of hydrochloric acid at temperatures up to 110° C.

Another feature of the year was the British Empire Exhibition, at which a considerable amount of plant and machinery suitable for chemical works was on view. Most of this was housed in the "Palace of Engineering," but many very interesting plant exhibits were to be found in various other halls and pavilions. The scattered nature of these exhibits, both in the "Palace of Engineering" and elsewhere, whilst bringing to the notice of those interested numerous other machines, involved a considerable waste of time in finding particular exhibits, and did not tend to impress the average visitor with either the magnitude or importance of chemical engineering. Practically every type of machine used in chemical works was on view, and the quality of the goods exhibited showed that the home-manufactured product was of sound design, made of good material, and revealed high-class workmanship.

PROGRESS IN STEAM GENERATION DURING THE YEAR

By DAVID BROWNLIE, B.Sc., M.I.Chem.E., A.M.I.Min.E.

A striking advance has been made during the year in what is now, at last, being recognised to be the highly important science of steam generation. Considering that about 500,000,000 tons of coal and lignite are being burned per annum in the stationary land boilers of the world for the one operation of making steam, and probably over another 150,000,000 tons in locomotive and steamship boilers, it is surprising the subject has been neglected for so long. Also it is still more staggering that Great Britain, for example, which is no worse than any other country, still goes on squandering about 20,000,000 tons of coal per annum in boiler fireholes for want of scientific methods that are little more than elementary common sense. However, great progress is to be recorded so far as the large water-tube boiler is concerned, and it is the object of this contribution to indicate the advances that have been made, during the past 12 months, particularly in so far as interests the chemical engineer and the technical chemist.

Progress in Power Station Practice

First of all, looking at the whole subject of steam generation from the point of view of a broad general survey, perhaps the most striking fact is that a number of boiler tests have now been carried out with both pulverised fuel and mechanical stoker firing giving over 92 per cent. boiler plant efficiency, and we seem to be within sight of 90 per cent. continuous efficiency all the year round, that is, including light running at night and during the week-end, together with stand-by losses. It is perhaps not easy to grasp the amazing character of this achievement. The average chemical works boiler plant, as with most other industries, is running at a continuous efficiency of less than 60 per cent., and only a small percentage of ordinary large electricity stations reach 75 per cent., the vast majority being less than 70 per cent., whilst if all the boiler plants

of Great Britain were by some miracle raised to 90 per cent. efficiency, the saving would be about 32,500,000 tons of coal per annum, that is, say, £40,000,000. Pulverised fuel firing is largely responsible for this success, but whilst it first rendered possible the 85 per cent. continuous efficiency boiler plant, as at Lakeside, Milwaukee, mechanical stoking has now made remarkable progress, and the struggle for supremacy between the two systems is keener than ever.

Mechanical Stokers

Developments during the year with mechanical stoking have largely been in the direction of air heating, the invention of the "Murray" water-cooled combustion chamber side walls, and the great size of individual units. Thus a single travelling grate stoker can now be constructed 24 feet wide and over because of the use of the flat suspended firebrick arch, that is essentially the use of special firebrick blocks attached to steel girders instead of the old sprung arch, which, under the conditions of mechanical stoking, cannot be made more than 8 or 9 feet across.

The great increase in size now possible with the multiple retort type of stoker is well indicated by the new Kearney electricity station of New Jersey, U.S.A., in which multiple retort stokers are being installed to burn no less than 30,000 lb. (13½ tons) of coal per hour each on normal running, or about 15 tons per hour overload, corresponding to an evaporation of nearly 300,000 lb. of water per hour under average conditions. The "Murray" water tube walls at the Hell Gate power station, New York, have resulted in tests showing over 92 per cent. boiler plant efficiency, equal to the latest pulverised fuel figures.

Pulverised Fuel

Pulverised fuel firing is progressing rapidly and a number of installations are now in hand for Great Britain, noteworthy being the equipment for Messrs. Synthetic Ammonia and Nitrates, Ltd., whilst the power station plants include Willesden, St. Pancras, Birmingham and Derby. In the United States many installations have been started up and new ones ordered. Thus Lakeside, Milwaukee, and the Ford plant at River Rouge, Detroit, have been doubled in size, whilst Cahokia, St. Louis, has been set in operation and the installations of the new Trenton Channel Station, Detroit, and the Cleveland Electric Supply Co. will soon be ready. Perhaps the most remarkable development of pulverised fuel firing is the almost completely automatic boiler plant in which the supply of pulverised fuel and air is controlled by the flow of steam in the main, operating through steam meter mechanism. This method of firing has rendered possible the monster boiler of which the latest example is at the Allegheny County Steam Heating Co., which, fired with "Lopulco" pulverised fuel, has 32,750 sq. ft. heating surface and will evaporate comfortably 400,000 lb. of water per hour. This is equal to about 60 "Lancashire" boilers 30 ft. by 8 ft.

The general tendencies in pulverised fuel firing are, first, the recognition of the fact that the natural moisture of the coal substance is no obstacle to efficient pulverising, but the trouble is the external moisture, so that it is only necessary to dry down to about 3—5 per cent. The ideal of pulverising is now to obtain absolutely even particles, so that 95 per cent. will pass through 100-mesh, and not so much division so that 65 per cent. will pass through 200-mesh, and 90 per cent. through 100-mesh. Further, both air heating and the "Murray" water-cooled side walls are now being used, as well as air-cooled walls and the water screen.

Boiler Feed Treatment

The efficient treatment of boiler feed-water has received more attention, and the huge boiler of 250,000 lb. evaporation per hour and over has only served to emphasise the deleterious effect of small amounts of oil, mud, apparently harmless inorganic salts such as sodium sulphate, and dissolved air and carbon dioxide, apart, of course, from common salt and calcium and magnesium salts. Several new zeolites have appeared and the design of "degassing" or de-aerating plant has improved, whilst an interesting development—although not directly connected with steam generation—is the continuous treatment of the cooling water of steam engine and turbine condensers with a trace of chlorine gas to prevent the growth of organic deposits on the condenser tubes. Further, also, much attention is being given in the United States to the use of carbon dioxide for partially dissolving and loosening boiler and pipe scale.

Action of Caustic Soda on Boiler Plates

The Massachusetts Institute of Technology have continued their investigations into the cause of "embrittlement" or "season cracking" of steam boiler plates. This only takes place at about 160 lb. pressure or over, and is apparently due to the action of caustic soda, formed by the decomposition of sodium carbonate, on the normal impurities present between the steel crystals of the boiler plate, which are dissolved out, allowing bubbles of hydrogen to penetrate and extend the crevices. The remedy is no excess of soda ash in the feed-water, and in this connexion the National Electric Light Association of New York has just published some amusing figures giving the detailed analyses of 15 boiler compositions. These almost all contain caustic soda or soda ash, and, in one case, the price charged was equal to seven dollars per lb. for soda ash!

Flue Gas Analysis

The principle of continuous flue gas analysis is also making good progress, and the modern practice is to use duplex machines which give a continuous record of carbon dioxide and also either carbon monoxide and unburnt products or excess oxygen. A very interesting new absorbent for oxygen has been produced by Louis F. Fieser, and consists of an alkaline solution of sodium hydrosulphite with a small amount of anthraquinone-β-sulphonic acid to act as a catalyst, 30 g. caustic soda, 40 g. hydrosulphite and 5 g. of the catalyst being made up to 250 c.c. This is stated to be a big improvement on

the use of phosphorus sticks, and, of course, the messy alkaline pyrogallol. For continuous determination of carbon monoxide the general principle is to burn by means of an electric coil and determine the increase in carbon monoxide.

High Steam Pressures

The use of higher and higher steam pressure continues to be adopted, and we are not so very far off red-hot steam pipes, that is, a temperature of 1000° F. (540° C.). During the year, full details have at last been published of the remarkable North Tees plant running at 475 lb. pressure, and quite a number of boiler plants will soon be running at over 500 lb., including the new Crawford Avenue station at Chicago at 600 lb. Experimental boilers are also being constructed in Germany and the U.S.A. to work at 1000 lb. pressure and over. Thus one design has drums that are steel forgings no less than 4 in. thick. Other striking new boilers, entirely different from ordinary designs, are the "Blomquist" revolving tube boiler at 1500 lb. and the "Brunler" boiler using a flame under water. The most remarkable of all, however, is the "Benson" super-pressure generator, already described in these columns, operating at 3200 lb. pressure and the "critical conditions," when water is converted into steam at the same volume without the absorption of latent heat, allowing of over 35 per cent. thermal efficiency from raw coal to the switchboard. Of the greatest interest is the "Emmet" mercury boiler and turbine, using mercury instead of water in the generator, and driving the turbine with mercury vapour in place of steam.

Sulphur and Ash Fusibility

Attempts have been made to determine the fusibility of ash in large-scale furnace work by determination of the sulphur content of the coal in the laboratory. The results are not decisive, but it is evident that, roughly speaking, the higher the sulphur content the lower is the fusibility of the ash. If 2500° F. (1400° C.) is taken as the dividing line between a good and a bad ash, very few examples are known of a coal with a high sulphur figure giving a good ash. Thus, out of 1163 coal samples, only 16 contained less than 0·5 per cent. sulphur, and all these had an ash of over 2500° F. melting point.

Other Developments

Many other interesting developments in connexion with steam generation are to be recorded during the year, including the proof that sulphur in coal does not affect concrete bunkers, the use of steam pipe ranges over 3500 ft. in length with little or no condensation loss, the production of several new steam meters and a radiation pyrometer, the use of steam-jet mechanical boiler-flue cleaners, the utilisation of waste gas and heat from coke-oven plant and also the sensible heat in the coke itself, the introduction to Great Britain of the "Ruths" steam accumulator, a new household refuse utilisation plant at Birmingham, and improved boiler and pipe coverings, including the use of blue asbestos and new compositions to place next to very high pressure piping.

THE PROGRESS OF CHEMICAL INDUSTRY AND TRADE IN FRANCE DURING 1924

By MAURICE DESCHIENS

The chief features noticeable in the French coal industry (an industry which is so fundamentally important to chemical industry) during recent years, are the increased production and the discovery and development of new deposits. In 1913 the production averaged 40,600,000 metric tons yearly, compared with a consumption of 63,000,000 m.t., or an average daily production of 136,147 m.t. (1913). Passing over the war years, daily production in January, 1923, was 121,064 m.t., after which it rose to 144,680 t., in January, 1924, and 151,982 t. in October, 1922. A great part of this increase is due to the reconstruction of the Nord and Pas de Calais mines, whose daily production has increased from 85,000 t. to 90,000 t. From these figures, and particularly from the output of 4,103,516 t. in October, 1924, it appears probable that the production will approach 60,000,000 t. per annum in 1925.

The consumption of coal remains heavy, and the imports in October, though slightly less than in previous months, were still large — *i.e.*, 2,070,983 t., of which 1,012,155 t. came from Great Britain. Similar important improvement is noticeable in ordinary and metallurgical coke. Coke produced by the coal mines, excluding that from metallurgical works, totalled 230,694 t. in October, against 131,994 t. in January, 1923, and 222,979 t. in March, 1924. This increase was due to the installation of numerous new batteries of coke ovens.

In the coke industry three chief tendencies are noticed, the object being to produce metallurgical coke from fat coal and recuperate the largest possible quantity of distillation products capable of being used as motor fuel. One tendency is to carbonise for a short period in narrow, long and high ovens made of silica bricks. Another tendency is to heat to 300° as quickly as possible, increase from 300° to 600° by 50° each hour, and then arrive rapidly at 800°; and the last tendency, the method of the domanial mines of the Saar, is to treat fat coal with 32 to 38 per cent. volatile matter in special retorts at low temperatures, and then to mix the semi-coke obtained with four times its weight of fat coal for carbonisation in the usual manner in an ordinary oven.

The shortage of French metallurgical coke tends to diminish, despite the import of 356,353 t. in October, 1924. French metallurgy now controls practically half of the world's reserves of iron ore, and extracts over 30,000,000 t. yearly. Of the 221 blast furnaces in existence, 135 are alight, the production of cast iron and steel in October, 1924, being 659,926 t. and 609,122 t., respectively. The number of blast furnaces alight is still increasing, and the production during 1924 will be found to have increased by some 60 per cent. compared with 1923. There is an interesting increase in the manufacture of steel in the electrical furnace.

After the war period, recent years, and especially 1924, show a veritable rebirth of chemical industries,

which have completely changed the economic physiognomy of France. The various sulphuric acid works utilising either the chamber of the contact processes (the two processes often being used in the same factory) can produce 2,000,000 t. of acid of 53° Bé yearly, compared with a consumption of 1,500,000 t. Despite the existence of French deposits, supplies of pyrites are expensive, especially when of Spanish origin, 500,000 t. being imported from all sources. The situation as regards nitric and hydrochloric acids, soda and sodium salts is normal, the consumption of soda being roughly 700,000 t., which allows of exportation. A new soda factory, independent of the large groups of manufacturers, has been installed at Monguerre.

The production of mineral phosphates in France, Tunis and Algeria, was 276,500 t. in 1913, and since 1921 a remarkable increase has been observable in North Africa. In Algeria the output has risen from 400,000 t. in 1921 to over 620,000 t., in Tunis from 1,418,000 t. to 2,500,000 t., and in Morocco from 80,000 t. in 1922 to over 250,000 t. at present. This increase is in sharp contrast with the decrease in the world's production of crude phosphates. An interesting tendency is to use finely ground mineral phosphates direct as an agricultural fertiliser, also the use of crude phosphates that have been calcined in rotary furnaces. The major part of the mineral phosphates, however, is converted into superphosphates, an industry which is developing owing to the large production of sulphuric acid, the French output having increased from 1,920,000 t. in 1913 to roughly 2,500,000 t., with exports approximating to 130,000 t. The consumption of superphosphates increases annually in France. French agriculture pays more attention to the use of basic slag, the by-product of the steel industry, and of which the production may attain, at normal rate of working, 2,000,000 t., though at present it is not greater than 1,000,000 t., and the consumption of 400,000 t. allows heavy exports.

The return of the Alsatian potash mines has made France an exporter of potash salts. The annual production is roughly 1,080,000 tons of salts (250,000 t. K_2O), and the exports are about 7000 t. of potash salts yearly. An agreement has been reached between the French and German producers of potash salts, and the French producers are seeking a market in Austria. The production can be raised to 500,000 t. K_2O per annum, and the construction of new shafts is being considered. In the nitrogen industry, the recent law approving the installation of the Haber process at Toulouse and the constitution of an Office Industrielle de L'Azote foreshadows an interesting increase in the French production of nitrogen. Under modern agricultural conditions, French agriculture would require at least 300,000 t. of nitrogen, whereas the production only reaches 19,000 t., in addition to imports of 70,000 t. The production of ammonium sulphate is 88,500 t. and imports are 75,000 t. The chief occurrences of note during the year are the starting-up of plants erected by the large chemical manufacturers utilising the Claude, Casale and other processes. The imports are thus likely to be reduced by the development of these processes, and of the production of by-product ammonium sulphate and of cyanamide (50,000 t. annually). Imports of Chilean nitrate are still roughly 270,000 t., imports of Norwegian nitrate of lime being 11,000 t., and of cyanamide, 12,000 t. The use of the hydrogen from coke-oven gases in the Claude and Casale processes suggests the possibility of synthesising ethyl alcohol from the ethylene of coke-oven gas. With the Claude and Casale processes and the manufacture of cyanamide, plants now constructed or about to be constructed will fix 69,000 t. of nitrogen in a few years. The utilisation of 600,000 t. of fixed nitrogen in agriculture is a decided possibility of the future.

The manufacture of dyestuffs has increased from the production of 1000 t. in 1913 to 10,000 t. at present, and imports of 6000 t. in 1920 have been reduced to 1000 t. Taking account of the exports, it will be noticed that in ten years, of which only five were really effective, the French Industry has greatly reduced imports and has increased its production from 10 per cent. to 90 per cent. Thus, imports of azo dyes have been reduced from 47 to 8 per cent. The production of indigo is sufficiently large to allow exportation, but small quantities of sulphur dyes have still to be imported. Progress has continued to be made in the other groups of dyestuffs. New plants manufacture the larger part of the undermentioned products and also supply the perfumery and pharmaceutical industries.

In the fuel and petroleum industry the chief event has been the encouragement to exploration in France and its colonies and the search for substitutes for petroleum such as alcohol, gas oil, benzole, "Carburant National," tetralin, wood charcoal, and various kinds of vegetable, animal, and shale oils. The output from the single French oilfield at Pechelbronn is of the order of 75,000 t. of crude oil yearly and is being increased.

Compared with the pre-war figures the production of dyeing and tanning extracts has diminished, but the manufacture of chestnut extract (80,000 t. per annum), and of oak extract, are prosperous. Exports of dye-woods amount to some 3000 t. The glue and gelatin industry had a prosperous year during 1924 and exported 4000 t. In the industry of artificial plastics and artificial textiles, the manufacture of cellulose acetate and of synthetic resins such as bakelite is developing. During 1923, 30 t. of synthetic resin was manufactured monthly and 17 t. was imported monthly from Germany. In 1924, the output was 50 t. monthly, and as the increase of customs duty in November, 1924, practically prohibited importation, manufacture will further develop. It is estimated that some 60 t. of cellulose acetate is made monthly and production is expected to increase still further now that a further factory has been established. During the year the increasing demand for artificial silk led to the establishment of a large number of factories using either the acetate, viscose or Chardonnet processes. Difficulties in the dyeing of cellulose acetate silk have now been overcome.

MODERN ELECTROLYTIC CELLS

By PROF. A. J. HALE, B.Sc.

(Concluded)

CELLS FOR PRODUCING VARIOUS COMPOUNDS

The most important of these cells are those used for the production of hypochlorite liquors and chlorate. Considerable progress has been made during recent years with hypochlorite electrolysers, the early type of Kellner and Oettel being followed by improved cells such as those now being constructed by Mather and Platt of Manchester, and the "Manchester" Electrolysers made by F. S. White and Company of Prestwich.

Platinum electrodes have been superseded by graphite, each cell carrying a considerable number of bi-polar electrodes. Circulation of the electrolyte coupled with efficient cooling is essential for the production of hypochlorite from brine. One electrolyser (Fig. 32) consists of a rectangular trough of glazed earthenware divided into a number of cells by graphite plates which act as electrodes. the graphite electrodes are not suspended, but rest on a glass bottom cemented into the trough. In this electrolyser 1 kg. of active chlorine is obtained by the expenditure of 8 kw.-hrs.

The "Manchester" electrolyser (Fig. 33) consists of a rectangular stoneware trough divided by carbon plates into some 30 compartments, each chamber having a hole at the bottom and another at the side about two inches from the top. The electrolyser is placed in a tank, 6ft. by 4 ft. by 3 ft. deep and this is filled with 15 per cent. brine. When electrolysis starts the evolution of hydrogen carries the liquid upward causing it to overflow through the openings in the sides, whilst it is replaced by fresh brine entering through the holes in the bottom. Each electrolyser takes 80 amperes at 110 volts and lead coils through which cold water circulates are placed on each side to keep the temperature below 30° C. A consumption of 88 kw.-hrs. yields about 10 kg. of active chlorine. In some electrolysers only 6—7 kw.-hrs. are required to give 1 kg. of active chlorine, the average concentration being 10—15 grams per litre.

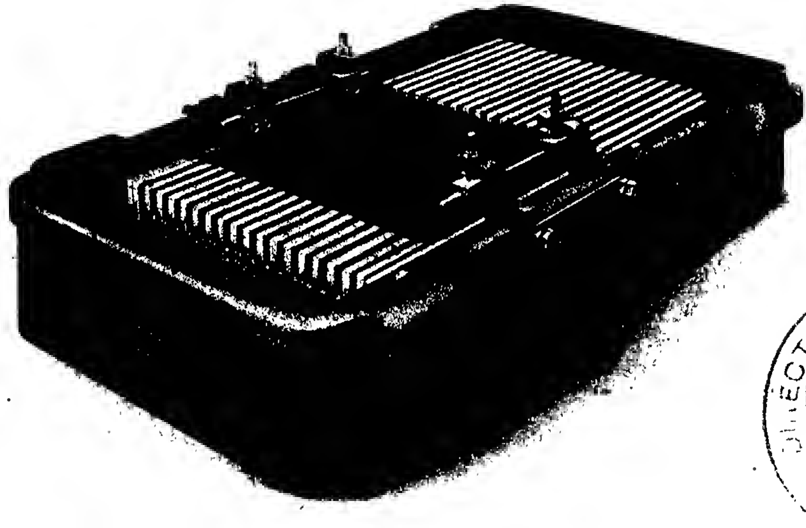


FIG. 32
The Mather and Platt Electrolyser

The channels between these plates are continued at either end by walls formed of glass plates. A chamber at one end receives the electrolyte from the pump, and the liquid flows over a glass weir into the spaces between the electrodes, thence into a second chamber from which it is again passed to the pump and recirculated until the brine contains about 12 grams of active chlorine per litre. The tank beneath the electrolyser is fitted with cooling coils to keep the electrolyte at a low temperature, 20—30° C. There are 17 cells in the trough illustrated and a voltage of 100/110 volts is required at the terminals for the passage of the normal current of 80/100 amperes. The glass plates and

In the "platinode" electrolyser, made by Mather and Platt, Ltd., an ebonite cell (Fig. 34) is fitted with platinum electrodes which are built into the body of the cell to afford them protection from injury. This cell is placed in a glass container and any number of these containers may be placed in a cooling trough. Each glass cell is filled with 20 per cent. brine and requires 5 amperes at 10/12 volts when working. The 1200 c.c. of liquid in the container will be brought to a content of 20 grams available chlorine per litre in approximately $4\frac{1}{2}$ hours.

The internal structure of the unit is shown in Fig. 35. The platinum foil electrode, *a*, is backed with a vulcanite block, *b*, and inserted in a dished

recess in an ebonite plate, *c*. The foil is connected with a terminal, *f*, by a platinum wire, *e*, in the channel, *d*. The electrode carrier shown is normally immersed in the electrolyte to the depth indicated by the horizontal line and access of the electrolyte to the channel, *d*, is prevented by a filling squeezed into position by the plug, *h*. Electrolyte circulates by the opening, *j*, at the bottom of the cell through the channel, *i*, and overflows through openings in the side on the electrolyte level.

In the press type electrolyser of Mather and Platt (Fig. 36) there are 23 graphite electrodes forming 22 cells, mounted transversely on steel bars covered

the required amount of active chlorine, 11—12 grams per litre, has been formed.

This type of electrolyser requires 225 to 250 amperes at 100—110 volts and will give 9 lb. of active chlorine per hour, the power consumption being relatively low, 3 kw.-hrs. per lb. of active chlorine, that is about 6 kw.-hrs. per kg. The electrolyte is allowed to circulate through at the rate of 18 gallons per minute.

Another hypochlorite electrolyser made in various sizes is the "Graphode" (Mather and Platt) a 5-ampere unit being shown in Fig. 37. It consists of a stout holder with graphite electrodes forming five cells, the

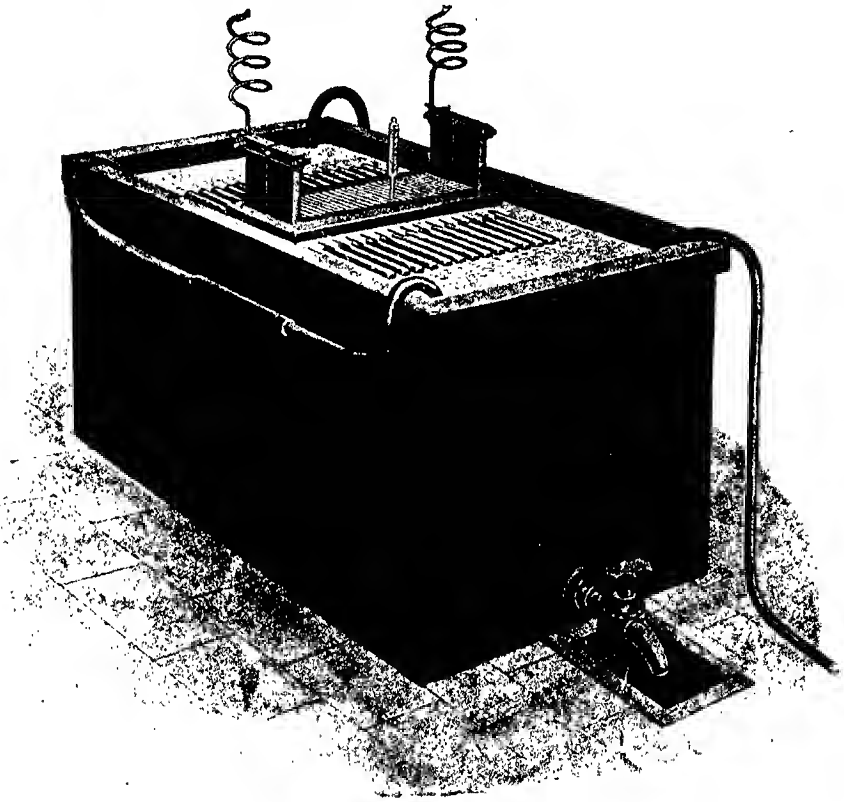


FIG. 33
"Manchester" Electrolyser by F. S. White and Co.

with vulcanised rubber. The cells are formed by suitable insulating distance frames between the electrodes, end pressure screws being provided for adjusting purposes.

Brine liquor falls into the electrolysers through the perforated bottom of a cast iron feed tank which is lined with vulcanite, and each cell is fitted with an outflow syphon-tube which regulates the flow and ensures that each cell is filled to the required height. The electrolysed liquor falls into a cement trough from which it is pumped to the cast iron feed tank, the circulation being continued until

whole being placed in a glass container of about 1 gallon capacity. After about 3 hours a concentration of 10 grams of active chlorine per litre will be reached with a voltage of 20—24 volts. Units of larger capacity (12½ or 30 amperes) can be supplied, but they are usually equipped with sufficient graphite bi-polar electrodes to render them serviceable with the ordinary electricity supply.

Chlorate and perchlorate cells, especially the former, are generally constructed on a larger scale, and the graphite anodes are connected to a common bus bar, the iron tank itself often being the cathode.

The chlorate cell of the United Alkali Company (E.P. 173,028/21) is an iron tank, 8 ft. x 4 ft. x 15 in. wide, and is fitted with a central steel cooling coil. Both the coil and the tank serve as cathodes whilst ranged around the tank are graphite anode --ds at which chlorate formation takes place when

Fig. 34
"Platinode" Electrolyser

he potassium chloride solution is electrolysed. The emperature being maintained below 40° C., the arbon anodes are not seriously corroded by the hlorate. A current of 1500 amperes may be used, ployed are of the diaphragm type, as it is necessary to prevent cathodic hydrogen from interfering with the discharge reaction taking place on the anodes.

Hydrogen peroxide is frequently produced by the distillation of acidified ammonium persulphate, this salt being always manufactured by electrolysis of ammonium bisulphate solution.

The simplest form of cell from which the larger industrial units are planned consists of an outer earthenware jar in which stands a porous pot. Any kind of cylindrical electrode suitable for the work to

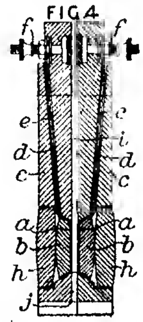


Fig. 35
"Platinode" Electrolyser

be done can be used, one for the inside of the porous pot and a larger one outside it, and all electrolytic oxidation or reduction can be accomplished on the laboratory scale in such apparatus. Sodium hydrosulphite is the principal salt prepared by electrolytic reduction, but a diaphragm is not essential for this purpose. If a suitable solution of bisulphite is allowed to circulate through an electrolytic tank or cell at

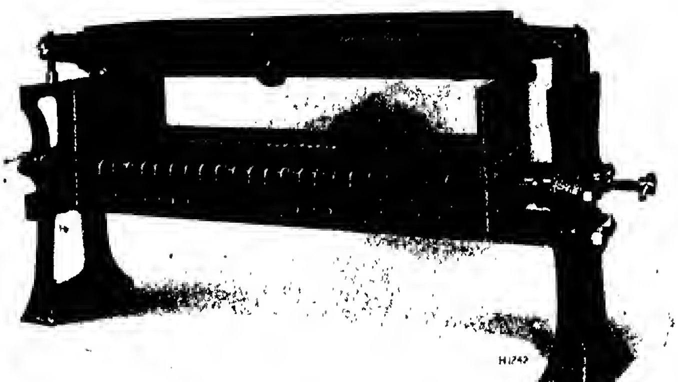


Fig. 36
Vertical Flow Type of the Mather and Platt Electrolyser

nd the electrolyte is caused to circulate in the tank r, when a number of tanks are in use, a cascade ystem of circulation can be utilised.

Persulphates, permanganates and perborates can e manufactured by electrolysis. The cells em- 10–15°, concentrated solutions of hydrosulphite can be obtained (E.P. 13,901/13).

For reduction or oxidation of organic compounds, the most promising field in which electrolysis as applied to organic compounds is being explored, the

simple cell described above suffices, although it may be often necessary to fit such cells with a gas-tight cover, refluxing apparatus and a good stirrer in order to obtain satisfactory results.

Recent patents of C. J. Thatcher for a diaphragm cell, in which organic substances can be oxidised or reduced (E.P. 188,056/22), and for a series arrangement of diaphragm cells in which anthracene may be converted into anthraquinone (E.P. 188,042/22) indicate some advance in this field.

The Society of Chemical Industry in Basle some years ago devised a tank cell, for organic reduction or oxidation, in which the electrodes are fixed horizontally, one near the surface of the electrolyte, and the other near the bottom. The compound to be treated is dissolved in a light or heavy solvent which easily forms an emulsion with the electrolyte (caustic soda or dilute sulphuric acid) such emulsification being assisted by a to and fro motion of the electrode concerned in the reaction (E.P. 15,750/15). This cell is now in use on a large scale.

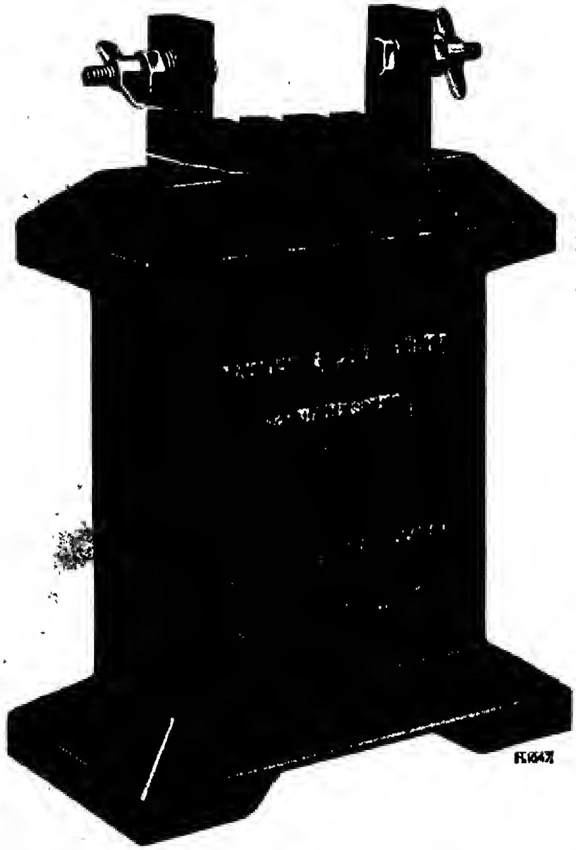


FIG. 37
"Graphode" Electrolyser

Recently Plauson has patented a cell for chlorinating, oxidising or reducing by electrolysis (E.P. 181,848–49/21). It resembles the common cylindrical diaphragm cell in many respects, but one electrode, which is centrally placed within the porous pot or diaphragm, is formed of a metal tube fixed in a porcelain insulator so that only a very small portion of it is exposed to the electrolyte. In this manner a very high current density is obtained, so that the electrode may be maintained at any temperature up to about 120°, and in this condition, promotes many electrolytic changes which, under ordinary conditions, take place to only a small extent or not at all.

Cells constructed on the plan of the cylindrical diaphragm unit for producing caustic soda will, no doubt, prove suitable for the reduction or oxidation of organic compounds, the central compartment containing the organic substance to be treated. The diaphragm, however, must be protected by some non-conducting material such as vulcanite, from the excessive wear which will result from vigorous stirring of a solution or emulsion of the compound to be reduced or oxidised.

The electrolytic cells described in this article represent the various types which have been designed for electro-chemical service during the last twenty-five years. From a study of their construction it should be possible for an investigator in this field to devise a cell suitable for the special electrolytic process which it may be his object to develop.

Finsbury Technical College, E.C. 2

[Acknowledgment is due to the various firms who have kindly supplied illustrations and information, and particularly to Messrs. Longmans, Green and Co., for permitting the reproduction and lending the blocks of Figs. 16, 17, 18, 21 and 27 (from the author's "Applications of Electrolysis in Chemical Industry") and to Messrs. Virtue and Co., Ltd., for a similar favour in respect of Figs. 1, 3, 5 and 20, which are from the author's "Modern Chemistry, Pure and Applied.—ED.]

THE PROPERTIES OF SOME ALIPHATIC COMPOUNDS CONTAINING BOTH OXYGEN AND NITROGEN, AND THEIR CONNEXION WITH THEORIES OF LATENT POLARITIES AND AROMATIC SUBSTITUTION

By PROF. ARTHUR LAPWORTH, D.Sc., F.R.S.

In a paper on "Latent polarities of atoms, etc" (*Mem. Manch. Lit. and Phil. Soc.*, 1920, 64, ii., 1 *et seq.*) the generality of "the principle of induced alternate polarities" was shown, by considering reactions of molecules containing either one predominating "key atom" or two effective "key atoms" arranged "homogeneously"—that is to say, in such positions as would lead to the same relative latent polarities in the atoms affected by both.

The much more abstruse question of effects resulting from "heterogeneous" arrangements of two or more powerful "key atoms" was not dealt with in detail, but a preference was expressed for the idea that the molecule might at different times be activated

from different "key atoms," and thus occur in two (or more) phases with inverted relative induced latent polarities (*loc. cit.*, p. 6, (A) and (B) as examples). No case was mentioned where two atoms, each capable of exercising a powerful inducing effect, are so arranged that an effect from one must necessarily be transmitted "through" the other. Had it been he writer's intention to enter into such complex uestions he would have selected the cases of oxygen d nitrogen competing in this manner, and would ave based his remarks on well-established experi- nental data obtained prior to 1920, and on lines such as the following :—

The first example is familiar to all organic chemists —an oxime. Here, as elsewhere, the most satisfactory test of a marked latent polarity distinction is one based on its reversible reactions with water. The result is unequivocal and shows that the nitrogen atom is negative with respect to the attached carbon atom :—

$$HO{\cdot}N{=}CR_1R_2 + H_2O \longleftrightarrow HO{\cdot}NH_2 + O : CR_1R_2$$

he same conclusion follows from the reversible dition of hydrogen cyanide at the same position :—

$$HO{\cdot}N{=}CR_1R_2 + H^{\cdot} + CN' \longleftrightarrow HO{\cdot}NH{\cdot}C(CN)R_1R_2$$

oth this and the previous reaction occurring exclu- ely in the direction indicated.

In the case of nitroso compounds on the other and, the balance between the nitrogen atom nd the oxygen atom appears to be in favour of he oxygen atom in all cases in which this can be ested by the behaviour of the compound in eactions with ionisable compounds $\overset{-}{X} - \overset{+}{Y}$, or 1 reactions giving rise to such an ionisable com- ound. The balance between the nitrogen atom and e oxygen atom is, however, so extremely easily sturbed that in nearly all cases where the change is ssible, the compound undergoes isomerisation into oxime in which the nitrogen atom definitely exer- es full control over the system which it separates, gr aphically, from the oxygen atom.

Co sidering next the normal nitroparaffins. These mp ounds show properties which are in excellent cord with the assumption that the oxygen atoms termine the order of polarities, even "through" e intervening nitrogen atom. In the *iso*-nitro- raffins the predominance of the oxygen atoms evident only in so far as these compounds show tendency to revert to the normal nitro-compounds- r the rest it is known that, in some cases at least, e major portion of the *iso*-nitro-compound undergoes drolysis when liberated from its salts, the hydro- sis doubtless taking place in much the same way with oximes, but in the case of the oxy-oximes, *iso*-nitro-paraffins, the oxyhydroxylamine (dehy- oxylamine) formed appears, as usual, in the form nitrous oxide, the organic residue turning up as lehyde or ketone (compare Nef, *Annalen*, 1894, 0, 263, and Lowry, *Trans. Chem. Soc.*, 1898, , 992) :—

$$HO_2\dot{\bar{N}}{=}\overset{+}{C}R_1R_2 + \overset{+}{H_2}\overset{-}{O} \rightarrow [H_3NO_2] + O{:}CR_1R_2$$
$$\downarrow$$
$$\tfrac{1}{2}[3H_2O + N_2O]$$

[t seems clear, therefore, that in the same compound w one atom and now another may assume the rôle of "key atom." It should also be evident that no organic chemist worthy of the name would at any time, since oximes became familiar, have suggested that divalent oxygen must necessarily be the dominant atom in molecules also containing nitrogen.

In considering these facts and their bearing on aromatic substitution, it has to be remembered that divalent oxygen and tervalent nitrogen directly attached to the nucleus exercise a very great *o-p*-directive effect. When either atom is separated from the nucleus by an intervening atom, however, its influence is exceedingly small (for example, substitution in salicylic acid is almost wholly determined by the oxygen atom directly attached to the nucleus). If, therefore, in nitrosobenzene, for example, the "key negative" influence of the nitrogen atom is not wholly suppressed by its association with the oxygen atom, any influence of this kind will be grossly exaggerated during the process of activation of and substitution in the nucleus, just as any polar properties of the oxygens of the carboxyl group in salicylic acid are ineffective as compared with the polar properties of the phenolic oxygen.

FORTHCOMING EVENTS

1925

Jan. 5. INSTITUTION OF THE RUBBER INDUSTRY, *London Section*, Engineers' Club, 39, Coventry Street, London, W. 1, at 8 p.m. "Mechanical Structure of Rubber," by A. Healey.

Jan 6. WEST YORKSHIRE METALLURGICAL SOCIETY, George Hotel, Huddersfield, at 7.30 p.m. "The Value of Some Workshop and Laboratory Tests." Discussion.

Jan. 6. INSTITUTE OF METALS, *Birmingham Section*, Chamber of Commerce, New Street, Birmingham, at 7 p.m. "Cobalt, its Production and Some of its Uses," by T. H. Gant.

Jan. 6. MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, "Young People's" Meeting, 36, George Street, Manchester, at 3.30 p.m. "A Few Chemical Curiosities," by Dr. J. E. Myers and F. Fairbrother.

Jan. 8. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section*, Meeting with Chemical Society.

Jan. 9. SOCIETY OF CHEMICAL INDUSTRY, *Manchester Section*, 16, St. Mary's Parsonage, Manchester, at 7 p.m. "The Melting Point of Coal Ash, Part 2," by N. Simpkin and F. S. Sinnatt.

Jan. 9. MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, 36, George Street, Manchester, 7 p.m. Chemical Section Soirée.

Jan. 9. INSTITUTION OF MECHANICAL ENGINEERS, Storey's Gate, London, S.W. 1, at 7 p.m. "The Maintenance of High-Compression Oil-Engines."

Jan. 9. WEST CUMBERLAND SOCIETY OF CHEMISTS AND ENGINEERS, Workington, at 7 p.m. "The Structure of Matter," by E. H. Todd.

Jan. 9. INSTITUTE OF METALS, *Sheffield Section*, The University, St. George's Square, Sheffield, at 7.30 p.m. "Die Casting," by A. H. Mundey.

Jan. 10. INSTITUTE OF METALS, *London Section*, 85-88, The Minories, Tower Hill, London, E. 1, at 7.30 p.m. "Extensometers," by R. H. Greaves.

Jan. 12. INSTITUTE OF BREWING, ENGINEERS' CLUB, 39, Coventry Street, W. 1, "The Season's Barleys," by J. Stewart.

SOCIETY OF CHEMICAL INDUSTRY

MEETING OF COUNCIL

The monthly meeting of Council was held on December 12, 1924. The President (Mr. W. J. U. Woolcock, C.B.E.) was in the chair.

The President extended a cordial welcome to Mr. G. H. Clegg, and Prof. N. M. Comber, new members present for the first time.

The following among other matters were dealt with:

The Address to be presented to the University of Leeds on the occasion of the celebration of its coming of age was submitted and approved.

The steps taken at headquarters and by the local sections to obtain new members were reported. The effect of the entrance fee being suspended for 1925 had been widely advertised, and a notable increase in the number of applications had already resulted, at the same time, the numbers of resignations and of unpaid subscriptions for the current year were distinctly less than the numbers at the corresponding date in 1923.

Reports of various sub-committees were submitted, and 48 new members were elected: Home 37: Overseas 11.

The question of a member bringing more than one guest to the Annual General Meeting and having to be supplied with tickets for all the functions, for many of which no payment is made, was fully discussed, and it was decided that every member of the Society attending the Annual Meeting has a right to obtain a ticket for one guest, and has also the privilege of obtaining further tickets by payment of 10s. 6d. in respect of each additional guest.

SUSPENSION OF ENTRANCE FEE

As an inducement to Chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Society in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 4, June 13 and 27, July 4 and 25, September 19, or October 3 and 17, 1924, that they are willing to dispose of to the Society.

EDINBURGH SECTION

The third ordinary meeting for the present session was held jointly with the Institute of Chemistry, in the Hall of the Pharmaceutical Society, 36, York Place, Edinburgh, on December 11, 1924, Dr. A. Lauder in the chair.

Lieut.-Colonel W. Glen-Liston, C.I.E., M.D., delivered a lecture on "Fumigation with Hydrogen Cyanide." The first use of hydrogen cyanide had been made by James Bell, who in 1877 employed it to prevent the destruction of his collection of insects by moths and other vermin. In 1886 Coquellet had introduced the gas for destroying parasites on citrus trees in California. So successful had the method proved that by 1890 it was in general use throughout the district. The next development had been made by the Cape Government in 1898, when hydrogen cyanide was employed for fumigating railway carriages. From then on its use had grown steadily, and experiments for the destruction of rats in the East had been started in 1909. These experiments had been undertaken for the purpose of reducing the ravages of plague, which it had been proved had been distributed by fleas with which rats were infested. In connexion with the fumigation of ships, the method had grown extensively, so that in 1922 no less than 1347 vessels had been disinfected with hydrogen cyanide in New York Harbour. Owing to the deadly nature of the gas great care had to be taken in clearing any closed space which had been fumigated. The apparatus designed by Lieut.-Colonel Glen Liston to facilitate the use of the gas was exhibited and explained by means of lantern slides, and an account was given of experiments which had been made on various ships with the plant.

CHEMICAL SOCIETY

An ordinary scientific meeting was held on Thursday, December 18, when the President announced that no award of the Harrison Prize could be made this year; a serious difficulty in making any award had, in fact, arisen in connexion with the interpretation of the trust deed.

The first paper was read by Mr. D. A. Spencer:—

The action of bromine on sodium and silver azides. Parts I and II.

In the absence of water, bromine reacts with sodium and silver azides to give the highly unstable triazobromide:—

$$XN_3 + Br_2 = XBr + N_3Br$$

This compound, whilst resembling triazoiodide in its general properties, differs in its greater volatility and immediate decomposition by water.

Bromine water reacts instantly with sodium azide solutions to give a mixture of azoimide and hypobromous acid. The solution then evolves nitrogen as a result of the interaction of these substances

$$NaN_3 + Br_2 + H_2O = NaBr + HN_3 + HBrO$$

The reaction between silver azide and bromine water differs from that with iodine solutions in that it is better represented:—

$$2\ AgN_3 + Br_2 = 2\ AgBr + 3\ N_2$$

The only evidence for the momentary existence of triazobromide in aqueous solution is the formation of a certain amount of azoimide with consequent loss of free nitrogen.

The density or viscosity of all nitrogen samples obtained was determined, but no indication of the existence of the polymer N_3 was obtained.

Dr. R. H. Pickard, congratulating the author on overcoming the experimental difficulties attendant on the explosive nature of the substances investigated,

said that he was glad to hear that work of this character was being carried out in an English laboratory. The results seemed to demonstrate the existence at low temperatures of the compound N_3Br.

The President also referred in appreciative terms to the author's courage and good luck.

Mr. W. H. Patterson then read the following paper :—

A method of determining the presence or absence of complex salts or ions in dilute aqueous solutions. [With J. Duckett.]

The method described is the change in the critical solution temperature of phenol and water by the addition of salts or salt mixtures. The complexity of the salts is thus tested in dilute aqueous solution above 66° C. The investigation might be extended, however, by selecting other temperatures of mutual miscibility and also for other solvents.

It has been shown (in a previous communication) that the ions may be arranged in a series, nearly identical with the Hofmeister series, and thus the effect of any simple salt (essentially soluble in water only) in raising the critical solution temperature may be foretold.

If, *e.g.*, 0·1 mol. of one salt and 0·1 mol. of another salt (per 1000 gms. of total solution) are added to the phenol water mixture, and no complex occurs, the critical solution temperature found is the mean for 0·2 mol. of each salt separately. If a complex is formed in solution there is a change in condition and temperature.

Simple mixture was found in the case of the following :—

NaCl, KCl : KCl, LiCl.
$MgSO_4$, K_2SO_4 (schoenite)
$MgSO_4$, Na_2SO_4 (astrakanite)
Alums
$MgSO_4$, KCl (kainite).

Complex formation :—

HgI_2,KI
CdI_2, KI.
Sodium ferrioxalate
Sodium ferrocyanide.

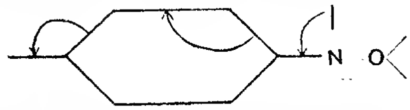
In reply to Prof. Bassett, Mr. Patterson said that the advantage of his method over other recognised methods lay in its greater delicacy and ease of application, and in the fact that the question of the influence of the solvent did not arise.

Prof. C. K. Ingold next discussed :—

The nature of the alternating effect in carbon chains. Part I. The directing influence of the nitroso-group in aromatic substitution.

The directing influence of the nitroso-group in aromatic substitution has been determined—for chlorination, bromination and nitration—and the results are better in harmony with the view that the alternation along a carbon chain is an alternation in the quantity, rather than in the electropolar quality, of the residual affinity.

A letter from Prof. R. Robinson, in the following terms, was read by the Secretary :—" The directive effect of the nitroso-group ought to be *o-p* because like the azo-group and one end of the azoxy-group it is a group which can increase its covalency with the nuclear carbon with the aid of free electrons (lone pairs) in the octet of the nitrogen atom nearest to the nucleus. Aromatic substitution in the course of nitration, halogenation, sulphonation, or coupling with diazonium salts depends on a reaction cycle in the performance of which the carbon atom in the position attacked becomes negatively charged. By virtue of the tendency for a more even distribution of valency (actual, not residual) such negative charge is very easily acquired in the *p*-position to any atom attached to the nucleus and containing lone pairs in its octet. Representing an electron pair by a line, the following exhibits the covalency changes leading to the negatively charged *p*-position :



This figure is in strict accordance with the views on the electronic explanation of conjugation which were expressed by Kermack and Robinson. It is also in agreement with Prof. Lapworth's views. According to this hypothesis only one positively and one negatively charged centre exists in any particular activated phase. Symbols such as $\overset{-}{A}-\overset{+}{B}-\overset{-}{C}-\overset{+}{D}$, etc., merely express what may happen in a number of conceivable activations of the molecule. Polar activation and valency redistribution occur simultaneously and are not, as Prof. Ingold seems to imply, irreconcilable hypotheses."

Prof. G. T. Morgan, recalling the days when he had received instruction in the Crum Brown rule from the President, remarked that the rule, although showing how substitution occurred, did not explain why it did so. Nevertheless, subsequent experimental work remained in consonance with the rule, except in the case of nitration of aromatic amines. Here, however, a derivative, and not the base itself, was usually concerned, and variation in the course of nitration according as the sulphuric or nitric acid is present in excess was usually accounted for by postulating the formation of an intermediate derivative. The speaker, while disclaiming any knowledge of " this plus and minus business," was, on the whole, rather inclined to prefer Flürscheim's theory.

Dr. B. Flürscheim remarked that substitution in the benzene ring was the simplest case for experimental investigation, which would assist in the elucidation of the whole question of chemical affinity. Whilst many experiments were necessary to prove a theory, only one was necessary to destroy it! He was unwilling to deal at such short notice with Prof. Robinson's contribution, but amid some amusement he admitted his impression that the latter author was " trying to make on the swings what he had lost on the roundabouts." Prof. Ingold's results, he said, could also be explained by Thiele's Partial Valency Theory, but that would similarly postulate *o-p*-orientation for every other substituent containing a double bond directly attached to the benzene nucleus, a postulation which was

contrary to fact. The results militated not only against the induced polarity theory of aromatic substitution, but also against any electronic aromatic substitution theory so far advanced, since the proved increase of electron affinity in proceeding from left to right of a period in the periodic classification necessitated that in —N=O, oxygen should be given the negative and nitrogen the positive sign, if signs were to be used at all.

Prof. Ingold said that his paper was primarily intended to publish a new experimental fact; he found great difficulty in understanding the views expressed by Prof. Robinson. The issue could only be settled by crucial experiments in some dozens of suitable cases.

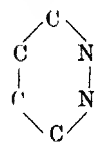
The President, in according the author the thanks of the meeting, said that Prof. Lapworth had expressed great regret at his enforced absence.

Prof. Ingold then dealt with the substance of the following three papers:—

The additive formation of four-membered rings. Part VI. The addition of azo-compounds to ethylenes and some transformations of the dimethylene-1 : 2-di-imine ring. [With S. D. Weaver.]

EXPERIMENTS on the additions of azo-compounds to ethylenes have resulted in the production of four and six-membered rings of the types I, II, and III. Some transformations of these, including the production of a hetrocyclic bridged-ring are also described.


I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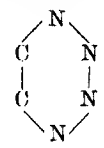
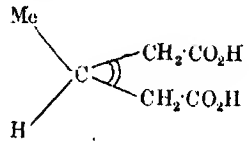

III

The chemistry of the glutaconic acids. Part XVII. Three-carbon tautomerism in the cyclopropane series. Part IV. [With F. R. Goss and J. F. Thorpe.]

A NOTEWORTHY characteristic of glutaconic isomerism is that it can co-exist with tautomeric mobility, which, presumably, would destroy any definite geometrical configuration around the double linking. It is shown that this characteristic reappears in the cyclic series, and new proofs are given (1) of the mobility of the three-carbon system; (2) of the absence of ordinary structural isomerism (*cf.* Feist, *Annalen*, 1924, **436**, 135). (Geometrical isomerism is necessarily absent for stereochemical reasons.) It is also shown that both series of isomerides can display optical activity, an observation which is being followed up since it forms an important check on all speculations regarding the nature of the isomerism.

The conditions underlying the formation of unsaturated and cyclic compounds from halogenated open-chain derivatives. Part VI. Products derived from halogenated a-methylglutaric acids.

THE correctness of the theory connecting the angles between carbon-to-carbon valencies and the atomic volumes of the attached groups is confirmed by the correspondence between the anticipated order in a series of substances and the observed order in relation to ease of ring formation. Thus in glutaric acid (II) the replacement of one of the β-hydrogen atoms by methyl would depress the angle between the acetic acid chains (I); on the other hand, the replacement of one of the α-hydrogen atoms by methyl would increase the angle because of the greater space-filling power of the branched acetic acid chain (III).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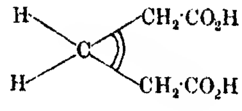
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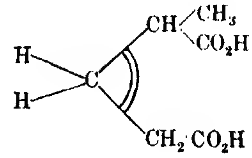
III

These conclusions have been tested by the method used in previous investigations of the series, and the results have been found to be in good agreement.

Prof. D. R. Boyd, congratulating the authors, asked whether they were convinced that in the case of the *cyclo*propene acid stereoisomerism of the deflection type was impossible.

Dr. J. L. Simonsen briefly contributed to the discussion.

Dr. F. R. Goss replied. Whilst admitting that the suggestion of an abnormal deflection of the valency linking the methyl group might serve as an explanation of the isomerism of the cyclic acid, he did not think that such a suggestion could be given weight in view of the fact that it could not be applied to the similar isomerism throughout the glutaconic series.

In view of the lateness of the hour, the reading of a paper on 6-chlorophenoxarsine by Dr. E. E. Turner and Mr. A. B. Sheppard was postponed.

THE SUGAR REFINING INDUSTRY AND THE BEET SUBSIDY

According to *The Times* it appears that the sugar-refining industry is in a serious position and considers that the Government subsidy should be confined to raw beet-sugar and not extended to its refining by the three groups engaged in the development of beet-growing. With a combined capacity for refining 1,500,000 tons of sugar annually, the industry produced only 1,100,000 t. last year, the decrease being ascribed to foreign competition. One firm of refiners, however, held more optimistic views of the future, believing that prices were near bedrock, so that a better position could be anticipated; especially as there was always a steady demand for British-refined sugar, owing to its superior quality and consistency.

CORRESPONDENCE

PERFUMES FROM SCENTLESS FLOWERS

Sir,—Great as have been the achievements of the rticulturalist in the evolution of improved fruits id blossoms, little attention seems to have been paid therto to the question of the production of perfume r the hybridisation of scentless flowers. The modi- ations of fruit and blossom probably proceed in cordance with the hypotheses advanced by Lamarck id Darwin, but the production of perfume, where one previously existed, is a problem appropriate to e technical chemist. It is noteworthy that the alian professor, Guido Mariotti, has been able by ybridisation to produce, not only a scented camelia, it also some thirteen varieties of coloured and ented gardinias shaped like roses. It may be noted so that the deliciously scented sweet pea of to-day omes from a scented stock. Perhaps it is pertinent remark that scented fruits like the pear and the pple are the product of an odourless blossom; rther, that many flowers are odoriferous at certain nes of the day, but scentless at others. This whole bject, that of the production of pleasant smelling ganic compounds by suitable plant breeding, is its infancy. It is, perhaps, not extravagant to iggest that it may develop into a very important ranch of chemical technology.—I am, Sir, etc.,

Margate F. DE FABRETTI

PERSONAL AND OTHER ITEMS

Mr. D. C. Henry, M.A., has been elected a member f the Board of the Faculty of Science in the Man- hester University.

The degree of D.Sc. of the University of London as been conferred on Mr. Harold Hunter, of East ondon College and Battersea Polytechnic.

Mr. A. F. Greaves-Walker, head of the ceramics epartment of the North Carolina State College, as been appointed consulting refractories engineer or the United States Bureau of Mines.

The honorary degree of D.Sc. was conferred on meritus Prof. J. B. Cohen, F.R.S., during the elebrations of the coming-of-age of the University t Leeds. The honorary degree of LL.D. was con- erred on M. J. Louden, chairman of the Textile ndustries and Dyeing Committee of the University.

William Alexander Smith, of Tay Bank, Helens, urgh, N.B., chairman of Messrs. Bryant and May- td., a director of the Bakau Co., Ltd., the British hemical Co., Ltd., the Scottish Acid and Alkali o., Ltd., and chairman of the Carpet Manu- acturing Co., Kidderminster, who died on August 5, aged 77, left personal property of the value of 35,217.

The name of Herman Frasch is well known to hemists, for his discovery of a method for removing bjectionable sulphur from petroleum and par- icularly for his fine chemical engineering work which nade it possible to utilise the deep-seated deposit f sulphur in Louisiana and Texas. The will of his idow, Mrs. E. B. Frasch, now made public, bequeaths several million dollars to found the Herman Frasch Foundation for Chemical Research with the object of encouraging research in agricultural chemistry.

As another illustration of the growing tendency in the United States to apply accumulated wealth for the betterment of the public, it is interesting to record that the late A. W. Preston, President of the United Fruit Co., has left, in default of issue, several million dollars to be used for "advancing the science of chemistry in the United States."

Mr. L. Emery, who died in Philadelphia recently, was a pioneer chemical manufacturer and oil producer in the United States. He will be best remembered as one of the first manufacturers of oxalic acid by the potash and sawdust process and for his staunch fight to obtain a tariff protecting the manufacture against German competition.

The death is announced, from New York, of Dr. E. J. Winter, consulting chemical engineer, who was a well-known expert on industrial distillation.

Harrison Memorial Prize

The Harrison Memorial Prize Selection Committee is unable to make an award of the Harrison Memorial Prize for 1924.

A New Insecticide

Research on various insecticides has shown that sodium fluosilicate can be used to replace arsenicals and sodium fluoride in the control of various insect pests. Sodium fluosilicate is cheaper, acts as a contact as well as a stomach poison, kills more rapidly, is not so poisonous to people and is effective against a wide range of insects. The disadvantage of commercial sodium fluosilicate is its density, but it is hoped (*J. Ind. and Eng. Chem.*, Dec., 1924) that with further research a sodium fluosilicate suitable for dusting to control the boll weevil will be ob- tained.

Academie d'Agriculture

M. E. Roux described recent work by M. F. Picard, on the extraction of tannins. Acetone, in which all the tannins are soluble, cannot extract the whole of the tannins in vegetable tissues, boiling water or steam being used for industrial extraction. Extrac- tion, however, is not complete, and a large quantity of tannin is lost. According to M. Picard this loss could be avoided by a double treatment with ether and boiling water, it being possible to recover practi- cally the whole of the ether used for extraction.

Nitrate Producers' Association.

Sales of Chilean nitrate have been resumed by the Producers' Association, an amount of 21,436 metric quintals having been disposed of for delivery in January, 1926. These sales represent the first contracts which had been made since the week ended November 6, when 41,656 metric quintals were sold for shipment in January and February. The total sales of the fertiliser to date for delivery in the current season amount to 18,620,753 metric quintals.

REVIEW

LOW-TEMPERATURE CARBONISATION. By S. N. WELLINGTON and W. R. COOPER. Pp. ix+238. London: Charles Griffin and Co., Ltd., 1924. Price 25s.

The authors present a well-arranged and illustrated account of the more important of the processes proposed for the low-temperature carbonisation of coal. The historical record will prove to be of interest to many, and the chronological treatment of the patent literature in a separate section is to be commended, since the main text is rendered much more readable by its elimination.

To the general reader the section of most interest is that in which the possibility of combining low-temperature carbonisation plant with electrical generating stations is examined in considerable detail. Several alternative proposals are set out and discussed from an economic point of view. The assumptions made will not be accepted *in toto* by anyone. Some of them are startling until it is seen that the authors do not wish to allow bias to influence the figures in favour of raw coal. Perhaps it is sufficient to indicate that the conclusions are very nearly in favour of the consumption of raw coal under boilers at the generating stations in preference to any form of combination of the power plant with the low-temperature carbonisation process. This chapter is of distinct value, since the reader can substitute his own market values for those given and should be assisted in forming considered opinions upon points which are too often the subject of popular discussion without sufficient reference to fact.

The rest of the book is made up of an account of a detailed analysis of a particular low-temperature tar and of notes upon the chemistry of tar and of coal. It is reminiscent of a student's note-book and should have been given more consideration before publication. The abstracts of scientific papers are good in themselves, but an attempt has been made to cover too wide a field, with the result that there is some lack of co-ordination. The reference to the factors affecting the free carbon content of tar is likely to leave quite a wrong impression with the reader, since no hint is given that the free carbon found in ordinary gasworks tar is mainly the result of the decomposition of volatile hydrocarbons at the high temperatures of the retort and is largely influenced by the amount of the free space within the retort.

H. HOLLINGS

PARLIAMENTARY NEWS

British Dyestuffs Corporation

Replying to Mr. Waddington, Sir P. Cunliffe-Lister stated that the question of the financial reorganisation of the British Dyestuffs Corporation had for some time been receiving the attention of the board of the Corporation. They had been informed that the Government were prepared to give favourable consideration to any reasonable scheme with that object in view which may be put forward. In a written answer to Sir W. de Frece, he also said that the Government Directors of the British Dyestuffs Corporation received the same remuneration as the ordinary directors. This also applied to the recently-appointed Government director.—(Dec. 16.)

British Sugar (Subsidy)

In introducing the financial resolution to authorise the payment of a subsidy in respect of every hundredweight of sugar or molasses, Mr. E. Wood said that for refined sugar of a polarisation exceeding 90° the subsidy would be at the rate of 19s. 6d. per cwt. for the first four years, 13s. per cwt. for the three following years, and 6s. 6d. for the final three years, other grades of sugar and molasses being provided with appropriate rates. The policy had been proposed because the experience of all beet-producing countries showed that with this industry it was necessary to be prepared to give a measure of assistance in the earlier years. As a condition of the subsidy it would be necessary for the factory to pay the growers a certain minimum price for the beet which they buy from the farmers during the first four years. That price would be fixed at 44s. a ton with 15½ per cent. sugar content. The second condition was that a factory enjoying the subsidy should use machinery 75 per cent. of which was made in this country. The scale of the subsidy proposed was exactly the same as the scale at present enforced in the Customs Duty, and endeavour had been made to hold the scales evenly between the raw-sugar interest and the refining interest. Some wished to make fine sugar, whereas others, partly because the process was less expensive, and partly because they had no other facilities, wished to stop at the raw-sugar process, and the scale was devised in an endeavour to mete out impartial justice according to a scale, the scientific value of which had been more or less accepted. There was nothing to prevent the refining interest itself going into this business and establishing its own factories and thereby qualifying itself to draw the subsidy. It was proposed to extend slightly the principle by which, if a refiner preferred to go into the raw-sugar process and carry the raw sugar away to his existing refinery, he should receive the sugar subsidy on the refined sugar, on the final stage in the refinery. In conclusion it was stated that the cost of the final resolution would be about £530,000, but off this should be taken about half, which represented the income from the reimposed excise, leaving the net cost to the State about £265,000. The resolution was carried by 223 votes to 22.—(Dec. 18.)

Safeguarding of Industries Act.

Replying to Sir Robert Gower's proposal that owing to the very serious position of the glass-making industry in the United Kingdom on account of unfair foreign competition, glass should be included in any legislation that may be brought in to protect efficient industries, Sir P. Cunliffe-Lister stated that the Government did not intend to schedule any industries in the Safeguarding of Industries Bill. Duties would only be imposed after an enquiry had established that a particular industry fulfilled the necessary conditions.—(Dec. 18).

COMPANY NEWS

COURTAULDS, LTD.

It has been reported that Messrs. Courtaulds have acquired the rights over a new process for the manufacture of artificial silk, by the use of which it is hoped to effect greater economy in production costs and to turn out a much higher-grade material of consistent quality.

A dividend on the 5 per cent. cumulative preference shares will be paid on January 1.

PEACHEY PROCESS CO., LTD.

The annual ordinary general meeting was held on December 17, Sir R. W. Gillan (chairman) presiding. The past year, so far as immediate concrete results were concerned, had been a disappointing one. Very much had depended on the progress of the leather company, since they were the pioneers, and the delay in the development of that company's operations (*cf. Chem. and Ind.*, Dec. 12, 1924, p. 1242) had acted unfavourably on the development of other lines. If this company succeeded, rapid development of business would result, and it was certain that the issue would be settled in a very short time, and their action would have to be made accordingly. The directors proposed, therefore, to call an extra-ordinary general meeting before the end of April next, when the shareholders would be informed of all the facts and of the directors' proposals, and would have an opportunity of discussing them. There had been a large decrease in expenditure, the directors having waived their fees, which had not been drawn for over two years. It was thought inadvisable to weaken control over foreign rights, but it was felt that it would be in the interests of both companies to establish a cordial understanding with the leather company, and for this purpose a joint committee of representatives had been formed.

METROPOLITAN-VICKERS ELECTRICAL CO., LTD.

Mr. Arthur E. Scanes, secretary of the company, will retire at the end of the current year, after being associated with them for 35½ years. Mr. R. H. Haviland has been appointed acting joint secretary as from January 1 next.

SANTA RITA NITRATE CO.

An interim dividend has been declared of 5 per cent., less tax, payable to holders registered on December 18. The dividend for 1923 was 15 per cent., and no interim was paid.

SULPHIDE CORPORATION

The accounts for the year to June 30, 1924, show a net profit of £84,142, to which has been added £100,000 over-provided in former years against taxation, making a total of £184,142. From this has been deducted £183,942 for capital expenditure in excess of amortisation, leaving £200 to be carried forward. In order to combat the fire which broke out in July, 1923, the amount of £187,123 was taken from the reserve for contingencies, reducing that reserve to £92,877.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£21 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	.. **£45 per ton.**
Powder.. ..	.. **£47 per ton.**
Acid Hydrochloric	.. 3s. 6d.–6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	.. **£21 10s.—£27 per ton makers' works, according to district and quality.**
Acid Sulphuric ..	.. **Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.**
Ammonia Alkali..	.. **£6 15s. per ton, f.o.r. Special terms for contracts.**
Bleaching Powder	.. **Spot £11 d/d.; Contract £10 d/d. 4 ton lots.**
Bisulphite of Lime	.. **£7 10s.** per ton, packages extra.
Borax, Commercial—	
Crystal.. ..	.. **£25 per ton.**
Powder.. ..	.. **£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)**
Calcium Chloride (Solid)..	£5 12s. 6d. to £5 17s. 6d. per ton, carriage paid.
Copper Sulphate ..	.. **£25 per ton.**
Methylated Spirit 64 o.p.—	
Industrial ..	.. **2s. 7d.—2s. 11d. per gallon, according to quantity.**
Mineralised ..	.. **3s. 8d.—4s. per gallon, according to quantity.**
Nickel Sulphate ..	.. **£38 per ton d/d. Normal business.**
Nickel Ammon. Sulphate	
Potash Caustic ..	.. **£30—£33 per ton.**
Potass. Bichromate	.. **5¾d. per lb.**
Potass. Chlorate..	.. **3d.—4d. per lb.**
Salammoniac ..	.. **£32 per ton d/d.**
Salt Cake.. ..	.. **£3 10s. per ton d/d.**
Soda Caustic, solid	.. **Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.**
Soda Crystals ..	.. £5—£5 5s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	.. **£24 per ton.**
Sod. Bicarbonate (refined)	£10 10s. per ton, carr. paid.
Sod. Bichromate..	.. **4¼d. per lb.**
Sod. Bisulphite Powder 60/62%.. ..	.. **£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.**
Sod. Chlorate ..	.. **3d. per lb.**
Sod. Nitrate refd. 96%	.. **£13 5s.—£13 10s. per ton ex Liverpool. Nominal.**
Sod. Sulphide conc. solid 60/65	.. About £15 per ton d/d.
Sod. Sulphide cryst.	.. £9 5s. per ton d/d.
Sod Sulphite, Pea Cryst.	**£15 per ton f.o.r. London, 1-cwt. kegs included.**

RUBBER CHEMICALS

Antimony sulphide—	
Golden	.. **6¼d.—1s. 2d. per lb., according to quality.**

Antimony sulphide—	
Crimson	1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes White and Dark	5d.—9¼d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P.	£50—£65 per ton, according to quantity.
Sulphur Chloride	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£11 5s. per ton, and upwards.
Grey	£14 10s.—£15 per ton. Firmer.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand brisker in many localities.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. ,, ,, 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 9d. per gall. 60% O.P.
Solvent	5s.—5s. 3d. per gall. 40% O.P. Firmer.
Wood Tar	£4 10s.—£5 10s. per ton. Demand slack and stocks being held.
Brown Sugar of Lead	£42 per ton. Steady market.

TAR PRODUCTS

Acid Carbolic—	
Crystals	5¾d. per lb. Quiet.
Crude 60's	1s. 7d.—1s. 9d. per gall. Market quiet.
Acid Cresylic, 97/99	1s. 11d.—2s. 1d. per gall. Fair business.
Pale 95%	1s. 8d.—1s. 11d. per gall. Not much business.
Dark	1s. 7d.—1s. 9d. per gall. Market dull.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6½d.—7½d. per gall. Small demand
Unstrained	6d.—6½d. per gall.
Benzole—	Prices advanced; supplies very scarce.
Crude 65's	9d.—11½d. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 9½d.—1s. 11d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d.—1s. 7d. per gall. More inquiry.
Toluole—Pure	1s. 7½d.—1s. 9d. per gall. Steady demand.
Xylol—Coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	8d.—8½d. per gall. Not much business.
Middle Oil / Heavy Oil / Standard Specification	5½d.—6½d. per gall., according to quality and district. Market firmer. Steady demand.
Naphtha—	
Solvent 90/160	1s. 3d.—1s. 6d. per gall. Demand good. Market very firm.
Solvent 90/190	1s.—1s. 1d. per gall. Few inquiries.
Naphthalene Crude—	Cheaper in Yorkshire than Lancashire. Demand rather better.
Drained Creosote Salts	£3—£5 per ton. Steady but quiet.
Whizzed or hot pressed	£6—£9 per ton. No business.
Naphthalene—	
Crystals and Flaked	£12—£15 per ton, according to district.
Pitch, medium soft	50s.—60s. per ton, according to district. Plenty of inquiry for prompt and forward. Market very steady.
Pyridine—90/160	18s. 6d.—19s. per gall. Few inquiries.
Heavy	11s. 6d.—12s. per gall. Rather flat.

INTERMEDIATES AND DYES

Business in dyestuffs has been maintained but without further improvement.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb. naked.
Acid H.	3s. 10d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid, Salicylic, tech.	1s. 0½d.—1s. 1d. per lb.
Acid Sulphanilic	9d. per lb. 100% basis d/d.
AluminiumChloride,anhyd.	10d. per lb. d/d.
Aniline Oil	8d. per lb. naked at works.
Aniline Salts	8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	3s. 10d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chloraniline	3s. per lb. 100% basis.
p-Chlorphenol	4s. 3d. per lb. d/d.
o-Cresol 29/31° C.	3½d.—4d. per lb. Fair demand.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	2s. 3d. per lb.
Dichloraniline S. Acid	2s. 3d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 3d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 2½d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
G. Salt	2s. 3d. per lb. 100% basis d/d.
Monochlorbenzol	£63 per ton.
α-Naphthol	2s. 4d. per lb. d/d.
β-Naphthol	1s. per lb. d/d.
α-Naphthylamine	1s. 3½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.

m-Nitraniline ..	.. 4s. 2½d. per lb. d/d.
p-Nitraniline ..	.. 2s. 2½d. per lb. d/d.
Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. 3d. per lb d/d.
Nitronaphthalene	.. 10d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 4s.. per lb. d/d.
p-Phenylene Diamine	.. 10s. per lb. 100% basis d/d.
R. Salt	.. 2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 2d. per lb. 100% basis d/d.
o-Toluidine ..	.. 10d. per lb. naked at works.
p-Toluidine ..	.. 2s. 10d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £45 per ton, ex wharf London, in glass containers.
Acid, Acetyl Salicylic	.. 3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P.	.. 2s. 0d. per lb.
Acid Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 4½d. per lb. Increased demand.
Acid, Gallic ..	.. 2s. 9d. per lb. for pure crystal in cwt. lots. Easier.
Acid, Pyrogallic, Cryst..	. 7s. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic ..	.. 1s. 6d.—1s. 8d. per lb., according to quantity.
Acid, Tannic B.P.	.. 2s. 10d. per lb. Quiet steady demand.
Acid, Tartaric ..	.. 1s. 1d. per lb., less 5%.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 1s. 10d.—2s. per lb. More enquiry.
Amidopyrin ..	.. 14s. 6d. per lb.
Ammon. Benzoate	.. 3s. 3d.—3s. 9d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone.. ..	.. 13s. 9d. per lb. Slightly lower. Quiet steady demand.
Benzonaphthol ..	.. 5s. 3d. per lb. spot.
Bismuth Carbonate	.. 8s. 6d.—10s. 6d. per lb.
,, Citrate ..	.. 8s. 6d.—10s. 6d. ,,
,, Salicylate	.. 8s. 0d.—10s. 0d. ,,
,, Subnitrate	.. 7s. 7d.—9s. 7d. ,, According to quantity. Prices recently reduced.
Borax B.P. ..	.. Crystal £29, Powder £30 per ton.. Carriage paid any station in Great Britain.
Bromides	.. Market less firm. Prices uncertain
Ammonium ..	.. 2s. 1d. per lb.
Potassium ..	.. 1s. 10d. per lb.
Sodium.. ..	.. 1s. 11d. per lb.
Calcium Lactate ..	.. 1s. 6d.—1s. 8d. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate ..	.. 4s. per lb.
Chloroform ..	.. 2s. 6d. per lb. for cwt. lots.
Formaldehyde ..	.. £48—£49 per ton in barrels, ex wharf London. Supplies exceed demand.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Glycerophosphates—	
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. ,,
Guaiacol Carbonate	.. 9s. per lb. Reduced in price.
Hexamine ..	.. 3s. per lb. for bold crystal. Powder slightly less.
Homatropine Hydrobromide	.. 25s.—30s. per oz.
Hydrastine hydrochlor	.. English make offered, 120s. per oz.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. ,,
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb. Price recently reduced.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Light, pure ..	.. £40 per ton.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £25 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 57s. per lb. for December delivery.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials ..	.. Market very quiet. Mercury slightly firmer.
Red oxide ..	.. 5s. 2d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 5d.—3s. 7d. ,,
White precip. ..	.. 4s. 6d.—4s. 8d. ,,
Calomel ..	.. 3s. 10d.—4s. ,,
Methyl Salicylate	.. 1s. 9d.—2s. per lb.
Methyl Sulphonal	.. 22s. per lb. Slightly weaker.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 2s. 8d. per lb. for B.P. quality.
Paraldehyde ..	.. 1s. 2d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin ..	.. 5s. 6d. per lb.
Phenazone ..	.. 6s. per lb.
Phenolphthalein ..	.. 5s. 3d. per lb. for cwt. lots. Again lower in absence of active buying.
Potass. Bitartrate—99/100% (Cream of Tartar) ..	.. 86s. per cwt., less 2½% for ton lots.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Ferricyanide	.. 1s. 9d. per lb. Quiet.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included, F.o.r. London.
Potass. Permanganate	.. 7½d. per lb. spot. Forward prices higher.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 5s. per lb. in fair quantities. Supplies exceed demand.
Saccharin ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. per lb. for cwt. lots. Slightly lower. Limited demand.
Silver Proteinate..	.. 9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.

Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.	
Sod. Nitroprusside	16s. per lb.	
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Quiet market.	
Sod. Salicylate	Powder 2s. 1d.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 4d. per lb. Flake 2s. 6d. per lb. Strong demand. Market firm.	
Sod. Sulphide—Pure recryst.	10d.—1s. 2d. per lb.	
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.	
Sulphonal	14s. 6d. per lb.	Little demand.
Thymol	18s. per lb.	

PERFUMERY CHEMICALS

Acetophenone	11s. per lb.	Cheaper.
Aubepine	12s. 6d. per lb.	Cheaper.
Amyl Acetate	3s. ,,	
Amyl Butyrate	6s. 6d. ,,	
Amyl Salicylate	3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,	
Benzyl Alcohol free from Chlorine	2s. 9d. ,,	
Benzaldehyde free from Chlorine	3s. 3d. ,,	
Benzyl Benzoate	3s. 6d. ,,	
Cinnamic Aldehyde—Natural	18s. 6d. ,,	
Coumarin	17s. 3d. ,,	Again cheaper.
Citonellol	20s. ,,	
Citral	9s. ,,	Dearer.
Ethyl Cinnamate	12s. 6d. ,,	
Ethyl Phthalate	3s. ,,	
Eugenol	10s. 6d. ,,	
Geraniol (Palmarosa)	33s. 6d. ,,	
Geraniol	12s. 6d.—20s. per lb.	
Heliotropine	6s. 9d. per lb.	
Iso Eugenol	16s. ,,	
Linalol ex Bois de Rose	26s. ,,	
Linalyl Acetate	26s. ,,	
Methyl Anthranilate	10s. ,,	
Methyl Benzoate	5s. ,,	
Musk Ambrette	50s. ,,	
Musk Xylol	14s. ,,	
Nerolin	4s. 6d. ,,	
Phenyl Ethyl Acetate	15s. 6d. ,,	
Phenyl Ethyl Alcohol	15s. ,,	Cheaper.
Rhodinol	50s. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. 4d. ,,	
Vanillin	25s.—25s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	
Anise Oil	2s. 10d. per lb.	
Bergamot Oil	15s. per lb.	Cheaper.
Bourbon Geranium Oil	30s. per lb.	
Camphor Oil	65s. per cwt.	
Cananga Oil Java	11s. 3d. per lb.	
Cassia Oil, 80/85%	9s. 3d. per lb.	Cheaper.
Cinnamon Oil, Leaf	6¼d. per oz.	
Citronella Oil—Java 85/90%	7s. per lb.	
Citronella Oil—Ceylon	3s. 4d. per lb.	
Clove Oil	8s. 3d. per lb.	
Eucalyptus Oil 70/75%	2s. 2d. per lb.	
Lavender Oil—French 38/40% Esters	35s. per lb.	
Lemon Oil	3s. 4d. per lb.	Dearer.
Lemongrass Oil	5s. 9d. per lb.	
Orange Oil, Sweet	11s. per lb.	
Otto of Rose Oil—Bulgarian	42s. 6d. per oz.	
Otto of Rose Oil—Anatolian	28s. per oz.	
Palma Rosa Oil	17s. per lb.	
Peppermint Oil—Wayne County	45s. per lb.	
Peppermint Oil—Japanese	23s. 6d. per lb.	
Petitgrain Oil	9s. 9d. per lb.	
Sandal Wood Oil—Mysore	26s. 7d. per lb.	
Sandal Wood Oil—Australian	18s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Feb. 10th, they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Dec. 25th.

I.—Applications

Bamford. Centrifugal separators etc. 29,643. Dec. 10.

Gibbons Bros., Ltd., Marle, and Walter. Furnaces. 29,624. Dec. 10.

Granton and Smith. Separation of suspensoids or solids from liquids. 29,834. Dec. 11.

Hill. Kilns. 29,625. Dec. 10.

N. V. Handelsonderneming Feynald Maatschappij tot Exploitatie van Octrooien. Reducing-agents. 29,454. Dec. 8. (Ger., 7.12.23.)

Soc. d'Exploit. des Proc. Hidoux. Apparatus for mixing pulverulent etc. matter and liquid. 29,405. Dec. 8. (Belgium, 12.12.23.)

Synthetic Ammonia and Nitrates, Ltd. Means for utilising energy of liquids under pressure containing gases. 29,979. Dec. 13. (U.S., 17.12.23.)

Vacuumschmelze Ges. 29,463. *See* VIII.

I.—Complete Specification Accepted

22,249 (1923). Obermiller. Method of giving to air and other gases a definite moisture content. (204,039.)

II.—Applications

Allgemeine Vergasungs-Ges. Distillation of bituminous coal. 29,499. Dec. 9. (Fr., 24.6.24.)

Cox and McDermott. Refining of oils etc. 30,030. Dec. 13.

Dunstan, Pitkethly, and Smith. Utilisation of gas. 29,598. Dec. 9.

Finlayson, Smith, and Woodall-Duckham, Ltd. Removal of sulphuretted hydrogen from gas. 29,732. Dec. 10.

Henshaw, and Holmes and Co. Manufacture of fuel gases 29,826. Dec. 11.

Krauss. Treating fuels at different temperatures. 29,403. Dec. 8.

Lomax, Lucas, and V. L. Oil Processes. Cracking liquid hydrocarbons. 29,560. Dec. 9.

Longhi. Obtaining acetylene etc. 29,701. Dec. 10.

Patart. Gasifying coal etc. 29,561. Dec. 9. (Fr., 11.12.23.)

II.—Complete Specifications Accepted

22,259 (1923). Bloxam (Barnickel and Co.). Treating petroleum emulsions. (225,617.)

27,366 (1923). Morgan. Fuel for internal combustion engines. (225,685.)

IV.—Applications

Heyl. Manufacture of barium azo pulp or dry lakes 29,698. Dec. 10.

Imray. (Farbwerke vorm. Meister, Lucius, und Brüning Manufacture of dyestuffs etc. 29,558. Dec. 9.

[?]—Complete Specification Accepted

[?]485 (1923). British Dyestuffs Corp., Ltd., Baddiley, and Tatum. Dyes of the anthraquinone series. (225,678.)

V.—Applications

British Celanese, Ltd., Dickie, and Rooney. Manufacture of products having basis of cellulose derivatives. 29,720. Dec. 10.

Burlin, Holman, and Leicester. Manufacture of cellulosic material. 29,707. Dec. 10.

Carrier Engineering Co., Ltd., and Groom. 29,948. *See* XIII.

Cross and Engelstad. Manufacture of lignone derivatives. 29,731. Dec. 10.

Kampf. After-treatment of spools of artificial silk, horsehair, etc. 29,829. Dec. 11. (Ger., 3.7.24.)

Pennell. 29,457. *See* XIX.

Plinatus. Producing marble etc. effects on celluloid etc. 29,445. Dec. 8.

Plinatus. Production of coatings for nitrocellulose etc. masses. 29,566. Dec. 9.

V.—Complete Specifications Accepted

14,572 (1923). Lilienfeld. Production of viscose. (212,865.)

31,444 (1923). Soc. Franç. des Crins Artificiels. Conservation of the pellicles of hydrate of cellulose. (224,487.)

VII.—Applications

Spath. Extraction of nitrogen compounds from the air. 29,714. Dec. 10.

Synthetic Ammonia and Nitrates, Ltd. Treating synthesis gases of synthetic ammonia plants. 29,978. Dec. 13. (U.S., 13.12.23.)

VII.—Complete Specifications Accepted

19,612 (1923). Blumenfeld and Weizmann. Preparation of titanium hydroxide. (225,593.)

27,785 (1923). Reitmair. *See* X.

842 (1924). Fabr. [?] de produits chimiques de Thann et de Mulhouse. Manufacture of cyanides from alkaline earth cyanamides. (225,160.)

VIII.—Applications

Frink. Annealing glassware. 29,995. Dec. 13.

Vacuumschmelze Ges. Production of refractory linings for furnace hearths. 29,463. Dec. 8. (Ger., 21.12.23.)

VIII.—Complete Specifications Accepted

6122 (1924). Soc. Progil. Cold enamelling on wood, metal, cement or like surfaces. (215,722.)

8041 (1924). Cachemaille (Westinghouse Lamp Co.). Coating siliceous or vitreous articles. (225,763.)

16,325 (1924). Wade (Dixon Co.). Plate glass annealing lehrs. (225,789.)

IX.—Application

Wilkening. Heat insulating materials. 29,426. Dec. 8. (Ger. 22.12.23.)

IX.—Complete Specification Accepted

14,868 (1923). Ersley. Product for binding dust on roads etc. (225,587.)

X.—Applications

British Thomson-Houston Co., Ltd. Extraction of metals etc. from ores etc. 29,914. Dec. 12. (U.S., 14.12.23.)

Bruninghaus. Production of steel. 29,734. Dec. 10.

Buchalo and Haefeli. Treatment of cast metal. 29,479. Dec. 8. (Switz., 20.11.24.)

Falkenberg. Process for obtaining lead-tungsten alloys. 29,444. Dec. 8.

Marks (Schlesisches Kohlenforschungs Institut). Smelting of ores. 29,449. Dec. 8.

Procter. Application of white Babbitt-metal etc. to iron, steel, etc. 29,441. Dec. 8.

X.—Complete Specifications Accepted

27,785 (1923). Reitmair. Dispersal of mineral raw materials by chemical action. (225,687.)

7519 (1924). Metallbank und Metallurgische Ges. Improving alloys and metals. (213,575.)

12,914 (1924). Hodges. Educting valuable ingredients from ores etc. (225,779.)

18,345 (1924). Thaud, and Soc. Electro-metallurgique de Mont-Richer. Production of magnetic steels with a high content of silicon. (222,088.)

XI.—Applications

Evreynoff. Electric furnaces. 29,808. Dec. 11.

Hatfield. Apparatus for electrosynthesis of gases. 29,371. Dec. 8.

Williams. Electrolyte for accumulators. 29,524. Dec. 9.

XI.—Complete Specification Accepted

233 (1924). Stone and Co., Ltd., and Midgley. Electric storage batteries. (225,719.)

XII.—Applications

Armstrong (Naamlooze Vennootschap A. Jurgens' Margarinefabrieken). Process for distilling fatty acids etc. from oils etc. 29,619. Dec. 10.

Cox and McDermott. 30,030. *See* II.

XII.—Complete Specification Accepted

19,845 (1923). Schou. Manufacture of soap. (225,595.)

XIII.—Applications

Carrier Engineering Co., Ltd., and Groom. Application of cellulose paints etc. 29,948. Dec. 12.

Heyl. 29,698. *See* IV.

Plinatus. Manufacture of varnishes. 29,567. Dec. 9.

XIV.—Application

Pearhey and Skipsey. Vulcanisation of rubber. 29,[?] Dec. 9.

XIV.—Complete Specification Accepted

14,769 (1923). Smith and Delangeaz. Preparation of cold vulcanising rubber compounds. (225,586.)

XVIII.—Complete Specifications Accepted

14,745 (1923). Jena. *See* XX.

22,281 (1923). Quaker Oats Co. Preserving biological materials or specimens. (203,692.)

XIX.—Applications

Pennell. Treatment of laundry effluent etc. 29,457. Dec. 8.

Pickett and Thomson. Treatment of animal matter. 29,467. Dec. 8.

Stevenson. Treatment of milk. 29,954. Dec. 12.

XIX.—Complete Specifications Accepted

22,281 (1923). Quaker Oats Co. *See* XVIII.

22,821 (1923). Ravnestad. Clarification or purification of liquids. (225,635.)

XX.—Applications

Farbwerke vorm. Meister, Lucius, und Brüning. Manufacture of complex gold compounds. 29,159. Dec. 8. (Ger., 2.6.24.)

Kane, Thomson, Strange and Graham, Ltd., and Synthetic Products Co. Production of acetone etc. 29,678, 29,679. Dec. 10.

Merck. Preparation of homogeneous oleaginous bismuth preparations. 30,036. Dec. 13. (Ger., 13.12.23.)

N. V. Handelsonderneming Feynald Maatschappij tot Exploitatie van Octrooien. 29,454. *See* I.

XX.—Complete Specification Accepted

14,745 (1923). Jena. Production of specific ferment remedies. (225,585.)

XXI.—Complete Specifications Accepted

24,707 (1923). Kitsee. Producing integral multi-coloured screen on photographic blanks. (225,659.)

24,714 (1923). Namias. Obtaining positive photographic pictures by means of powdered pigments. (205,092.)

25,161 (1923). Watson. Composition for use in washing photographic plates, films, or the like. (225,664.)

XXII.—Application

Plinatus. Explosives. 29,713. Dec. 10.

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CHEMISTRY & INDUSTRY

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The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

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EDITORIAL

THERE are only three or four men who would have had the temerity to address the members of the Society of Chemical Industry on recent experiments in Protection and only one, our President, Mr. Woolcock, could have performed this feat so well as he did. He has one unique qualification: he knows, as only those who have been intimately concerned in some of these experiments can know, how they have been conducted, and with what result. Mr. Woolcock avoided a discussion of the merits of Free Trade and Protection; at times he resembled a skilful skater on thin ice which would hardly bear him, at other times he explained clearly and judicially the advantages and disadvantages of the three different varieties of Protection which are now practised in this country and the conditions which should guide those who have to choose between these three varieties. He carefully avoided, as the saying is, partiality on the one hand and impartiality on the ...er one. Twenty years ago many of us read with ...tisan avidity the pamphlet by Mr. Arthur Balfour ...Insular Free Trade and the many speeches by ...Joseph Chamberlain. We knew several selected ...sages by heart and were familiar with a great ...ss of controversial literature and statistics which ...h could interpret to his own liking. In all this ...w of oratory and feast of argument there was no ...h careful and scientific a treatment of the subject ...Mr. Woolcock gave us last Monday. He indulged ... no prophecy; he told us how the different pro...ctive measures fitted into our British system and ...ow in our essentially British way the measures were ...onceived and put into operation. We heard in the ...ubsequent discussion a reference to certain funda...ental and immutable principles; Mr. Woolcock ...ndicated the means of detecting which principles ...re fundamental and immutable, and the effect on ...them of some variable conditions. The prosperity of the chemical industries of this country is of vital interest to every chemist; Mr. Woolcock's address helps us to understand how Protection affects certain parts of this industry; it seems to us that his address is singularly novel and opportune, and that every chemist, whether he is interested in politics or not, should read his careful and weighty words and remember his conclusions. This address is a striking departure from the technical and analytical discourses which have formed a large proportion of those delivered to meetings of sections. The discussion of the paper clearly showed that the topic, controversial as it might have been in less skilful hands, was handled so as to interest the audience and to set many scientific minds thinking how a number of political questions could be investigated with equal care and caution and the great problems confronting us be reduced to simple terms freed from the oratory which is necessary to stimulate the great mass of the population but is a cloud and a distraction to those who have been trained in scientific methods.

* * *

Thus with the year seasons return; the shooting season has been prematurely closed by the election season; the dining season has begun. The joint dinner of the Society of Chemical Industry and the Chemical Industry Club will be held on Friday, the 14th inst., at the Hotel Victoria, Northumberland Avenue. The Society and the Club have many things in common besides the dinner. When we consider how popular the Club is, and how much it is frequented by chemists and by others who are glad to be associated with chemists, it is somewhat surprising that such a Club was not founded many years ago. Well, better late than never, as the astronomer said when he missed his train. Founded it was in the fulness of time and now flourishing; it is a permanent and valuable part of our corporate life. The dinner will be a pleasant gathering, the numbers will be considerable, the music and speeches will prevent any prolonged and bitter arguments between those who doubt, and those who advocate, the validity of alternate polarities or the electro-negative character of zinc. There will be an atmosphere of content; sweet are the thoughts that savour of content; there will be harmony, such harmony is in immortal souls. We trust that those who partake of the feast will murmur as they leave: "Fate cannot harm me, I have dined to-day." But let not the dinner be a mere meal; let us regard it as a contribution to that better understanding of each other and of ourselves which will lead to more concerted action, more community of thought, the highest common factor of human experience, united action towards an important end, the advancement of human happiness and human prosperity. These are dark days; we can all help to brighten them. One of the greatest duties which man has is to be cheerful; to a certain extent this power grows by experience; the longer we live the happier we become. And in the month of November this duty is unusually necessary.

ECONOMY IN THE GENERATION AND UTILISATION OF STEAM. PART I

By CHAS. F. WADE, A.M.I.Mech.E., A.M.I.E.E.

When we talk about "coal," it is not sufficiently realised that this is a general name for a *class* of material rather than a substance of definite composition and characteristics. Coal may range from the almost pure carbon known as anthracite to the semi-lignite with no uncombined carbon in its composition, and consisting mainly of volatile hydrocarbons, moisture and incombustible matter or ash. Between the two extremes mentioned there is an infinite variation in the composition. While, on the one hand, the variation in the properties of coal presents the valuable feature that we have a selection of what is virtually a large variety of combustible material, each variety of which has certain properties which make it of especial value for specific purposes, on the other hand the variability, if neglected, may lead to considerable financial loss through insufficient attention to the particular properties required in the fuel for the special work to which it is to be applied.

Only too often is the purchase of fuel for manufacturing works left in the hands of a quite non-technical Stores Department which asks for coal of some particular name or decides upon purchase on the basis of size and price only. Such a method of buying almost invariably leads to financial loss, because even with coal from the same seam and pit large variations will occur from time to time in the composition of the fuel supplied, whilst the label on the truck or name of coal on the invoice does not always give a correct description of the material supplied by the agent.

This series of articles being particularly concerned with matters relating to steam raising, we will confine ourselves to the discussion of the desirable properties to be looked for when selecting a suitable fuel for economical steam raising.

Calorific Value

Although selection of fuel by calorific value against price will be a quite unsatisfactory basis of purchase by itself, yet this test forms an essential preliminary without which ultimate commercial valuation cannot be carried out. The test for calorific value is the starting point, and *the starting point only* from which we proceed to make further investigations as to the physical properties of the fuel so as to arrive at the actual suitability of the fuel for our purpose and to calculate the necessary deductions to be made from the theoretical heat value as disclosed by the calorimeter. The calorimeter test gives no idea whatever of the nature of the fuels tested, and will correctly give similar heat values for a number of fuels having widely varying characteristics in use and ultimate commercial values.

Many people have attempted to arrive at a valuation of coal on the basis of B.Th.U. of heat value per unit of price. This system would be scientifically correct if conditions of use were uniform in every case, and the ash content and percentage hydrogen of the fuel were constant in composition and amount respectively. Selection by calorific value will only be correct where the coal is already known to be suitable in respect to its proportion of volatile matter and fixed carbon and the nature of its ash. Even then the commercial value of the fuel will not bear a regular proportion to the calorific value, as the calorific value does not decrease nearly so rapidly as the practical value with increase of ash content.

Practical Selection of Coal

This involves a simultaneous investigation of the various properties of the fuel in the laboratory, together with careful observation of the behaviour of the coal under working conditions, combined with careful tests of the various losses associated with the particular fuel under observation.

In addition to the test for calorific value the other laboratory investigations consist of proximate analyses of the fuel so that its composition in terms of moisture, volatile matter, "fixed" carbon and ash will be determined, together with visual observation of the coking properties of the coal and the nature of the ash. It is usual to include a sulphur determination in addition to the proximate analysis, but for steam raising purposes this is of little value and may be omitted without detriment to the pra[illegible] value of the results obtained.

Proximate Analysis

This consists essentially of a progressive heating of the fuel under varying conditions of temperature and air admission. A detailed description of the various stages of this analysis is outside the scope of this article, but a summary of the procedure is given herewith.

(1) *Moisture* is determined by heating a weighed sample of the finely powdered fuel in a current of air in an air-jacketed oven until there is no further loss of weight. The difference in weight before and after heating gives the uncombined moisture in the fuel. As with all the stages of proximate analysis, this test must be carried out under standard conditions, preferably those recommended by the Fuel Research Board and published in their Interim Report on Methods of Analysis of Fuel (H. M. Stationery Office).

The moisture test should be carried out on the air-dried fuel or a sample of the fuel which has been powdered and placed in a desiccator overnight. Free moisture is not a characteristic feature of any fuel, but is influenced mostly by weather conditions in transport and does not therefore affect the real value of the coal.

Water also exists in the combined form in coal mainly as carbohydrates of the cellulose type, whilst hydrogen and oxygen also occur in other portions of the coal substance, but the original combinations of these elements are but slightly known at present. Empirical formulæ are available by which a close approximation to the actual percentages of oxygen and hydrogen may be arrived at, but a knowledge of the percentage of hydrogen is the more important point in determining the actual practical value of a

bituminous coal or other fuel containing appreciable proportions of hydrogen.

(2) *Volatile Matter* is determined as a percentage of the fuel by heating a sample in a covered crucible without access of air until the whole of the volatile hydrocarbons are expelled. In order to obtain uniform results the temperature employed must be standardised because very large variations in volatile matter will be caused by heating at different temperatures owing to the variation in the nature of the reactions. The temperature now adopted as a standard is 900° C. The residue from the volatile matter test is the coke, consisting of the "fixed" carbon and ash of the original fuel.

(3) *Percentage Ash* is obtained by roasting a sample of the fuel in a muffle at a high temperature and in a current of air until the whole of the combustible is removed and only incombustible residue remains.

These three tests constitute the usual routine of proximate analysis, the percentage of fixed carbon being obtained by difference from the other three determinations.

Hydrogen in Fuel.—This may be determined directly by the ordinary methods of organic analysis, in a combustion tube; but this is not usual in the majority of practical fuel laboratories. Hydrogen is usually calculated by means of some empirical formula, such as Diederichs', which is as follows :—

$$H = V \left(\frac{7\cdot35}{V + 10} - 0\cdot013\right),$$

where H = percentage of hydrogen in the combustible.

V = percentage of volatile matter in the combustible,

and combustible = Volatile matter plus fixed carbon

The total hydrogen in the air-dried coal will therefore be the hydrogen as found above plus one-ninth of the moisture.

The importance of the hydrogen content lies in the effect of the water produced by the combustion of hydrogen in absorbing a very large amount of heat which is carried away in the waste gases in the form of latent heat of evaporation, in addition to sensible heat and superheat. In the calorimeter the whole of this heat is recovered, owing to the condensation of the water of combustion, thus giving a higher figure of heat value than can be obtained in practice where condensation does not take place before the gases reach the atmosphere.

Coke.—The coking properties of the coal may be very well observed during the test for volatile matter, and note should be made of the hardness and coherence of the coke produced. Heavily caking coals are to be avoided as far as possible when selecting steam coal for average working conditions because of the great difficulty in obtaining complete combustion with moderate draught without excessive opening of firing doors for slicing and poking.

Ash.—The principal point to be noticed about the ash is its fusibility. Low fusing-point in ash is generally caused by iron compounds which exercise a strong fluxing action on the other constituents of the ash. Such low fusing-point is shown in the proximate analysis by the colour of the ash, which varies from dark chocolate brown in the very fusible ash to pure white in which case the iron content is negligible, and the fusing point very high. Low-fusing ash reduces the practical value of a fuel much more than a high-fusing ash. In addition to the actual reduction in heat value, due to the incombustible matter, there is its action in closing up the firegrate spaces so that combustion is retarded. Again the molten slag entraps and envelops appreciable quantities of carbon so that combustion is arrested, however much air is admitted to aid in the process. Incidentally it may be remarked that American coals are very troublesome in this respect, and it is for this reason that pulverised fuel is finding such wide adoption in the States.

Apart from questions of direct economy in the use of fuel with a low-fluxing ash, considerable additional expense in the maintenance of water-tube boiler brickwork is caused by the fluxing action of the iron compounds on the brickwork, which requires much more frequent renewal than when high-fusing ash is present. This also applies to the cast-iron firebars, which burn and fuse much more rapidly with the low-fusing ash. Owing to this trouble the testing of ash fusibility is a regular feature in fuel investigations in many modern American plants.

Working Tests of Fuel

Before actual placing of a contract for the supply of a fuel a preliminary order should be given for a truck or so, of each coal which has been offered and has shown itself to be of apparently suitable character from tests of calorific value and proximate analysis, so that observation may be carried out upon the behaviour of the fuel under working conditions. Such observation should be carried out upon a boiler provided with a water meter on its feed-pipe, so that the rate of evaporation may be observed and regulated.

During the working test of the coal the following observations should be made :—

Test of waste gases by means of the Orsat apparatus and determination of the maximum percentage of carbon dioxide obtainable without carbon monoxide being present.

Temperature of waste gases.

Maximum possible rate of evaporation without carbon monoxide being present in the waste gases.

Average percentage of carbon dioxide in the gases during the whole of the trial.

Coking characteristics of the fuel, also tendency to slagging ash or otherwise.

Power required by draught fans.

Amount of fuel used and ashes removed.

Ultimate Evaluation of the Fuel

Having obtained the necessary laboratory and boiler house data as described, we are now in a position to form an accurate idea of the practical value of each fuel offered by various tenderers, in terms of B.Th.U. per unit of cost.

The first deduction to be made from the calorimeter value of the coal is the unavoidable loss due to water vapour or steam in the waste gases, caused either by moisture or combined water in the original fuel,

or by combustion of the hydrogen. This loss, known as the hydrogen loss, is obtained from the following formula :—

Loss per lb. of fuel =

$$9H([212-t]+970{\cdot}4+\{0{\cdot}48[T-212]\})$$

where

H = Hydrogen in fuel expressed as a fraction.
t = Temperature of air in degrees F.
T = Temperature of air in waste gases in degrees F.

The higher or gross calorific value of the coal, less the above deduction, gives us the lower or nett calorific value at the temperature of the waste gases for the particular case under observation. The commercial value of the fuel is not, however, by any means represented by the lower value already arrived at, for a further deduction will have to be made for the sensible heat loss in the waste gases when working under the most favourable conditions. The method of calculating these losses would require a very considerable amount of space to describe, but the formulæ may he obtained from various books on the subject.

The next deduction to be made is the loss due to unburned carbon in the ash heap; this is obtained by taking the difference between the absolute ash as found by proximate analysis and the percentage of ashes removed and calculating this as a percentage of the fuel used with the assumption that the increase of weight is due to carbon with a calorific value of 14,544 B.Th.U. per lb. This final deduction leaves us with the practical thermal value of the fuel and, under some conditions, is a measure of the commercial value.

Where coals are being selected from a large number of qualities which vary widely in calorific value and ash content the cost of labour in firing and ash removal will have to be taken into account. This is of considerable importance when considering the purchase of low-grade fuel at what appears to be a particularly advantageous rate if based upon calorimeter tests. Not only are labour charges and power costs increased when low-grade fuels are used, but the practical working calorific value will be a smaller percentage of the calorimeter value than with high-grade fuels owing mainly to the physical effect of the ash in reducing the possible thermal efficiency obtainable, as well as the maximum possible output of steam per boiler unit and per man employed.

Although the reduction below the theoretical thermal value does not increase very rapidly at first with increase of ash percentage, yet the rate of reduction increases very rapidly with ash increase until with a coal containing 40 per cent. of ash the practical value is zero under normal conditions of draught and firegrates.

If it is desired to take full advantage of the low price at which low-[illegible] coals are usually offered, the conditions un[illegible]ich such fuel is to be used will have [illegible] be ma[illegible]table for the purpose, but this wi[illegible] be a [illegible] proposition unless it is intended [illegible] use low-grade fuel permanently.

Coal should be selected for any purpose with as low a percentage of volatile matter as can be economically burned with existing conditions and possible requirements as to a reducing atmosphere ; it should have as low an ash content as possible, and the ash should be as free as possible from iron compounds ; it should not form a dense coke if required for steam raising ; it should have the highest possible calorific value per unit of price ; and for steam raising purposes it should never be purchased in a larger size than about 4-inch cobbles.

THE MAKING OF A COMPLEAT CHYMIST

By HENRY E. ARMSTRONG

(*Continued*)

Students are not often allowed to make experiments—seldom, if ever, encouraged to do so. They are spoon-fed on demonstrations and verifications. Think this out, please ! Lecturers are falsely said to *show* experiments—you can't declare the result of an *experiment* in advance, though you may foresee it ; an experiment is a question put, not an assertion ; you can give demonstrations to justify faith in your statements. Assistants are properly called *Demonstrators* ; the Experimenter, let alone the Philosopher, has not hitherto been officially recognised.

If you study Bernard Shaw's *Joan of Arc* you will realise that the lecturer who gives demonstrations is just a miracle worker. We no longer believe in the miraculous and fortunately we do not always trust lecturers ; their miracles may often be read more ways than one, as books may ; you will remember what Stevenson says in the passage I quoted. Only some of us, far too few, are seeking to make experiments.

It will be the office of those among you who become " thinkin' men " and acquire " bloomin' souls," when you go into schools, to deal with a very awkward situation. You will desire to be logical but the examiners controlling you—probably the Board of Education Inspector also—will only take the old coin. You must slip your logic in unawares. No headmaster will suffer a teacher who makes boys think—if they did they would find out the absurdity of the school system. To-day, Oxford and Cambridge, in particular, make the rational teaching of Science in schools impossible by setting questions, in the College entrance examinations, which are not fit even for their fellows. Boys are asked to gas about Ions and Electrons and all sorts of high falutin' matters but never a question on real fundamentals. No worse service to science teaching was ever done than that of allowing the Intermediate Examination to be taken from school. The Board of Education special courses have an equally bad effect. The work can't be done properly under school conditions without cramming. School is the place in which as broad a general foundation as possible should be laid : it hasn't the scientific atmosphere ; in school there should be no teaching of special branches of scientific activity, no chemistry even, certainly no elaborate makers' apparatus—only a general course bearing upon the affairs of life.

This may equally be asserted of the period at the University up to the first degree—this should be the

medal course but no clasp should be held without the medal. Each special subject might well have its clasp. The growing tendency to give degrees in special subjects is one that appals me. Thoroughness of knowledge and breadth of outlook are the essential qualifications in every profession to-day. Scarcely a problem in chemistry can be dealt with from a single point of view; nor can any problem in practice. The one-sided treatment to which problems are being submitted is leading us nowhere in particular and is a great waste of time and energy.

The burden now laid upon the student is an intolerable one—far greater than he can bear; what is worse, he is asked to memorise so much that he has no time left in which he can learn to think. The practical work is not well thought out and there is far too little of it. So-called research work is brought in at the end, too late to give the mental balance which didactic and dogmatic teaching have all but destroyed.

Chemistry needs cleaning up—a thorough stock-taking of what we have and a clear decision as to its value. We need to develop a true philosophy of our science which the student could assimilate:—

> O for a Muse of fire, that would ascend
> The brightest heaven of invention.
> A kingdom for a stage, princes to act
> And monarchs to behold the swelling scene.

Of our kingdom we are sure, for it is the world, nothing less; princes to act are wanting, who will unfold the drama we have composed in terms that monarchs and the common people will understand. members of my class are the greatest sinners—are "over-full of self affairs" and make no reasoned effort to come down from our stilts. We are in no way ourselves possessed by the scientific spirit. Let me give an illustration from my own person. Recently I have had to ask why I was born so soon. Prof. Bancroft, *the* authority on theoretical questions in the U.S.A., has been moved to discuss the *Action of Metals on Nitric Acid* and to come to the broad conclusion Acworth and I came to in 1877, that the metal merely displaces hydrogen from the acid and that products other than a nitrate are due to secondary interactions—that, as Bancroft put it, the interaction is a case of electrolytic corrosion. My remark upon this is, that if Bancroft be right and I but plagiarised him, therefore, in 1877, chemists generally must have been very obtuse—for none has accepted the view. The story of nitric acid is a disgraceful muddle in the text books. The case is made worse by the fact that, from 1885 onwards, I have persistently contended that all chemical interchange is electrolytic in character. No one has either accepted or denied my explanation. No other explanation has been offered. The Arrhenic hypothesis merely states that action is between ions; nothing is said as to the conditions which determine interaction. The subject is calmly left untouched. Chemists are satisfied to be without any clear conception of the nature of the process by which they gain their living. Such appears to be the psychology of the scientific mind—it can flatly say: "I won't think! It doesn't!"

Some of you may remember how the sage, Sembobitis, answered Balthasar: "My Lord, science is infallible but the learned often err"; how, when Balthasar had discovered a star and urged the Sage to admire it, "Sembobitis did not see the star because he would not see it. Wise and old, he did not like novelties." On this issue, I would have you study Walter Pater's *Marius the Epicurean* (Macmillan and Co. 3s. 6d.).

The learned should be made to wake up. Here the *Compleat Chymist* will come in—he must be a person trained to reason; doubting all things, ready, at all times, to discuss.

To give a technical tone to our talk, let me go a little further into this question of the acid function and also refer to certain fictions which are commonly put upon the student and which he is weak enough to accept. Just as in old days the doctrine of original sin was accepted by the good, water is made an original sinner in chemistry—it starts life bad, we are told. It is dissociated into its ions, though ever so little. The logic of this assertion is ridiculous. It is based upon the statement of one Kohlrausch that water which he had purified so far as he was able still had a certain slight electrical conductivity. The assumption made is, that the water he examined *was pure*. What does *pure* mean? To my thinking, the thing itself—free from all impurity. It is inconceivable that the Kohlrausch water can have been pure, in this sense: no vessel we can use is to be had free from surface impurity, even if it be not to some slight extent itself soluble. The doctrine of the original sin of water is, however, so firm a matter of faith among chemists that it is useless to protest. Now that Bishop Barnes is coming to Birmingham, perhaps a new miracle may be enacted: he gave away the Church's doctrine of original sin at the British Association meeting, at Cardiff, two or three years ago; perhaps, under his patronage, your Professor will become a convert—or should I say pervert—to the doctrine that water lacks morality through evil associations and would not in itself be bad could it be forced away from their company.

You know the Arrhenius speculation—I use the word advisedly, as it never was *a theory*—about electrolytes generally: that they exist in solution, more or less, as free ions; hence their activity. Though a conceivable hypothesis, it is in no way a necessary one and there is not a shred of proof that it holds; the facts, in large measure, are against it. Yet it remains fashionable at the end of nearly forty years. Who will say that chemists are not like the proverbial old woman; that their motto is not the simple converse of her's—"I know it's untrue but I believe it"? Let us hope that some day soon, if not the knight of the *Daily Mail* some other doughty champion of scientific truth, may tilt them into unbelief. I learn that tailors are at last advising their customers that the cult of the turned-up trouser is nearing its end—so anything may happen; I fancy, indeed, that the day is not far distant when the crowd *will* see that their king has no clothes. I hope you remember your nursery tales.

The short skirt of the male chemist to-day is the acid reduced to its hydrogen ion: his nakedness is

astounding, his modesty nil in wearing so little. The fashion is but a fashion—there is not the slightest reason to suppose that the acid radicle is not co-operative in all interactions of acids.

These just by way of example of problems to which the *Compleat Chymist* may well turn his attention, straws which show how carelessly blows the wind of belief among us, how doctrinaire we are apt to be, how difficult it is to be philosophical. I lay no claim to superiority but in life there must be times when the man of thought feels that, like Gilead P. Beck, he has struck 'ile. Such thought was mine in 1877. As my orbit seems to be 44 to 47 years, I feel that I may well await the time when my *unbelief* of 1885-6 and onwards in ions as freelovers becomes current as the *belief* of our tribe.

Last, let me ask—is the *Compleat Chymist* possible? Only by the method of very gradual approach and never the finished product! First, let us recognise that only the few can approach completeness. Special provision should be made for the drones, not to overburden them, whilst training them to be competent artificers, yet seeking to charge them with a sufficient burden of logic, so that if the "thinkin' man" arise in them at any time, a "bloomin' soul" may have the chance to frame itself. I have known more than one such case of late development in after-life among my pupils: suddenly, some chord has been struck to which there has been real response. Will you believe it, I was desperately afraid, at one time, that the now Sir (William) Pope would never make a chemist; that he might degenerate into a mere mathematician. However, one day, something happened: all at once his marvellously dextrous fingers were at work in every direction; the "bloomin' soul" *was* there and in full operation.

To return for a moment to nitric acid. If, as Faraday maintained, the terms chemical and electrolytic action be synonymous, if all chemical interchange be electrolytic in its nature, the acid can act only in one way and, as it were, in one place: the radicle H at the one and the radicle NO_3 at the opposite "contact" with the metal. The only possible product of the interaction of a metal and nitric acid (given the necessary third component of the electrolytic system) are hydrogen (H_2) and the nitrate. The secondary products are due to the reduction of the acid—by what? Not by the hydrogen, even when nascent—*i.e.*, still in circuit: this cannot be, as hydrogen is formed away from the acid radicle and the radicle can act neither in two places nor in two ways at once. The primary reduction of the acid must be due to some other cause. We know as a fact that nitric oxide is the primary reducing agent and it is probable that hydrogen comes into operation only after a reducible "nitrous compound" has been formed by the interaction of nitric acid and this oxide.

The *Compleat Chymist* will be an artist and—as I have said elsewhere in speaking of the work of Sir James Dewar—the experience of ages goes to show that Art of every kind is a matter of individual expression and that it cannot brook control. He must, therefore, as far as possible, be left to his own devices and mainly learn by doing. Neither at school nor at college, to-day, can the student learn to help himself nor to think for himself: he is so ceaselessly tutored and directed; he must work at play as well as play at work; he has no time in which he can cultivate hobbies and interests, little chances of becoming a good Naturalist. The true chemist is but little else: the world is his oyster, to open with stirring rod, test tube and balance.

As chemistry is before all others *the* experimental science, the early period of study at school and then at college should be spent in real experimenting—not in mere verification work. In other words *Research*, as we are pleased to call it to-day, should come at the beginning not the end of the course and be continued all through it. It is the attitude that counts in learning chemistry. Most students begin research work after the art of experimenting has been memorised out of them. As I have said elsewhere, in addressing the Institute of Chemistry, I would have students spend much time in familiarising themselves with materials, but the work should be done from their own reading not from any laboratory manual. Just as the bug-hunter collects, sets and arranges his insects, so the chemist should hunt down this and that compound and bring it into being on his bench. The Squeers principle of learning to spell winders by cleaning 'em has to be applied in chemistry. I am not speaking at random when I give this advice.

As to reading—most reading is mere memorising: the art of reading, to which I have already referred, is rarely learnt by the student. As Sir Nathaniel says (*Love's Labour Lost*):—

> He hath never fed of the dainties that are bred in a book;
> He hath not eat paper, as it were; he hath not drunk ink;
> His intellect is not replenished; he is only an animal,
> only sensible in the duller parts.

He hasn't pegs in his closet to hang the clothes upon which the examiners would have him own: so he just throws them at random into the press and may or may not be able to find this or that article when called upon to produce it. He has no joy in his clothes. The only way to read with effect is to acquire interests—best through practical work—and ever to consider the bearing of what is read upon these interests—in short, what use can be made of it.

Desultory reading leads nowhere. It is possible to read an account several times without finding anything in it—then something happens to make it of interest and when read again it may be found to be full of point. To read with effect it is necessary to have a philosophy:—

> Study is like the heaven's glorious sun,
> That will not be deep-search'd with saucy looks;
> Small have continual plodders ever won,
> Save base authority from others' books.

As to subjects of study. Just as all roads lead to Rome, so chemistry now travels upon all roads and the chemist must at least be able to wander sympathetically upon most of them. Before all things he must have real feeling for current elec-

tricity—as chemistry and physics are inseparably linked in all the phenomena of chemical interchange.

My feeling is that a chymist may be compleat without knowing a vast deal—if only he have acquired a certain outlook. It is not only undesirable but wrong to qualify the term by any prefix. "Research Chemist" is a contradiction in terms, as the man who has the "bloomin' soul" of the chemist is never otherwise than an experimentalist; those who have not are not chemists but mere artificers. Recollect always, it's the bloomin' soul that counts. The great example is that set us by Emil Fischer in the marvellous work he did in laying solid foundations for the future treatment of vital problems in terms of structural chemistry. He never called himself otherwise than Chemist and was proud of the significance of the title; he knew that he was no biologist. To-day we have a school yclept "*Biochemists*," who, for the most part, are but crude bits of chemists and still smaller bits of biologists; in like manner, the physical chemist is neither physicist nor chemist but only a fragment of each: physics and chemistry are essentially one subject. To work with a product of vital origin, such as starch, doesn't make the worker a biochemist; nor does working with enzymes, which are vital agents. Your Professor of Brewing, the pupil of whom I am especially proud, has done remarkable work on Starch. In a recent account of the inquiry, he speaks of the discovery of the several constituents of starch giving "a new conception of its nature," adding that this was "the result of the 'pure' chemist working in concert with the biochemist." This is just an "aside" to help the lame dog along: the conception comes from work done by an exceptionally qualified chemist—one of the Samurai. There ain't no such thing as a Biochemist: the "pure" chemist don't exist—to be compleat he must be very impure, a mixture of many "ists."

The spirit of Paul's message to the Corinthians should be more with us. "Now I beseech you, brethren, that ye all speak the same thing and that there be no divisions among you; but that ye be perfectly joined together in the same mind and in the same judgment."

Infinite injury is being done to our great subject by the present-day loose specialisation, built upon an insufficient foundation of primary knowledge and entirely lacking in breadth of outlook. The result is that problems are so narrowly envisaged that far too little of the work done is of practical value and our science is in serious danger of sacrificing public esteem, through lack of that culture and outlook which Huxley hoped would be gained in Mason's and like colleges.

Our Universities should take stock of the situation and consider how far they are on the downward path in failing to pay proper, adequate attention to scientific method—the method of Zadig; to consider by what means and how far method may be made the first charge upon their madness, as a corrective of the herd instinct innate in man and a means of raising his tribal efficiency.

FORTHCOMING EVENTS

Nov. 10. Biochemical Society, Physiological Department, St. Bartholomew's Hospital, 5 p.m. "Micro-estimation of Urea in 0·2 c.cm. of Blood," by G. Thomas; "Excretion of Salicyluric Acid after Ingestion of Sodium Salicylate by the Human Subject," by E. Holmes; "Carbohydrate Enzymes of Starch-free Monocotyledons," by R. E. Chapman; "Effect of Ultra-violet Irradiation of Environment on Growth and Calcification of Rats fed on Vitamin A-deficient Diet," by E. M. Hume and H. Henderson Smith; "Effect of Insulin on Cholesterolæmia," by G. A. Harrison; "Observations on Glucose and Lævulose Tolerance Tests," by R. L. Mackenzie Wallis.

Nov. 10. Institute of Brewing, Engineers' Club, 39, Coventry Street, London, W., at 7.30 p.m. "Preservative Properties of Hops," by A. Chaston Chapman.

Nov. 11. Society of Chemical Industry, *Birmingham and Midland Section*, University Buildings, Edmund Street, Birmingham, at 7.15 p.m. (1) "Studies in the Acenaphthene Series, Part I: 2-Amino-naphthene," by Prof. G. T. Moran and H. M. Stanley. (2) "Researches on Molybdenum Salts," by W. Wardlaw, F. H. Nicholls and R. L. Wormell. (3) "Observations on the Higher Fatty Acids," by G. T. Morgan and A. R. Bowen. (4) "Researches on Residual Affinity and Co-ordination, Part XXIII: Trialkylstibine Derivatives of Platinum and Palladium Chlorides," by G. T. Morgan and V. E. Yarsley.

Nov. 12. Leicester Literary and Philosophical Society, *Chemistry Section*, The Museum, Leicester, at 8 p.m. "Water Supply," by S. F. Burford.

Nov. 13. Textile Institute, *London Section*, 38, Bloomsbury Square, London, W.C. 1, at 5.45 p.m. "Textile Fibres Produced Within the Empire," by J. S. M. Ward and F. R. Econ.

Nov. 13. Oil and Colour Chemists' Association, 8, St. Martin's Place, Trafalgar Square, London, W.C. 2. "The Examination of Varnishes: Drying under Standard Conditions: Water Absorption," by J. A. F. Wilkinson and E. F. Figg.

Nov. 13. Society of Chemical Industry, *Chemical Engineering Group*, Kelvin Room, Engineer's Club, Coventry Street, W. Discussion on "Chemical Works Costs," opened by F. M. Potter and followed by H. C. Marris. W. J. U. Woolcock, C.B.E., will occupy the chair.

Nov. 13. Institute of Metals, *London Section*, Royal School of Mines, South Kensington, at 8 p.m. "Oxidation, with Special Reference to Thin Films," by Prof. T. Turner.

Nov. 13. University of London, St. Thomas's Hospital Medical School, S.E. 1, at 4.30 p.m. "Enzymes," by Prof. J. Mellanby. Also on Nov. 20 and 27.

Nov. 13. University of London, Bedford College, Regent's Park, London, N.W. 1, at 5.15 p.m. "Atomic Structure and Quanta," by Prof. W. Wilson.

Nov. 14. Institute of Metals, *Swansea Section*, University College, Singleton Park, Swansea, at 7.15 p.m. "The Inner Structure of Alloys," by W. Rosenhain.

Nov. 14. University of London, King's College, Strand, W.C. 2, at 5.30 p.m. "Scientific Method," by Prof. L. T. Hobhouse.

Nov. 14. Society of Chemical Industry, *Glasgow Section*, jointly with the Ardeer Chemical Club and the Institute of Chemistry. "Chemical Pottery," by J. G. Roberts.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

It is hoped that members who intend to be present and who have not yet applied for tickets will do so as soon as possible, in order to facilitate the seating arrangements.

SUSPENSION OF ENTRANCE FEE

As an inducement to Chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Society in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

VOL. IX (1924)

This volume is in course of preparation, and an order form will be sent out in due course with the application for the annual subscription for 1925.

The list of subjects dealt with and the names of the authors are as follows :—

Plant and Machinery	S. G. M. Ure.
Fuel	J. W. Cobb and H. J. Hodsman.
Gas—Destructive Distillation—Tar Products	W. B. Davidson.
Mineral Oils	S. J. M. Auld.
Colouring Matters and Dyes	E. H. Rodd.
Fibres, Textiles, Cellulose, and Paper	S. H. Higgins.
Bleaching, Dyeing, Printing, and Finishing	A. J. Hall.
Acids, Alkalis, Salts, etc.	P. Parrish.
Glass	E. A. Coad-Pryor.
Ceramics, Building Materials, and Refractories	W. J. Rees.
Iron and Steel	C. O. Bannister.
Non-Ferrous Metals	C. A. Edwards.
Electro-Chemical and Electro-Metallurgical Industries	J. N. Pring.
Oils, Fats, and Waxes	H. M. Langton.
Paints, Pigments, Varnishes, and Resins	C. A. Klein.
Indiarubber	D. F. Twiss.
Leather and Glue	D. M. McCandlish.
Soils and Fertilisers	H. J. Page.
Sugars, Starches, and Gums	E. Eynon and J. H. Lane.
Fermentation Industries	H. L. Hind.
Foods	G. W. Monier-Williams.
Sanitation and Water Purification	J. H. Johnston.
Fine Chemicals, Medicinal Substances, Essential Oils	H. King.
Photographic Materials and Processes	W. Clark.
Explosives	J. Weir.

LONDON SECTION

There was a large attendance at the opening meeting on November 3, when an address was delivered by the President, Mr. W. J. U. Woolcock, C.B.E., entitled "Experiments in Protection," of which an abstract follows :—

I need hardly say that in dealing with this subject I do not propose to treat it in any party political spirit. I do, however, feel that it would be useful that we should discuss together and endeavour to understand the experiments in protection which have been tried in Chemical Industry. I shall confine myself to a discussion of the methods, and not the principles of protection. There are, in general terms, only three methods which can be used to protect artificially the industries of a country :—(1) Subsidy. (2) Prohibition of Imports, except under Licence. (3) Tariff.

(1) The method of subsidy was used fairly extensively during the war. In theory it presupposes that the industry to which it is to be applied is of direct national importance and that every taxpayer is therefore concerned in its maintenance. If this is accepted it is logical to make all pay for what is for the benefit of all. In practice, however, it is a very difficult method to work. It entails the necessity of deciding to whom the subsidy shall be given; more difficult still is it to determine the amount of the subsidy. A subsidised industry always lies under the implication that it is inefficient, although the the necessity for the subsidy may be due to causes outside the control of the industry, such as depreciated currency in foreign countries and the differences in exchange values. For these reasons although the method of subsidy was used during the war, and in war time is less objectionable than in peace time, it has fallen into disrepute.

(2) *Prohibition and Licence.*—Experience has shown that where there already exists an organised body of consumers of a class of commodities or where such can be organised, the method of prohibiting the importation of these goods except under licence can be utilised with comparatively little friction. The consumer invariably feels that if there is a prohibition of foreign imports he will have to pay more for his goods. He argues that there would be no need for prohibition if the British goods were cheaper. He is, however, interested in the maintenance of the British industry quite apart from national patriotic motives, because if the foreigner has no competition in Britain, the prices the British consumer will have to pay will be higher than those charged in other foreign countries with competitive industries.

If I use the Dyestuffs (Import Regulation) Act, 1920 to illustrate this method it will perhaps make these general observations clearer. The origin of the Dyestuffs (Import Regulations) Act, 1920, and also of the Safeguarding of Industries Act, 1921 can be found in the report of the Committee on Commercial and Industrial Policy presided over by Lord Balfour of Burleigh, and usually called the Balfour of Burleigh Report. In June, 1916, the Economic Conference of the Allies held in Paris passed among other things the following resolution: "The Allies decide to take the necessary steps without

lelay to render themselves independent of the enemy countries in so far as regards the raw materials and nanufactured articles essential to the normal development of their economic activities." Following this he then Prime Minister (Mr. Asquith) appointed the Balfour of Burleigh Committee.

At the close of the war the country was provided ith a mass of emergency legislation under the Dence of the Realm Acts, and, by reason of the interetation placed upon it, with machinery under the ustoms Consolidation Act of 1876 for the restriction imports into this country. The legality of the strictions for which the Act of 1876 was evoked was sted in December, 1919, when Mr. Justice Sankey's dgment declared them to be illegal except in the se of certain specific classes of goods such as firems, ammunition, explosives, etc. The effect of the dgment was to throw wide open the door to all nds of foreign imports. To meet this situation the overnment introduced the Imports and Exports egulation Bill, which met with considerable oppoion and was dropped. The situation with regard the manufacture of dyestuffs in this country then came very acute and at the close of the year 1920 Dyestuffs (Import Regulation) Act was passed. is was followed six months later by the Safeguard- of Industries Act. The two Acts together protect their different ways, the former by prohibition and ence, the latter by tariff, most of the industries ich the Balfour of Burleigh Committee regarded as ey" industries.

he Dyestuffs Act, which came into operation on uary 15, 1921, and continues in force for ten rs, prohibits the importation of all synthetic anic dyestuffs, colours and colouring matters, all organic intermediate products used in the nufacture of any such dyestuffs, colours, or uring matters except under licence. The Act owers the Board of Trade to issue licences for the ortation of any of the articles covered by the and constitutes an Advisory Committee to advise Board as to the issue of such licences. The cedure to be followed by an importer begins with atement of the name and quantity of the dyestuff ntermediate which he desires to import, together his reasons for making the application. As the of the Act prohibits the importation of article, the onus of convincing the Advisory mittee of the necessity for importation is on the orter. The Act was passed with "a view to the guarding of the dyemaking industry"; therefore uate cause must be shown before the Committee advise that a licence should be issued. On the er hand, although it finds no expression in the there is an implied condition that, when necessary licence must be issued. The question arises, on hat grounds can the importer claim that a necessity as arisen for the issue of the licence? It is suggested hat the strongest case is made out when it is proved that: (a) The dyestuff for which the licence is required is not itself made in this country; (b) that no suitable substitute is available; and (c) that it is required by a consumer for immediate use in his business and for a stated purpose. If conclusive evidence on these three points is furnished to the Committee a licence would be issued almost automatically. An application for a licence merely on the ground that it is desired to make a speculative purchase which may or may not result in a sale is not likely to be regarded with favour by the Licensing Committee. But between these two extremes there is room for a considerable argument, and the constitution of the Advisory Committee as provided by the Act makes it certain that the application will be considered from several points of view.

The Advisory Committee is composed (Section 2 and 3) of five persons concerned in the trades in which goods of the class prohibited to be imported by this Act are used, three persons concerned in the manufacture of such goods, and three other persons not directly concerned as aforesaid. One of the last-mentioned is appointed Chairman by the Board of Trade, and in practice, if he is absent, one of the "other persons" acts as his deputy. In the main it is a technical Committee with a sufficient number of non-interested persons to hold the balance fairly between what are bound to be two opposing views. The consumers' representatives may be expected to take a somewhat pessimistic view of the possibility of a British dye-maker producing an adequate substitute for a foreign dye; the representatives of the dye-makers are apt to take a too optimistic view of the capabilities of the British dye-maker. The truth, as usual, lies between the two, and the "other persons" taking a disinterested view assist in finding it.

The machinery set up by the Act has worked quite well mainly because there is on the side of the users of dyestuffs a very efficient Colour Users' Association. Only where the products which it is desired to protect are used by a great number of unorganised concerns is the method of prohibition and licence likely to fail. The only real difficulty which arises is the amount which the consumer has to pay to maintain the industry in the country. It will be obvious that the claim to import a foreign commodity may be made on one of two grounds, namely, that no identical British product is made, or that although such a product is made its cost is so high that the firms who have to use it are handicapped in their business by its price.

The practice under the Dyestuffs Act is to put the onus of proof that the British product is equivalent in quality to the foreign dyestuff upon the British manufacturer. This question can fairly easily be settled in the testing laboratory. The onus of proof that a colour user is being placed in an unduly disadvantageous competitive position is on the user, and is not proved so easily. It is, in practice, impossible to take each individual case and demonstrate that a possible sale of, say, 100 pieces of coloured cloth has been lost because of the cost of the dye in the cloth. Yet some kind of limit has to be fixed especially if only one maker is making a particular dyestuff. Where a number are making the same colour the internal competition compels each maker to seek greater and greater efficiency and consequently a lower price. But here arises one of the fundamental problems of industry. If the total quantity required of one particular colour can be made in one works, the increased output should make

for a lowering in price to the advantage of the consumer. This is true when the foreign market is open as a check on prices and a stimulus. When, however, you prohibit the importation of the foreign article and concentrate the manufacture in one works you have to provide some other stimulus to efficiency.

The problem to be solved is, How much can the consumer afford to pay in order that the industry shall be established in this country. The answer, of course, is, the amount he estimates it would cost him if he had to rely entirely on the foreigner. This can only be an estimate. In practice the only thing to be done is to fix an arbitrary factor with which to work and agree that as long as the British price is not greater than that arrived at by the use of the factor it will be considered that the user is not being placed in an unduly disadvantageous competitive position.

3. *Tariff* Our only example of protection by means of a tariff is to be found in the Safeguarding of Industries Act, 1921. Here it is desired to protect a variety of industries the products of which go to an even greater variety of consumers. Obviously the method of prohibition and licence would be difficult to apply, and hence the tariff method is adopted. The Safeguarding of Industries Act swept into its net all the other industries, apart from dyestuffs, which had been reviewed by the Balfour of Burleigh Committee. It dealt with synthetic organic chemicals, fine chemicals, optical glass, optical instruments, wireless valves, magnetos, arc-lamp carbons, and a number of other things. It also dealt with the protection against dumping. I have little to say about the dumping part of the Act except that in the form in which it was drafted it was of very little use. I do not, however, think that no machinery can be devised for this purpose. The first part of the Act, dealing with the safeguarding of "key industries," has worked and has done something to establish firmly the industries in this country.

The Act provides that there shall be charged, levied and paid on the goods specified in the Schedule to the Act on their import into the United Kingdom a Customs duty of 33⅓ per cent. The Schedule contains a number of headings of classes of articles included in this part of the Act, and only in very few instances are the articles themselves enumerated. The Act therefore also provided in order to avoid disputes whether a particular article is covered by the Schedule, that the Board of Trade may issue from time to time lists defining the articles which are to be taken as coming within the general descriptions in the Schedule. The effect of the publication of the name of any article in such a list is the same as though the article itself were named in the Schedule. This list was first published in September, 1921, and certain amend[illegible] since been made in it.

I have [illegible] on a subject which is not per[illegible] top[illegible] which you are accustom[illegible] me[illegible]ngs. I have done so becau[illegible] the commencement, the Society holds [illegible] position in that it represents both the Scien[illegible] the Industrial sides of Chemistry. These sides have been too far apart in the past. I think perhaps your place as chemists has not been sufficiently emphasised in the industrial world. I feel even more certain that chemists have not fully recognised the necessity of studying the industrial problems as well as the scientific. For this reason, among others, I have gone out of the beaten track and sought in this way to encourage you to realise the interdependence of the scientist and the industrialist. The success of British Chemical Industry is as vital to the chemists as to the industrialists. If members of the Society, realising this, work for this end, then the Society will have more than fulfilled the task for which it was founded.

NOTTINGHAM SECTION

A discussion on "Textiles" was held jointly with the Faraday Society, at University College, Nottingham, on October 30, the Chairmen being Sir Robert Robinson, K.B.E., and Mr. G. J. Ward, M.I. & S.I. Dr. W. Lawrence Balls, F.R.S., sketched the general conditions of the textile problem, and pointed out that the unit from the textile point of view was the single hair or fibre, a unit which to all intents and purposes had only two dimensions, being entirely flexible in the third. With this material three-dimensional persons and furniture must be covered. A scale model of a cotton fibre made of rubber tubing ½ in. in diameter would be 60 ft. long. All the surface properties of such fibres became enormously important. The slivers moved over one another along these surfaces in the process of drafting, which, although invented in 1745, is one of which we knew least. By trial it had been found that the rollers should be covered with leather, should have true surfaces, and machinery had been perfected so that defects in yarn and fibres formerly due to faults in the machinery must now be considered to be inherent in the properties of the raw material. The exaggeration of these properties in one direction, which was peculiar to the material of the textile industries, opened a new field of applied physics for which the author proposed the term "Trichodynamies" in 1918.

Dr. J. Barratt, of the Research Department, Woolwich, then summarised his work on the lustre produced in cotton by mercerisation and on the measurement of the transparency of a fabric. Photographs of fabrics stretched and unstretched during mercerisation showed a much smoother surface in unstretched material, and the disappearance of the folds and creases would account for the superior brilliancy and increase in the intensity of light regularly reflected. In order to measure the intensity of light reflected at various angles a special form of Joly's photometer had been designed. Most of the increased lustre shown in a mercerised fibre was due to the light regularly reflected in a direction along the length of the fire. This regular reflection was intermediate in intensity between that from glass and that from the unmercerised thread. The diffuse reflection was greater with unmercerised fabrics, in which the lustre due to the single fibres was enhanced. A mercerised fabric also showed a distribution of very bright and very dull points. By the same photometer the relation between the total transparency and the thread transparency (*i.e.*, the percentage of the

light falling on the threads alone which was transmitted by them) could be determined. Thus, the thread transparency 24·8 of a muslin was increased to 30·8 by a "hard finish."

Dr. Guy Barr described the various methods of investigating the action of sunlight, and of artificial lights, such as the mercury arc, approximating to sunlight upon fabrics, especially those used in the construction of balloons. The distribution of destructive power in the spectrum had been investigated by Scheurer, Aston, Ramsbottom, and Glendinning; and it had been conclusively shown that the weakening of cellulose threads was chiefly due to rays of wave-length less than 4000 A.U.; cellulose was extremely sensitive to the rays of very short wave-length less than 2950 A.U., which were present in the light of the mercury arc, but absent from sunlight. The breaking strain, reduced from 120 to 102 lb. per in. by light of 6250 to 5330 A.U. transmitted through red glass, fell to 12 when transmitted through violet glass (6300 to 3230 A.U.) and to 2 with no glass. The fabric was partly protected by pigmented dopes, the most effective being lead chromate. These changes were due to oxidation, for they are almost inhibited in absence of oxygen, and cotton which had been insolated answered the tests for oxycellulose.

Dr. S. A. Shorter then gave a detailed account of his theories relating to the behaviour of woollen fabrics during manufacture under the heads:—(1) The elastic properties, (2) the absorption of moisture and its effect on the elastic properties, and (3) the surface structure of the film. The creeping of wool fabrics when rubbed was due to surface structure, which also caused the shrinkage in milling. The absorption of water could be treated thermodynamically, as heat was given out during absorption and the atmospheric humidity necessary to produce a given moisture content increased with the temperature. Thus wool saturated and apparently dry at one temperature became obviously moist on heating. Some experiments were described which seemed to show that the wool fibre was perfectly elastic; if the stretching was slow an extension of 30 or even 40 per cent. might be followed by complete recovery. Many reasons were adduced in favour of the theory that the wool fibre consisted of an elastic envelope enclosing a material which behaved as a viscous liquid. The extensibility was greater when the wool was wet. On exposure to boiling water the elastic envelope underwent a change similar to the annealing of a metal.

Dr. Barratt remarked on the variability in the results which express the action of light on textiles. There might be some other agency at work, such as a chemical action resulting in an increase of acidity, and the greater resistance of wool might be traced to the fact that it is not so easily attacked by acids. Experiments might profitably be made upon quite neutral fabrics. Dr. Balls enquired how far the effect of bacteria had been eliminated, and said the conditions governing the formation of a free water film on different fibres were different: where none existed the results might be considered free from the suspicion of bacterial or mould action. He did not claim that such action seriously vitiated the experiments, but it might mask or intensify the effect of light. The viscosity method of following the changes produced by light was very interesting; the changes in viscosity were five or six times more rapid than those in tensile strength. He suggested that the light disintegrated the fibres longitudinally and not transversely. Mr. Burford, illustrating the importance of the time factor in the recovery of fibres from stretching, said that pellets of sugar moistened with acid and then dried did not char for a long time when kept in air-tight bottles. Dr. Prideaux asked if quantitative experiments had been carried out on the effect of the standard sunlight which could be obtained in some tropical regions. Sir Robert Robertson pointed out the great differences between the solar spectrum and those of the mercury and carbon arcs. The daylight lamps used in "fadeometers" and the 1000 c.p. pointolite lamp gave results more in accordance with daylight.

Dr. Barr, in reply, said the cotton was washed thoroughly before the experiments. No elaborate precautions were taken against micro-organisms, as their effect was almost negligible compared to that of light, and those which would cause damage were destroyed, especially by the short wavelengths which were most destructive to the fabric. Some experiments had been made in the tropics, but the difficulties were great. The "daylight" lamp was not intended to give the same ultra-violet intensity as sunlight, but rather to give the same ratio of distribution in the spectrum. The explanation of the cause of the differences between the viscosity and tensile strength figures was most suggestive; was it partly due to differences in the adhesion of separate fibres? The initial high viscosity of unexposed cotton was probably due to a highly polymerised cellulose forming the outer cuticle. It was fairly well established that the outer layer, present in extremely small amount, was different from the rest; and it was probably the disintegration of this which caused the rapid fall in viscosity. The Chairman mentioned as evidence for the existence of highly polymerised cellulose the fact that in nitrating to obtain the most nitrated (most viscous) product, a portion was more highly nitrated. It contained, say, 13·8 per cent. of nitrogen, but, on stabilising, the nitrogen went down to 13·4 per cent. Replying to Mr. Heyes, Dr. Barr said that copper numbers of the solutions of exposed fabrics had not been determined. He intended to try this, but thought that the differences would be much less than those shown by the viscosity.

Dr. Bramley asked whether the effect of the rate of drafting and the temperature had been measured. Was there any connexion between the fibrils mentioned by Dr. Balls and the lustre produced by mercerisation; did they become more evident after this process? Mr. Palmer emphasised the probability that the breaking of yarn was really a surface slipping effect. In silk this effect was negligible. The strength of cotton fibre was as great as that of silk and very much in excess of that of cotton thread. Dr. Shorter inquired as to the effect of humidity on the single fibre. Was it, like the yarn, made stronger? Dr. Balls could not give

a definite opinion as to the effect of twisting and drafting on the fibres. Information on fibrils would be found in a paper read before the British Association and published in the *Empire Cotton Review*, January, 1923. The use of cotton appeared to be justified only by its great tensile strength, which in fine and coarse varieties, and allowing for air spaces, worked out at 17 to 18 tons per square inch. This, however, was not translated into the tensile strength of the yarn. Dr. Barratt remarked that the wetting of fibre increased its apparent tensile strength by increasing its extensibility. Mr. Dunford understood from the papers that wool could be stretched and allowed to recover a number of times. Would that not have a tendering effect? When hosiery goods were heated with water, would not the colloidal material be leached out or unevenly distributed?

Mr. Palmer enquired whether Dr. Shorter could apply his theory to fibres other than wool. He had not been able to apply the theory of retraction to silk or artificial silk. Was the time of retraction for wool equal to that of extension. Dr. Balls said the failure to obtain parallel results with silks was to be expected in view of the difference in structure; silk being an extruded substance quite different from the highly cellular cotton and wool. Ought there not to be some relation between the maximum extension of the wool fibre and the dimensions of the net-work, on the supposition that the elastic network was rigid and had a kind of "lazy-tongs" structure? Dr. Shorter said that the 40 per cent. extensibility was only found with cold-treatment; hot water had a permanent effect. There was a loss of about 1 per cent. on boiling, rather less if the material was acid. All fibres showed more or less the effect of the extension and recovery, but cotton and silk gave permanent extensions. When wetted, wool only swelled in width, but silk also in length. The time of recovery was always longer than that of extension. Theoretically it was infinite. If one wetted the fibre and extended slowly the results were much more uniform. He found groups which gave a uniform extension of 35 per cent. and others of 42 per cent. which bore out Dr. Balls' suggestion. Mr. Brimley suggested that the degree of perfection of the framework is a function of the ratio, amount of water in cell to saturation capacity. Dr. Shorter said he did not think the water content affected this property much. Dr. Balls said he could not give any opinion as to the mechanism of swelling. Owing to the structure, the fibre was anisotropic, and the longitudinal swelling, which was easy to measure, was different from the tangential or radial. He had long been trying, but unsuccessfully, with Mr. Hancock, to measure the changes in radial dimensions, but had only succeeded in doing so with the fibre immersed in liquid, which of course altered its properties. Dr. Bramley enquired whether the elasticity of fibres was impaired after treatment with organic solvents. Dr. Shorter said that benzene and such liquids had no effect, but alcohol caused swelling. Mr. Edwards understood that treatment with organic liquids would remove the natural grease; after scouring it was necessary to add some fat. Mr. Heyes asked how Dr. Shorter's theory agreed with the microscopic structure—the outer cuticle enclosing spindle shaped cells? Dr. Shorter said that the structure referred to in his paper was sub-microscopic. Dr. Barrett suggested that the time of shear might have a great effect on the time of set. If the structure were ultramicroscopic there must be a minimum shear to produce any movement in a viscous liquid. Was Dr. Shorter's description of the frame-work as perfectly elastic hyperbolic? If Dr. Balls had measured the change of length and of volume, that should give the change in cross section. Dr. Shorter said that the densities had been determined in benzene and in water. He assumed that the former was the true one. Mr. Calam, referring to Dr. Shorter's theory, suggested that the cell walls might be simply the dividing lines between large colloidal molecules, which in recovering after stretch re-established a molecular equilibrium. Dr. Shorter said that the effect of sudden shear agreed with the viscous liquid theory. The proof of perfect elasticity was the complete recovery on wetting.

Mr. Barber asked whether the viscous substance could be coagulated before extension, and Dr. Shorter replied that it was coagulated when dried, and the material was then not elastic. Mr. Pentecost enquired whether, in the work on the effect of light, precautions had been taken against mildew and bacterial action, which were the chief causes of deterioration of lace curtains. Dyed cotton apparently was not so liable to deterioration. Dr. Barr thought that it was not established that the growth of fungus on cotton was the chief cause of damage. Dr. Bramley referred to the use of dyes and mordants and wished to know whether the protection was similar to that of an opaque covering or was due to selective absorption. Mr. Hancock suggested that the growth of mildew might be checked by mercerisation.

The Chairman said he could fully realise the importance of this kind of work in the rigid control of manufacture. During the war they introduced a new propellent made from nitro-cellulose of a low nitration, dissolved in alcohol-ether instead of acetone. The new process worked well on the experimental as well as on the large experimental scale. A factory was built at Gretna and the manufacture proceeded smoothly for three months. Then in some batches the cords emerged, not continuously, but in jerks. The cotton was traced to two works, in one of which the waste cotton was boiled in open pans instead of keirs. The viscosity of this cotton was not correct, and the introduction of technical control and viscosity tests quite removed this trouble.

LIVERPOOL SECTION

The first meeting of the session was held on October 31 in the Midland Adelphi Hotel, Mr. Edwin Thompson in the chair. Nearly ninety members and guests were present. The chairman announced that Lord Leverhulme had very kindly given to the Section the fee that he had received as Messel Lecturer, in the form of 20 per cent. Preference shares in Messrs. Lever Brothers, Ltd., the interest to be

utilised for the purpose of an annual prize for chemistry students at the University of Liverpool.

The President, Mr. W. J. U. Woolcock, C.B.E., addressed the meeting on: "Publicity in Chemical Industry." Referring to the Society he said that its position was unique among the organisations representing chemical science and chemical industry, in that it represented both the scientific and the industrial sides of chemistry. This position presented very great opportunities for usefulness, and the influence which might be exerted by its thousands of members was of great value to the community. Its responsibilities, therefore, were extremely heavy and at the moment were not being shared fully among all the chemists and industrialists engaged in the industry.

He then dealt with the financial position of the Society and gave an account of the internal working of the Society's affairs. At present, owing to the depression in the industry, the burden of carrying on the various societies to which chemists belong was becoming intolerable, and steps were being taken to co-ordinate the work of the societies to prevent overlapping and to reduce expenses. As an instance, he mentioned the co-operation between the Society and the Chemical Society for the joint production of chemical abstracts.

The duty placed upon societies of conveying scientific information to their members entailed a very considerable expense, and he thought that still further avenues might be explored which would lead to a closer co-operation between the various societies and a diminution in the expenditure of each of them.

The President then discussed the necessity of informing the general public of the work on which chemists were engaged, and the impossibility of building up a reputation without publicity. As an example of such work he instanced the British Empire Exhibition, the publication of "Chemistry in the XXth Century" and its effects on scientists in other countries, and to the pamphlets which had been prepared for the public giving some information as to various branches of chemical industry. In conclusion he stressed the point that chemical industry and chemical science were so brought together that it was impossible for the industry to succeed without the chemists, and there would be no chemists unless the industry were there to find employment for them. After a full discussion a very hearty vote of thanks was accorded to the President for his address.

POTASH DEPOSITS IN SPAIN

According to A. Marin (*Bol. Inst. Geol. España.* 4, 44), the potash basin in Catalonia is 26 miles long by 9 to 10 miles wide, and the potash is found between 656 and 2624 feet, in depth like that of the Alsatian deposits. The thickness of the bed is about 13 ft. and take 6½ ft. as an average, exploration has shown the presence of 268,000,000 t. of potash (K_2O) at workable depths, equivalent to 2000 million tons of potash salts.

CORRESPONDENCE

A PATERNAL OPINION

Sir,—You will, I believe, admit my right to assume something of a paternal attitude towards you. Let us come to the point at once and see page 1083 of your last issue—"racy" or "funny" editorials and too much blocking of the traffic by the triumphal car of Antimony. There are some in the West Riding of Yorkshire and elsewhere who do not like it; they accept jokes "wi' deeficulty" and prefer a lorry load of oil of vitriol to imaginary mediæval chariots.

I have been watching you, not without some anxiety, treading a very hazardous path. It is only a convention—and a very dreary one—that a weekly professional or trade paper should be all solid phase pudding. It is all part of the grimness of the desk and factory world—grind, grind, grind, and then for refreshment of spirit, off elsewhere and another kind of raciness than yours—rather pinker.

I confess that I was at first against you; I thought you were overdoing it. People need gentle leading. But I have felt no quarrel with your Editorials on the ground of their being light-minded. I will not send you to the hatter by saying how well I think of them. Your chief mistake is in dropping so easily—not *à la* Silas Wegg into poetry (others are getting that habit, and I have no objection)—but into Latin. I don't quarrel with the Latin; it is good to let people see the aptness of the Romans and the conciseness of their speech; but when you quote Latin you should do as Addison and his friends did in the *Spectator*—give the best English version in a footnote. It is an affront in these days to fling Latin about as if it were current coin.

As for your historical, political, economic and other allusiveness, go on as you are doing—carefully. You have, however, committed one grave offence. In your last editorial you put that it was said of Lockyer that "he sometimes forgot that he was the editor and not the creator of *Nature*." No, no, no, that was never said. I know no adequate Latin quotation for your offence. But there is something in Urdu that will appeal equally to you and your readers *wuh tum se kahta hai ki meri zaban men mujh se bolo.* What happened was this: someone said to Lockyer, "remember you are the editor—not the author—of *Nature*." And, by the way, *Nature* used to print comic verse by Sylvester, and I believe no one was a penny the worse.

The great danger to a really well-educated man is that he will offend by exactly that which would most please his equals—the assumption that they are at least as well-educated. Now, it has been hinted lately that the education of the modern chemist is not always perfect in its comprehensiveness. Care, therefore, is needed. Never mind a few grim faces, but—oh! that Lockyer lapse!—I am, Sir, &c.,

S.

THEORY OF SUBSTITUTION IN AROMATIC COMPOUNDS

Sir,—In read in your issue of October 24 (p. 1057) the following statement, attributed to Dr. B. Flürscheim, in the report of a discussion during which the induced polarity rule was considered:

"The theory assumed that when oxygen anp nitrogen are both present, the former is the negative key atom."

Three months ago I had to correct Prof. Ingold on the same point (this vol., p. 769). The original memoir (*Mem. Manch. Lit. and Phil. Soc.*, 1920, **64**, 111, 5) does not admit of any misunderstanding on this matter, and it may therefore be gathered that Dr. Flürscheim is not conversant with the "theory" which he criticises nor, *a fortiori*, with its possible applications.

Those who prefer Werner's theory of the distribution of valencies in carboxylic acids to Thiele's theory, and others who desire support for the view that para-bonds are present in aromatic amines and phenols, will doubtless find Dr. Flürscheim's theory acceptable. Others, who, like myself, consider Werner's carboxylic theory wholly at variance with the facts, including what we know of the very process it was devised to explain, will continue to think that Dr. Flürscheim's theory is untenable, while gratefully acknowledging many invaluable suggestions which he made in constructing it.—I am, Sir, &c.,

The University, Manchester ARTHUR LAPWORTH

NITROGEN FIXATION BY GREEN PLANTS

Sir,—I was interested to read your editorial on the fixation of elementary nitrogen by green plants. But—"honour to whom honour is due"—this subject was studied carefully by Mr. Thos. Jamieson, F.I.C. (late lecturer in Agriculture at Aberdeen University). The results of his researches and his opinions on this subject were met with such derision by his agricultural contemporaries that latterly he was forced to live the life of a recluse and, may I say, a heretic. His little book on "History of the Progress of Agricultural Science in Great Britain" (C. and R. Anderson, Edinburgh) is worth reading not only by those interested in this subject, but also by our younger chemists, particularly his remarks on the "retarding influence on progress of dogma and authority."

Jamieson's conclusions were confirmed by Zemplen and Roth (in Hungary) and Pollacci and Mameli (in Italy). Now comes fresh confirmation as noted in your editorial.

Personally I have never needed much convincing on this subject, as from a considerable experience of field geology I found trees of considerable dimensions growing from solid igneous rocks—not in cracks or crevices, but in rocks devoid of soil. The only obvious source of the nitrogen in such circumstances is the atmosphere.

In the case of trees there is a possibility that bacteria may play some part in fixing the nitrogen, as I have observed bacteria in the healthy living cells of many leaves.—I am, Sir, etc.,

Queen's Cross, Aberdeen JAMES STRACHAN

PERSONAL AND OTHER ITEMS

Prince Arthur of Connaught will open the Ramsay Laboratory of Chemical Engineering at University College, London, on November 12 at 5 p.m.

Dr. F. S. Fowweather, M.Sc., F.I.C., has been appointed to the new lectureship in chemical pathology in the University of Leeds.

At the recent election of office-bearers of the Royal Society of Edinburgh, Principal J. C. Irvine was elected a vice-president, Dr. A. Lauder a secretary, and Professor Sir James Walker a councillor.

Dr. H. M. Tory, President of the University of Alberta, will become permanent chairman of the Research Council of Canada.

Major J. Price, M.C., has been elected president of Price Bros., Ltd., succeeding his father, the late Sir William Price.

Mr. M. L. Davies, of Toronto, has been elected president of the Standard Chemical Co., Ltd., of Canada.

Mr. G. Scott Robertson has been appointed professor of agricultural chemistry in Queen's University, Belfast.

The Institution of Electrical Engineers has given 100 guineas to the Cavendish Laboratory at Cambridge, as a mark of appreciation of the electrical researches carried out there by Sir Joseph Thomson, Sir Ernest Rutherford, and other Cambridge physicists.

The Royal Institute of Scientific Industrial Research of Sweden has awarded its gold medal of the first class to Johannes Ruths, D.Sc., for his invention of the steam accumulator which equalises intermittent load on boilers in factories and power plants thus securing greater facility in working and substantial economies in running costs.

The late Sir Samuel Turner, of Turner Brothers Asbestos Co., Ltd., left estate of the gross value of £496,644, with net personalty £490,796.

The late Mr. John Allen, chairman of Frederick Allen and Sons (Poplar), Ltd., chemical manufacturers, left £15,389.

The death is announced of O. H. Steudel, a partner of the firm of Kraft and Steudel, Dresden, manufacturers of photographic papers.

The late Prof. Sir W. Bayliss, F.R.S., left estate of the gross value of £102,387, with net personalty £86,274.

Nitrogen Fixation at Niagara

It is reported that operation of the Casale process for fixing nitrogen by the Hooker Electro-chemical Co. at Niagara Falls is proving very successful and plans are under consideration for doubling the capacity of the plant.

Proposed German Dye Amalgamation

It is reported that negotiations are in progress for the amalgamation of all the German dye factories to form one large company in place of the looser union provided by the Interessen-gemienschaft. This movement is said to have been induced by the attempts of the French and United States dye manufacturers to come to terms with the Swiss industry. It is also rumoured that the French Compagnie Nationale des Produits Chimiques may come to terms with the Swiss makers. One step towards the German amalgamation has

already been made by the pooling of German dye agencies in Japan. It is now proposed to build up one selling organisation for the whole world and to "go in for greater specialisation," whilst reducing manufacturing costs.

First Forecast of the Indigo Crop of British India

From reports received from provinces which contain about 85 per cent. of the total area under indigo in India, the total area sown is estimated at 98,100 acres, which is 40 per cent. below the corresponding estimate of last year. The total yield of dye is estimated at 17,200 cwt., as compared with 30,400 cwt. last year or a decrease of 43 per cent. The weather has not been favourable, and the present condition of the crop, on the whole, is reported to be only fair.—(*Ind. Tr. J., Oct.* 16, 1924.)

Electrical Precipitation

On October 30, Sir Oliver Lodge delivered the seventh of the lectures on the relation of physics to industry which have been arranged by the Institute of Physics, the subject being "Electrical Precipitation." Of the two kinds of electrical precipitation, natural and artificial, Sir Oliver Lodge first dealt with the latter, which began with his work in 1884 on the electrical deposition of smoke or steam. This work had been applied on a large scale by the lecturer's sons in this country, and Dr. Cottrell in the United States to the recovery of metallic fume and the purification of blast-furnace gas. Over 200 plants of this type were now installed and very large amounts of solid matter were collected in some of them. Natural electrical precipitation was described as the process by which clouds turn into rain, a subject which was treated at length.

All-Australian Exhibition of Manufactures

Although the bulk of Australia's wealth is derived from her primary products, her secondary industries cover a very wide range, a fact which was made evident by the All-Australian Exhibition of Manufactures which was opened on September 13, showing the wide range and diversity of Australian manufactures. Machinery, furniture, textiles, electrical apparatus, cameras, boots and shoes, motor tyres and rubber goods, matches, cooking-stoves, chemicals, articles made from copper, brass and aluminium—all made in Australia—were displayed, and in most cases the manufacturers showed not only their finished products, but also the manner in which they were made. There are over 18,023 factories in Australia, employing, in all, 395,425 hands. Salaries and wages paid last year amounted to £71,133,000, light and fuel cost £8,659,000, and materials cost £186,082,000, leaving a margin of £60,621,000 for miscellaneous expenses and profits, making a total of £326,497,000. The total output 10 years ago was valued at only £161,500,000—less than half the value to-day.

Diseases of Pitch and Tar Workers

The Home Office, Factory Department, has issued a leaflet (Form 1782) relating to epitheliomatous ulceration as affecting pitch and tar workers and advising that such workers should seek attention at once when small warts or ulcers develop on the skin.

COMPANY NEWS

LANGDALE'S CHEMICAL MANURE CO., LTD.

According to the report, the profit for the year ended June 30, 1924, was £2,825, to which is to be added the balance brought forward from last year of £110 8s. 1d., making a total of £2,936. It is proposed to pay a dividend of 2½ per cent. (less income tax), which amounts to £2,725, leaving a balance to be carried forward of £210 17s. 3d. During the year it has been necessary to decline many orders which, owing to reduced prices consequent upon increased severity of foreign competition, would have involved heavy loss, and the output of manures has consequently been reduced. The coming season appears a little more hopeful as prices have been increased abroad. The demand for sulphuric acid has been heavily curtailed by the closing down of many coke ovens in the district, which it is feared will continue until there is improvement in the coal and iron industries.

SANTIAGO NITRATE CO., LTD.

The gross profit for the year ended June 30 was £17,637 (against £20,019 in 1922–23), and the net profit £12,420 (against £12,692), to which is added the balance of £10,196 brought in. A dividend of 7½ per cent., less tax, is to be paid, leaving £10,616 to be carried forward. The "oficina" was reopened on April 15, and it is stated that there will be no difficulty in producing all the nitrate necessary to meet its proportion of any sales the producers' association may make.

HART ACCUMULATOR CO.

An interim dividend of 5 per cent. on the ordinary shares has been declared. An interim of 5 per cent. in respect of 1923 was paid early this year.

CASTNER-KELLNER ALKALI CO.

The accounts for the year to September 30 show a profit of £288,052, compared with £263,188 last year. To this amount should be added £36,331 brought forward, making a total of £324,383, from which should be deducted debenture interest £7297 and interim dividend £80,000, leaving a balance of £237,086, out of which a final dividend of 14 per cent. is proposed, making 22 per cent. for the year (against 20 per cent.). The sum of £75,000 is again to be carried to the suspense account, leaving £22,087 to go to next account.

The Antofagasta Nitrate Co., Ltd., has published the prospectus of an issue of £400,000 7 per cent. second mortgage debenture stock, which will be secured by a specific mortgage in favour of the Law Debenture Corporation to rank immediately after the existing 6½ per cent. first mortgage debentures.

The Anglo-Chilian Nitrate Co., Ltd., has declared an interim dividend of 2s. per preference share and 2s. per ordinary share, or 10 per cent. in each case, less tax. Last year the interim dividend on the ordinary shares was 5 per cent., tax free.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 10s. per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate / Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	[illegible]3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to [illegible]gth. 20s. less for contracts.
Soda Crystals	[illegible]—£5 10s. per ton ex railway [illegible]ots or ports.
Sod. Acetate 97/98[illegible]	[illegible] per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£1[illegible] [illegible]s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £[illegible] 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	6½d.—1s. 2d. per lb., according to quality.
Crimson	1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes White and Dark	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P.	£47 10s.—£52 10s. per ton, according to quantity.
Sulphur Chloride	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

There is a general feeling that the fall in price of acetates during the last few weeks has reached its limit. The tendency is now to stiffen again.

Acetate of Lime—	
Brown	£11 10s. per ton, and upwards.
Grey	£14 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand quiet but price steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 9d. per gall. 60% O.P.
Solvent	5s. per gall. 40% O.P. Firmer.
Wood Tar	£4—£5 per ton. Very quiet.
Brown Sugar of Lead	£41 per ton. Steady market.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d. per lb. Quiet.
Crude 60's	1s. 8d.—1s. 10d. per gall. Market flat.
Acid Cresylic, 97/99	2s.—2s. 1d. per gall. Demand steady.
Pale 95%	1s. 8d.—2s. per gall. Not much enquiry.
Dark	1s. 8d.—1s. 10d. per gall. Market dull.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6½d.—7½d. per gall. Small demand
Unstrained	6d.—6½d. per gall.

Benzole—
Crude 65's .. .. 7½d.—9d. per gall. ex works in tank wagons.
Standard Motor .. 1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Pure .. .. .. 1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.

Toluole—90% .. .. 1s. 5d.—1s. 6d. per gall. More inquiry.
Pure .. .. 1s. 7d.—1s. 9d. per gall. Small demand for home consumption.

Xylol—Coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.

Creosote—
Cresylic 20/24% .. 8d.—8½d. per gall. Little demand.
Middle Oil .. .. }
Heavy Oil .. .. }
Standard Specification } 5½d.—6½d. per gall., according to quality and district. Fair business passing. A little more demand for export in bulk.

Naphtha—
Solvent 90/160 .. 1s. 3d.—1s. 4d. per gall. Demand good.
Solvent 90/190 .. 11d—1s. per gall. Fair inquiry. Local demand good.

Naphthalene Crude—
Cheaper in Yorkshire than Lancashire. Demand rather better.
Drained Creosote Salts £3—£5 per ton. Demand slightly better.
Whizzed or hot pressed £6—£9 per ton. Demand very poor.

Naphthalene—
Crystals and Flaked .. £12—£15 per ton, according to district.

Pitch, medium soft .. 42s. 6d.—60s. per ton according to district. Plenty of inquiry. Prospects brighter.

Pyridine—90/160 .. 19s. per gall. Steady demand.
Heavy .. 11s.—12s. per gall. Market dull.

INTERMEDIATES AND DYES

Business in dyestuffs has been very well maintained this week.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 7d. per lb.
Acid H. .. .. .. 3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic .. 9d. per lb. 100% basis d/d.
AluminiumChloride,anhyd. 1s. per lb. d/d.
Aniline Oil .. .. 8d. per lb. naked at works.
Aniline Salts .. .. 8½d. per lb., naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 3s. 11d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 1d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 19/31° C. .. 4d.—4½d. per lb. Rather quiet.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £85 per ton.
Diethylaniline .. .. 4s. 3d. per lb. d/d., packages extra, returnable.
Dimethylaniline .. .. 2s. 2½d. per lb. d/d. Drums extra.
G. Salt. .. .. .. 2s. 4d. per lb. 100% basis d/d.
a-Naphthol .. .. 2s. 5d. per lb. d/d.
Dinitrobenzene .. .. 9d.—10d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 2s. 10d. per lb. d/d.
Monochlorbenzol.. .. £63 per ton.
β-Naphthol .. .. 1s. per lb. d/d.
a-Naphthylamine .. 1s. 3½d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 4s. 2½d. per lb. d/d.
p-Nitraniline .. .. 2s. 2½d. per lb. d/d.
Nitrobenzene .. .. 5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol .. 2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene .. 10½d. per lb. d/d.
p-Nitrophenol .. .. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol 4s. 6d. per lb. 100% basis.
m-Phenylene Diamine .. 3s. 10d. per lb. d/d.
p-Phenylene Diamine .. 10s. 2d. per lb. 100% basis d/d.
R. Salt .. .. .. 2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate .. 2s. 2d. per lb. 100% basis d/d.
o-Toluidine .. .. 10d. per lb.
p-Toluidine .. .. 3s. per lb. naked at works.
m-Toluylene Diamine .. 3s. 10d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P. .. £43—£45 per ton, ex wharf London, in glass containers.
Acid, Acetyl Salicylic .. 3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P. .. 2s. 6d. per lb. Cheaper.
Acid Boric B.P. .. .. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric.. .. 19s.—21s. per lb.
Acid, Citric .. .. 1s. 4d. per lb., less 5% for ton lots. Market still weak.
Acid, Gallic .. .. 2s. 9d. per lb. for pure crystal in 2 cwt. lots.
Acid, Pyrogallic, Cryst. .. 6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic .. .. 1s. 6d.—1s. 8d. per lb., according to quantity. Slightly firmer.
Acid, Tannic B.P. .. 2s. 10d. per lb. Forward quotations higher spot value likely to increase.
Acid, Tartaric .. .. 1s. per lb., less 5%.
Amidol .. .. .. 9s. per lb. d/d.
Acetanilide .. .. 2s. per lb. for quantity. More enquiry.
Amidopyrin .. .. 15s. per lb.
Ammon. Benzoate .. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P. £37 per ton.
Atropine Sulphate .. 12s. 6d. per oz. for English make.
Barbitone.. .. .. 13s. 9d. per lb. Slightly lower. Quiet steady demand.
Benzonaphthol .. .. 5s. 3d. per lb. spot.
Bismuth Carbonate .. 10s. 6d.—12s. 6d. per lb.
„ Citrate.. .. 10s. 3d.—12s. 3d. „
„ Salicylate .. 9s.—11s. „
„ Subnitrate .. 8s. 8d.—10s. 8d. „
Borax B.P. .. .. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides .. .. .. Market exceedingly firm and prices advancing. Raw materials dearer. British prices lower than foreign.
Ammonium .. .. 1s. 11d. per lb.
Potassium .. .. 1s. 9d. per lb.
Sodium .. .. .. 1s. 10d. per lb.
Calcium Lactate .. .. 1s. 7d.—2s. per lb., according to quantity. Fair demand and steady market.

Chloral Hydrate	4s. per lb. Slightly easier.
Chloroform	2s. 6d. per lb. for cwt. lots. Price advanced by 6d. per lb.
Formaldehyde	£48—£49 per ton in barrels, ex wharf London.
Glycerophosphates— Calcium, soluble and citrate free	Fair business passing. 7s. per lb.
Glycerophosphates—	
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50% ..	3s. 6d. per lb.
Sodium, 50%	2s. 6d. ,,
Guaiacol Carbonate ..	10s. per lb.
Hexamine	3s. per lb. Forward prices higher.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor ..	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate— Light Commercial ..	£36 per ton net.
Magnesium Oxide—	
Light Commercial ..	£75 per ton, less 2½%.
Heavy Commercial ..	£25 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst, B.P. ..	62s. 6d. per lb. Market much firmer.
Synthetic	26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials	Market very quiet.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate ..	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate ..	1s. 9d.—2s. per lb. Seasonal increase in demand.
Methyl Sulphonal ..	24s. per lb. Slightly weaker.
Metol	11s. per lb. British make.
Paraformaldehyde ..	2s. 8d. per lb. for B.P. quality.
Paraldehyde	1s. 4½d.—1s. 6d. per lb. in free bottles and cases. Supplies plentiful.
Phenacetin	5s. 8d. per lb.
Phenazone	6s. 10d. per lb.
Phenolphthalein	5s. 9d. per lb. Supply exceeds demand.
Potass. Bitartrate— 99/100% (Cream of Tartar)	84s. per cwt., less 2½% for ton lots.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Ferricyanide ..	1s. 9d. per lb. Quiet.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite ..	7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate ..	7½d. per lb. spot. Forward prices higher.
Quinine Sulphate ..	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 6d. per lb.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 9d. per lb. for cwt. lots.
Silver Proteinate	9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P. ..	2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite— Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside ..	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt) ..	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Fair demand. Powder 2s.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 5d. per lb. Flake 2s. 6d. per lb.
Sod. Sulphide— Pure recryst.	10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.
Sulphonal	15s. 6d. per lb. Little demand.
Thymol	16s. per lb.

PERFUMERY CHEMICALS

Acetophenone	12s. per lb.	
Aubepine	15s. 3d. ,,	
Amyl Acetate	2s. 9d. ,,	
Amyl Butyrate	6s. 9d. ,,	
Amyl Salicylate	3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,	
Benzyl Alcohol free from Chlorine	2s. 9d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate	3s. 6d. ,,	
Cinnamic Aldehyde— Natural	18s. 9d. ,,	
Coumarin	19s. 6d. ,,	
Citronellol	17s. ,,	
Citral	8s. ,,	
Ethyl Cinnamate ..	12s. 6d. ,,	
Ethyl Phthalate	3s. 3d. ,,	
Eugenol	10s. ,,	
Geraniol (Palmarosa) ..	33s. 6d. ,,	
Geraniol	11s. 6d.—18s. 6d. per lb.	
Heliotropine	6s. 9d. ,,	
Iso Eugenol	16s. ,,	Dearer.
Linalol ex Bois de Rose ..	26s. ,,	
Linalyl Acetate	26s. ,,	
Methyl Anthranilate ..	9s. 6d. ,,	
Methyl Benzoate	5s. ,,	
Musk Ambrette	50s. ,,	
Musk Xylol	13s. 6d. ,,	
Nerolin	4s. 9d. ,,	
Phenyl Ethyl Acetate ..	15s. ,,	
Phenyl Ethyl Alcohol ..	16s. ,,	
Rhodinol	55s. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. 4d. ,,	
Vanillin	25s. 6d. ,,	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	
Anise Oil	2s. 10d. per lb.	Dearer.
Bergamot Oil	16s. 6d. per lb.	
Bourbon Geranium Oil ..	33s. 6d. per lb.	
Camphor Oil	65s. per cwt.	
Cananga Oil Java ..	10s. per lb.	

Cassia Oil, 80/85%	.. 10s. per lb.	
Cinnamon Oil, Leaf	.. 6½d. per oz.	
Citronella Oil—		
Java 85/90% ..	.. 6s. 10½d. „	Again dearer.
Ceylon	.. 3s. 8d. per lb.	Dearer.
Clove Oil	.. 8s. per lb.	Dearer.
Eucalyptus Oil 70/75%..	2s. 3d. per lb.	
Lavender Oil—		
French 38/40% Esters	32s. 6d. per lb.	
Lemon Oil ..	.. 3s. 2d. per lb.	
Lemongrass Oil ..	.. 4s. 6d. per lb.	
Orange Oil, Sweet	.. 11s. per lb.	
Otto of Rose Oil—		
Bulgarian ..	.. 40s. per oz.	
Anatolian ..	.. 18s. per oz.	
Palma Rosa Oil ..	... 16s. 6d. per lb.	
Peppermint Oil—		
English.. ..	.. 70s. per lb.	
Petitgrain Oil ..	.. 9s. 6d. per lb.	Dearer.
Sandal Wood Oil—		
Mysore	.. 26s. 7d. per lb.	
Australian ..	.. 18s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Dec. 29th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Nov. 13th.

I.—Applications

Campbell. Filters or separators. 25,407. Oct. 25.

Craig, and Spence and Sons. 25,096. *See* VII.

Dickinson. Grinding-machine. 25,304. Oct. 24.

Jackson. Apparatus for straining liquids. 25,342. Oct. 24.

Kelly. Acid-proof etc. containers. 25,271. Oct. 23.

Morris. Pulverising or emulsifying apparatus. 24,875. Oct. 20.

Portham. Centrifugal separators etc. 25,365. Oct. 24.

Silica Gel Corporation. Refrigeration. 25,444. Oct. 25. (U.S., 20.11.23.)

Soc. Beaudrey et Bergeron. Filters. 25,453. Oct. 25. (Fr., 29.11.23.)

Soc. des Appareils Mangondeaux. 25,455. *See* V.

Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Separation by liquefaction of complex gaseous mixtures. 25,028. Oct. 21. (Fr., 7.8.24.)

Soc. l'Auxiliaire des Chemins de Fer et de l'Industrie. Pumps for liquids at high temperature. 25,282. Oct. 23. (Fr., 3.11.23.)

Spencer, Chapman and Messel, Ltd., and Liebert. Manufacture and manipulation of colloidal substances etc. 24,902. Oct. 20.

I.—Complete Specifications Accepted

16,155 and 16,156 (1923). Peale and Peale. Separating materials of different specific gravities. (223,279 and 223,280.)

20,286 (1923). Forns, Stapley, and Harrison. Adjustable centrifugal machine for emulsifying. (223,347.)

II.—Applications

Clemm, Schmidt and Ges. f. Chem. Produktion. Process for making highly-active charcoal in grains. 25,138. Oct. 22.

Duffield. Production of gas from powdered carbonaceous matter. 25,071. Oct. 21.

Kraitschier. Fuels for internal-combustion engines. 24,880. Oct. 20. (Ger., 18.10.23.)

Malbay. Semi-water-gas producer plants. 24,933. Oct. 20. (Fr., 9.11.23.)

Michalski. Converting coal into gas. 24,929. Oct. 20. (Ger., 17.12.23.)

Roux. Treatment of peat etc. 25,425. Oct. 25. (Fr., 26.10.23.)

Shearman. Destructive distillation of bones etc. 25,338. Oct. 24.

Soc. des Appareils Magondeaux. 25,455. *See* V.

Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Production of coke. 24,925. Oct. 20. (Fr., 6.7.24.)

Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. 25,299. *See* VII.

Spencer. Gas purifiers. 25,098. Oct. 22.

II.—Complete Specifications Accepted

18,412 (1923). Electrical Improvements, Ltd., and Weeks. Fuel distillation. (223,297.)

18,461 (1923). Laing and Nielsen. Heat treatment of solid carbonaceous materials, and the manufacture of briquettes. (223,302.)

18,580 (1923). British Thomson-Houston Co., Ltd. *See* XI.

20,082 (1923). Curtiss. Fuel for the firing of bricks and other purposes. (223,345.)

21,492 (1923). Lamplough and Lamplough. Production of explosive or combustible gaseous-mixtures. (223,356.)

23,036 (1923). Stowart. *See* XXIII.

24,632 (1923). Merz and McLellan and Weeks. Low-temperature fuel distillation. (223,387.)

5756 (1924). Govan. Bituminous solution. (223,486.)

6017 (1924). L'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Treatment of illuminating or coke-oven gases and the like prior to partial liquefaction for the separation of their constituents. (223,489.)

7979 (1924). Brun. Manufacture of fuel briquettes. (214,229.)

III.—Applications

Cox and McDermott. Purification of benzol etc. 25,038. Oct. 21.

Jackson (Warren). 25,160. *See* IX.

IV.—Applications

British Dyestuffs Corporation, Ltd., and Saunders. Manufacture of intermediate compounds and azo dyestuffs. 25,069. Oct. 21.

British Dyestuffs Corporation, Ltd., Goodwin and Saunders. Manufacture of azo dyes. 25,152. Oct. 22.

Scottish Dyes, Ltd., Thomas, and Thompson. Manufacture of dyestuffs etc. 25,033. Oct. 21.

Soc. of Chemical Industry in Basle. Manufacture of condensation products of the anthraquinone series. 24,954. Oct. 20. (Switz., 26.10.23.)

IV.—Complete Specifications Accepted

29,730 (1923). Kalle and Co. Akt.-Ges. Production of vat colouring-matters. (207,553.)

5441 (1924). Durand and Huguenin Akt.-Ges. Manufacture of new mordant dyestuffs. (223,481.)

V.—Applications

Cuprum Soc. Anon. Apparatus for spinning artificial silk. 25,469. Oct. 25. (Switz., 26.11.23.)

Dreyfus. Manufacture of cellulosic products. 25,462, 25,463. Oct. 25.

Grewin. Manufacture of paper. 25,367. Oct. 24. (Sweden, 24.10.23.)

Heys and St. Anne's Board Mill Co. Apparatus for removing liquids from paper pulp etc. 25,289. Oct. 23.

Jackson (Severn Mills Co.). Treating wool. 24,922. Oct. 20.

Langwell. 25,275. *See* XVIII.

Oberlander. Manufacture of artificial silk. 25,060. Oct. 21.

Soc. des Appareils Magondeaux. Manufacture of granular cellulose and its application for storage of explosive gases etc. 25,455. Oct. 25. (Fr., 20.11.23.)

V.—Complete Specification Accepted

23,240 (1923). Vereinigte Glanzstoff-Fabriken Akt.-Ges. Working-up cellulose sludge. (204,322.)

VI.—Application

Lumb (Gerdner). Dyeing-machines. 25,330. Oct. 24.

VI.—Complete Specifications Accepted

21,078 (1923). Soc. of Chemical Industry in Basle. Process for producing fast tints on the fibre. (202,984.)

11,655 (1924). Brunner, Mond and Co., Ltd. Process of making ammonia by catalysis. (215,789.)

VII.—Applications

Bredig and Elod. Production of hydrocyanic acid. 25,160. Oct. 22.

Craig and Spence and Sons. Treatment of aluminous materials for filtering etc. media. 25,096. Oct. 22.

Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler. Manufacture of hydrogen cyanide. 25,147. Oct. 22.

Fabrique Nationale de Produits Chimiques et d'Explosifs-Anciens Etablissements Ghinigoult et Delattre Soc. Anon. Manufacture of ammonia and ammonia compounds from cyanamides. 25,148. Oct. 22. (Belgium, 23.10.23.)

Harper and Williams. Production of ammonia. 25,264. Oct. 23.

Johnson (Viscose Co.). Apparatus for separating caustic hydroxides from solutions etc. 25,290. Oct. 23.

Neill. Production of ferric oxide etc. 25,382. Oct. 24.

Soc. des Mines de Potasse d'Alsace, Amélie, Max, Joseph, Else, Théodore, Prince Eugène, Fernand (Autrefois Reichsland), Anna, Marie, et Marie-Louise. Manufacture of magnesium sulphate. 25,424. Oct. 25. (Fr., 29.10.23.)

Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Extraction of hydrogen from gaseous mixtures. 25,299. Oct. 23. (Fr., 8.3.24.)

VII.—Complete Specifications Accepted

15,237 (1923). Marks (Cobb Electro Reduction Corporation of Canada, Ltd.). *See* X.

19,735 (1923). "Allchemin" Aligem. Chem. Industrie Akt.-Ges., and Jahoda. Production of phosphorescent zinc sulphide. (201,922.)

1189 (1924). Seth. *See* X.

IX.—Applications

Airey. Manufacture and use of building etc. materials. 24,973, 25,199. Oct. 21 and 23.

Burley. Manufacture of cement and kilns therefor. 25,171. Oct. 22.

Jackson (Warren). Manufacture of bituminous compositions. 25,160. Oct. 22.

Rigby. Manufacture of cement. 25,162. Oct. 22.

IX.—Complete Specification Accepted

20,082 (1923). Curties. *See* II.

X.—Applications

Burgess and Vautin. Ferro alloys. 25,383. Oct. 24.

Kidd. Furnaces for heat treatment of metals. 24,995. Oct. 21.

Marks (Glockenstahlwerke Akt.-Ges. vorm. R. Lindenberg). Steel alloy for permanent magnets. 25,280. Oct. 23.

X.—Complete Specifications Accepted

15,237 (1923). Marks (Cobb Electro Reduction Corporation of Canada, Ltd.). Volatilising and oxidising minerals. (223,271.)

1189 (1924). Seth. Process for obtaining vanadium compounds or vanadium from pig-iron containing vanadium. (211,111.)

2857 (1924). Cornelius. Electric furnace for welding, tempering, burning, or for heating for other purposes. (211,462.)

XI.—Applications

Darby, Wilde, and Oldham, and Son. Galvanic batteries. 24,941. Oct. 20.

Electric Furnace Co., Ltd., and Taylor. Electric resistance furnaces.

Kahl and Rutgerswerke A.-G. Impregnating medium for electrodes. 24,946. Oct. 20.

XI.—Complete Specifications Accepted

18,580 (1923). British Thomson-Houston Co., Ltd. Electrodes having a high-electron emissivity. (201,900.)

2857 (1924). Cornelius. *See* X.

XII.—Applications

McNicoll. Treatment of crude cotton oils etc. 25,319. Oct. 24.

Shearman. Refining fats, oils, etc. 25,337. Oct. 24.

Sizer. Extraction of oil from seeds etc. 25,200. Oct. 23.

Sizer. Extraction of oil from oil-bearing substances. 25,421. Oct. 25.

XIII.—Application

Lorenz. Manufacture of wax-colour binding-means. 25,049. Oct. 21. (Austria, 23.11.23.)

XIII.—Complete Specification Accepted

17,663 (1923). Soc. Italiana E. de Angoli per l'Industrie dei Tessuti Stampati and Paulus. Manufacture of aqueous solutions from difficultly-soluble gums. (200,523.)

XIV.—Applications

Rigby. Rubber latex compositions, and application thereof. 24,970. Oct. 21.

Soc. Anon. des Pneumatiques Dunlop. Vulcanisation of rubber in solution. 25,400. Oct. 25. (Fr., 19.7.24.)

XIV.—Complete Specifications Accepted

12,964 (1923). Loomis and Stump. Manufacture of rubber goods from latex. (223,263.)

4069 (1924). K. D. P., Ltd. Manufacture of caoutchouc, gutta-percha, balata, and analogous vegetable resins. (219,277.)

XVIII.—Application

Langwell. Fermentation of cellulose materials. 25,275. Oct. 23.

XIX.—Applications

Fairbrother (Jackson Research Corporation). Disposing of municipal waste. 25,295. Oct. 23.

Hartley. Sewage purification. 24,868. Oct. 20.

Hind. Production of foodstuffs. 25,373. Oct. 24.

XIX.—Complete Specification Accepted

4505 (1923). Townsend and Lever Bros., Ltd. Treating pea-nuts for food. (222,975.)

XX.—Complete Specifications Accepted

20,425 (1923). Chemosan Akt.-Ges. Process for the production of solutions of mercury derivatives of hydroxy-sulphobenzoic acids and their homologues, suitable for use in therapeutics. (202,631.)

27,463 (1923). British Dyestuffs Corporation, Ltd., Cronshaw, Naunton and Green. Manufacture of diarylguanidines. (223,410.)

XXIII.—Complete Specification Accepted

23,036 (1923). Stewart. Regulating the gas flow to gas calorimeters. (223,375.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1), has received the following enquiries for British Goods. British firms may obtain further information by applying to the Department and quoting the specific reference number: *Belgium:* Paper, (463); *Brazil:* Steel, tinplate, zinc, cement, red lead, copper sulphate, (476); *Egypt:* Leather, (Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, London, S.W. 1, Ref. Muh. 1924/64/6); *France:* Steel, (464); *Italy:* Leather, (467); *Lithuania:* Pig iron, (A.X./1420); *New Zealand:* Hardware, (458); *Sweden:* Leathers, (471).

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

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EDITORIAL

THERE is a possibility that next summer we may receive a visit from some American engineers. There are big industrial cities in America and there are others here. It will be impossible for our visitors to avoid making a comparison, and the prospect of this is not particularly pleasing. We can show a[illegible] visitors—especially Americans—London, Edinburgh, Oxford, Cambridge, York and Canterbury with justifiable satisfaction. But our manufacturing towns—what do we think of them? What will they think of them? You may travel from King's Cross through York and Edinburgh to Inverness or even further, and are almost the whole time in pleasant and clean country, much of it beautiful country, but we can mention cities, even districts, in the Midlands, in Yorkshire and Lancashire and in Scotland, of which we are now, and for some time shall be, ashamed. They are mean and dirty; they have fine buildings, beautiful parks and other advantages, but they are begrimed with smoke. Who can be surprised that many of these districts return Socialists to Parliament? We think if we lived in them ourselves we should be as desperate as any of the most obstreperous of the Communists. Wigan, St. Helens, Glasgow and Leeds are not places of beauty. They might, though, be cleaner than they are. There is a Smoke Abatement Society, a League, a Conference, a set of pamphlets describing the ways of estimating the quantity and quality of smoke and of preventing or diminishing it. The problem is not insoluble; it is largely a matter of chemical engineering, and in essential matters it has already been solved. There are two sources of smoke almost equally important and obnoxious—house fires and works fires. We can solve the first difficulty quite easily; in our own domestic arrangements we have so organised things that we can sit in front of a smokeless fire, enjoy its warmth and life, stir it and look at it. Everyone else can do this if a trifling effort be made; is the effort worth while? Is it not worth some little effort to secure an ampler ether, a diviner air, clearer skies, cleaner houses and cleaner gardens? The smoke which arises from domestic houses is a nuisance for which we as individuals are largely responsible; we have the remedy in our own hands. The smoke from works, factories and furnaces is not so easily prevented, and it is not so much within the powers of each one of us. Even if we have ourselves sound ideas we have to submit them to a board of directors, to general managers and works managers, to trades unions and committees; we have to consider the views of shareholders, in fact everybody's views except those living in the vicinity of the works. But electricity and gas, pulverised fuel and briquettes, mechanical stokers and economisers come to the assistance of the manufacturer who wishes to do his duty.

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In these technical details mere editors soon get out of their depth. Every traveller for a firm of makers of mechanical stokers, of asbestos packing, of piston-rings, of heat economisers or of patent boilers shows by most imposing figures and calculations how easy it is to save fifteen per cent. of your fuel and to pay for the new plant out of the economics it effects in the first year or eighteen months. Did we describe their mathematics as imposing? They will convince you that if you buy enough of their devices you will get your fuel for nothing! It is not all imposition; you must, of course, make some allowance for the exuberance of the traveller; he needs an optimistic nature, a heart of oak and triple brass, to enable him to go round from works to works. If his prophesies are distinguished by a little buoyancy and imagination, oh blame not the bard! And when he who adores thee has left but the name, do not, the moment he has gone, consign his rectangular card to the waste-paper basket. Many of these modern improvements are meritorious; some of them do really save money; some of them do really burn the fuel more completely and send less unburnt or half-burnt—which is worse—coal into the atmosphere. If the most prudent of our chemical manufacturers, the wisest of our chemical engineers and the most public-spirited of our statesmen could organise a round table conference they could frame some means of encouraging the laggards in industry to greater effort, helping the lazy ones on with a stick, if we have not forgotten the songs which in our youth adorned the university or the camp. We could name a dozen members of the Society of Chemical Industry and a dozen members of Parliament who could be of great

value in this respect, but would they come if we did call upon them? Those who dislike dirt and those who hate Bolshevism should combine their forces for a while. There are many men who object to waste and communism; all women dislike dirt; what a chance for organised effort!

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Mr. Julian L. Baker's Streatfeild Memorial Lecture on "The Chemist and the Fermentation Industries" called back to us our first conception that these had any community of interest. Between thirty and forty years ago we remember a young man, destined to inherit a brewery, coming to a provincial college to learn science which would be of value to him in his business. This seemed to us, in our ignorance, a very strange proceeding. Brewing we could understand as a lucrative pursuit probably descending from father to son through several generations. The study of science we could appreciate even in those early days, but to mix up brewing and science seemed to be very singular. When we found that the young brewer was, in various laboratories, studying yeast, bacteria, alcohol and distillation, starch and sugar, there seemed to be some sense in the idea, and it was not long before we found out that a man might study these subjects for many years before getting to the end of them. We have no reason to think that the average man of to-day is much better able now, than we were so many years ago, to see how science and brewing fit in together. Such an address as Mr. Baker's helps us to see how the average man may be enlightened in such matters. Mr. Baker, besides giving an interesting account of some of the scientific aspects of brewing, calls our attention to a curious piece of red-tape which may be of importance. He tells us that our home fermentation industries yield nearly a hundred and forty million pounds a year in revenue to the State, and that the revenue authorities are extremely careful in watching the operations of the brewers and distillers and verifying in these the percentages of alcohol and sugar so that the nation may lose nothing of the proportion of the profits which it takes. In the "Amylo" process of fermentation it seems the Customs regulations and the details of the process conflict so that this process, widely used on the Continent, is forbidden here. If the process is as economical as Mr. Baker indicates, and there are no material factors omitted from his account of the situation, it appears the distillers have a just cause of complaint. If this is so we are satisfied they can obtain a reasonable amount of satisfaction if they make up their minds that they mean to have it. Governments and Government Departments are particularly susceptible to adequate pressure tactfully applied.

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Mr. Baker gave an account of the Finsbury Technical College, and alluded to some of the eminent men who taught there; he made an earnest plea for a continuation of the important work still carried on there. We sincerely hope his plea will be successful, although the figures he quoted show that his task of persuading the authorities to find the necessary money will be an extraordinarily difficult one. We received a few days ago a handsome volume describing the activities of the Leeds Philosophical and Literary Society during the last hundred years with some incidental remarks on the foundation of the Yorkshire College, now the University of Leeds. The Finsbury Technical College and the Yorkshire College had much in common. Each was started at a time when there was a great demand for scientific knowledge and very little supply. The earliest professors at each of these institutions included four or five young men of more than average ability, with no hard and fast traditions, with great zeal for teaching on the best methods and with a determination to make their college a centre of good teaching and good research. At Finsbury, Profs. Armstrong, Ayrton, Meldola, Perry and some others formed a closely allied band, who successfully attained the objects they sought; at Leeds, Profs. Green, Miall, Rucker and Thorpe, with some others, formed a similar nucleus. It seems now to be less easy to find either in London or in the provinces men of the type we have in mind; the sciences have g[illegible] immensely in volume, and those who study them have become much more specialised. Prof. Green was a first-class mathematician as well as a first-class geologist. Prof. Miall could have occupied the chair of geology or zoology with equal ease. Prof. Armstrong has not confined his activities solely to chemistry. He has wandered, perhaps trespassed, over many fields. It was perhaps the novelty of science, certainly not the prospect of making a fortune, which attracted such men to professorships in new colleges. Science is no longer so novel as it was fifty years ago. We can well remember the time in Leeds when the classes which each professor taught were very small, a mere handful of men, but all anxious to learn. We feel sure it was the same at Finsbury. There was a great opportunity, and both the colleges we have in mind seized it and made the most of it. That sort of opportunity and that sort of man have probably become extinct in this country. Chemistry is as well established and as well known as mathematics, perhaps even more. Classes in chemistry are huge. The small nucleus of half-a-dozen enthusiasts working together to start a centre of scientific education, overcoming gradually their own obstacles of education and organisation, has been replaced by a much larger body of equally able and learned men with more time taken up by routine and by teaching and with less time available for doing pioneer work. It is a pity in some respects that the old order has passed away. On the other hand, the haphazard and scanty scientific education of fifty years ago has been replaced by a widespread and generous system of education so well organised that in every town in this country are opportunities for a thorough scientific education which were unknown when Finsbury was started. No one can fail to notice the improvement, no one can fail to regret the disappearance of some of the singularly efficient colleges which half a century ago, though few in numbers, included some which were marvels of sensible teaching and accurate research. Finsbury was one of these.

THE SMOKE ABATEMENT CONFERENCE

The conference and exhibition organised by the Smoke Abatement League in Manchester were opened on November 4 by the Lord Mayor of Manchester, who said that no single factor impaired the amenities of a city more than black smoke. The Manchester Air Pollution Advisory Committee estimated, on a conservative basis, that the damage due to smoke in that city amounted to a million pounds annually. There were two lines of action. Legislation was necessary, but education was more important, as public opinion still needed to be aroused. Mr. C. Elliott gave an account of the difficulties under which the League was working, and rew attention to the need for financial support from ocal authorities. Next year it was hoped to arrange an international exhibition and conference.

Legislation

The opening session was devoted to the legislative aspects of the smoke problem, the first paper being by Mr. J. W. Graham, the chairman of the Smoke Abatement League. In his paper Mr. Graham discussed the law against smoke and showed the difficulties of applying the Public Health Act of 1875. In practice the legislation against smoke was a dead letter, except in London, and about seven provincial towns. It was impossible to legislate effectively against smoke, as the use of gas and electricity could not yet be made compulsory and universal. When low-temperature carbonisation had been established, legislation against all use of raw coal might become practicable and reasonable. In describing the recent attempts at legislation, Mr. Graham said the Departmental Committee that examined the question was so impressed by statements that smoke-making was essential to manufacture in Sheffield and the Potteries that the crucial point of making smoke emission a definite offence was abandoned. Instead of amendments to previous legislation, there should be a new Bill, of which the principal clause should make smoke emission a nuisance. Means of transport should be included, the local authorities, now ineffective, should be concentrated, and there should be more technical inspectors. It was impossible to abolish all smoke, but a suspicion of smoke in the atmosphere would do no harm. The rest of the paper was devoted to an account of means employed to abate smoke in the United States.

In the discussion Mr. C. E. Stromeyer said there was not much smoke in Manchester; the climate was to blame. Invisible smoke was far more injurious than visible black smoke. Dr. J. S. Owens later exhibited a slide, made that day, showing the smoke present in Manchester air.

The possibilities of smoke prevention under the Public Health Act, 1875, were considered by Mr. R. M. Rowe, who said that the manufacturing contribution to smoke could be dealt with at once; he hoped that pollution due to domestic smoke would be prevented as soon as possible. Mr. Rowe then gave an informative account of the powers given in the 1875 Act, and said that if the law were applied a great improvement would result.

At the second session, Dr. J. S. Owens discussed "Air Pollution," and observed that although a human being consumed 30 lb. of air daily and only 7 or 8 lb. of food and water, no attention was paid to the purity of air, in contrast with the severe control of the purity of food. Tables were given to show the extent of pollution in several districts, the deposit of impurity per sq. mile during the year ended March 31, 1924, ranging from 100·92 tons at Rothamsted to 413·6 t. at Salford, and 793·9 t. at Rochdale. The particles in the smoke were excessively small, but this might increase their harmful effect Dr. J. R. Ashworth, of Rochdale, exhibited diagrams of measurements of the atmospheric pollution in a Lancashire town, and said that the ratio of factory smoke to household smoke varied, but that it would be at least 50 per cent. in a town like Rochdale.

Sir Frank Baines, director of H.M. Office of Works, spoke at the evening conference on the effect of atmospheric impurities on buildings. He said that his department spent £1,570,000 a year in looking after Government buildings, and he estimated that from 30 to 40 per cent. of this expenditure would be saved if only we had a pure, acid-free atmosphere. Prof. J. B. Cohen, F.R.S., followed with an address on the work of the Departmental Committee on Smoke Abatement, and showed slides illustrating the damage done to plants by smoke. He had found, after careful experiments, that the amount of impurity emitted by domestic smoke was 6 per cent. of the coal burned. The Fuel Research Board was the proper authority to take up the question.

Low-temperature Carbonisation

On November 5 a morning visit was paid to the Bradford Road gasworks of the Manchester Corporation. The subject of the session which followed the visit was "Low-temperature Carbonisation and Smokeless Fuel."

Mr. R. Maclaurin described the Maclaurin smokeless fuel plant which is being erected for the Corporation of Glasgow by Blair, Campbell and McLean, Ltd. Low-coking coal with a small ash content and from 25 to 40 per cent. of volatile matter was preferred. The producer unit was 36 ft. high and shaped like a blast furnace, air ports being provided midway up in a central wall and in the side walls. In starting up, the producer was filled up to a little above the air port with ashes, and wood was inserted through special doors and ignited. When properly ignited the producer was filled with coke, the air blast being in action all the time. When the heat had travelled well up the charge, sufficient ash was discharged to admit a ton of coal, and every successive hour a discharge was made and a ton of coal admitted. After 25 to 30 hours the first coke made would be withdrawn, the coal having been heated from 15° C. through 700° C. in 20 hours, so that the hourly rise in temperature was about 35° C. This

gradual increase in temperature modified the nature of the coke, which was very different from ordinary gas coke. The coke was hardly a low-temperature coke, but its content of volatile matter had been reduced to 3 or 4 per cent., and it ignited readily (on account of its porosity) if the temperature had not been too high. Higher temperatures gave a silvery grey, harder coke, which was not so easy to ignite, though showing little difference in composition from the previous type. The quantity of gas made regulated the type of coke produced; with a make of 25,000 to 30,000 cb. ft., black smokeless fuel was obtained, the grey type being produced with gas yields of over 30,000 cb. ft. With Scotch coals (6—10 per cent. moisture, 30—35 per cent. volatile matter), about 55 per cent. of smokeless fuel had been obtained. The make of gas per ton of coal was guaranteed to be not less than 25,000 cb. ft. with an average calorific value of 240 B.Th.U. Before withdrawing the coke it was cooled by blowing in steam, which gave water gas on approaching the combustion zone. Producer gas was made in the combustion zone, and this gas, passing upwards, supplied the heat for carbonisation. Above the combustion zone there was a zone with a temperature between 500°—700° C., and here some ammonia was generated. Higher still was the distillation zone, where oil and gas were produced. The oils passed upwards through fuel at gradually decreasing temperatures, so that there was little decomposition and a highly phenolic crude oil was obtained, which contained paraffin and paraffin wax, olefines, some aromatic compounds, basic bodies and phenols, but no benzene, naphthalene or anthracene and little or no petrol. The oil that condensed in the cool upper region was caught in a trap, whence it passed to the gas main. The gas, passing through the cold fuel, was cooled down to 70° C., so that little heat was lost. The ammonia, of which the yield was 17 to 30 lb., contained no ferrocyanides or sulphocyanides, but a considerable proportion of polyhydric alcohols, which gave rise to useful pigments. The coke was divided into three sizes and discharged into bunkers. The gas will be used for heating vertical retorts. Duplicate plant was provided, wherever possible, to avoid any chance of stoppage. With coal at 20s. and other charges at 8·3, the total working charges were 28s. 3d., a figure which could be realised by sale of the products.

Some new aspects of low-temperature distillation were discussed by Mr. H. Nielsen, M.I.Chem.E., who, starting from the standpoint that low-temperature distillation was a business proposition, outlined the position of the process. No one knew the true value of low-temperature distillation oils, and it was doubtful if the recovery of the ammonia would pay, but the gas would form a source of revenue. The production cost would decide the economic success of the process, and this cost would depend on the locality; but it could be stated that the over-all and capital costs should not exceed 4s. and 10s. to 12s., respectively, per ton of raw material treated. Owing to the fact that existing assay methods did not give results comparable with those of large-scale operations, the author had developed an assay plant which gave good agreement. After considering the difficulties of distillation, the author described the "L" and "N" process, in which a slowly rotating, inclined retort was used. The raw material passed slowly downwards to the exit, where an air-lock enabled the residue to be discharged after cooling, without allowing the entry of cold air. The hot distilling medium, the choice of which depended on local conditions, entered at the lower end of the retort in counter-current to the fuel, gradually heated the material up to the proper temperature, and escaped, carrying with it the permanent gases and condensable matters evolved by the coal. A free-burning, smokeless fuel could not be made readily from almost any raw material, and non-coking, bituminous coal would not yield a coherent residue suitable for domestic use. Blending could be accomplished, but two suitable coals were rarely found at the same colliery. Experiments had shown, however, that a preliminary heating and briquetting in the hot state without a binder, follwed by a final distillation, would give a smokeless briquette of satisfactory quality, and the process was now working on a large scale. The industrial use of coke and powdered fuel would greatly reduce the smoke nuisance, and a preliminary distillation of powdered raw coal would give a semi-coke as safe to handle as fuel oil. This would also make it feasible to erect central distillation and pulverising works to supply a standard pulverised fuel in certain areas at the same price as the raw coal. An interesting possibility was thus opened up of the use of powdered semi-coke instead of oil. The gas produced by the process would be useful for metallurgical furnaces, and if its price could be brought nearer to that of the solid fuel its use would greatly increase. To do this, we must turn to complete gasification in conjunction with low-temperature distillation, working the "L" and "N" system in a three-stage process:—(1) Gasification of the solid residue in water-gas producers; (2) distillation of the raw coal by blue water gas, the residue being converted into water gas; (3) superheating the mixed gas for use in distilling more raw coal, the solid residue forming a smokeless fuel. Ordinary water gas would thus have been "carburetted" twice with raw coal. Low-temperature distillation also made it possible to utilise sewage profitably.

The Rt. Hon. G. H. Roberts and P. C. Pope read a paper describing the "Coalite" fuel made by Low Temperature Carbonisation, Ltd. A description of the Parker process was given, and it was pointed out that the best material for low-temperature carbonisation was small coal, and this, after washing, gave a fuel that burnt well without smell or smoke. If all the coal used in Great Britain, excluding that used in gas works and coke ovens, were carbonised first at a low temperature there would be a considerable national saving. Powdered Coalite gave better results than pulverised coal, and it had an interesting future in this direction. Contracts had already been made to supply London merchants with the whole of the output of plants producing up to 3000 t. a day.

The Effect of Light on Health

The papers on "The Effect of Light on Health," by Prof. L. Hill, F.R.S., and Dr. R. V. Clark, were

pleas for the prevention of smoke pollution. It was extraordinary that the Conference was studying the question merely as an educational measure, as the effect of light on health was so obvious. Sunlight was a necessary and an efficient means of treating disease, and yet we took no precautions to ensure that we had the sunlight necessary to induce health. Many striking instances were given to show the action of light on the human organism.

Engineering Aspects of Smoke Abatement

The session on Wednesday evening was devoted to smoke abatement from the mechanical engineer's point of view, and ended in a commonly accepted assertion that a great deal might be accomplished at a cost which would be no more than the cost of efficiency with consequent profits.

Mr. T. R. Wollaston, M.I.Mech.E., in a paper on "The Complete Gasification of Coal," said there were broadly only two methods of gasifying coal: one by heating in externally-fired retorts, the other by incomplete combustion in gas producers. Every furnace was really a gas producer and many of them were very bad ones, particularly the household fire and, in a lesser degree, the normal boiler furnace. After comparing the efficiency of the gas producer with that of the boiler grate, to the disadvantage of the latter, the boiler of the future was foreshadowed as "possibly not unlike the vertical fire-tube boiler, burning coke or smokeless fuel, and with metallic wetted surface to take fierce initial temperatures." An apparatus which aimed at the elimination of certain of the limitations of ordinary gas producers had been developed. In this apparatus the fuel was first subjected to heating or coking in thin layers in an upper retort before dropping into the producer. The producer gas was thus enriched and the fuel fed to the producer was so far coked that it became readily workable. This producer would work on fuels which could not be used in other producers or for boiler firing and cost 2s. to 10s. per ton less. An annular boiler surrounded the producer, so that steam was self-generated and clinker formation prevented, there being an average gain of about 20 per cent. in thermal efficiency. There was no smoke, no appreciable waste of fuel during stand-by periods, and the boiler responded quickly to variable demands for steam. The best method of generating electricity was the indirect method with by-product recovery, as illustrated by the South Staffordshire Mond Gas Co., Ltd. Such a system, laid down on modern lines, could deliver gas to a boiler house 5 or 10 miles away, with a considerable saving. The rest of the paper described a complete smokeless programme for future power, heating and lighting.

Dr. J. T. Dunn gave a paper entitled "Powdered Fuel and the Smoke Problem," in which he first described the various systems by which pulverised fuel was prepared, the main operations in the multiple system being crushing, magnetic separation to remove iron, drying, pulverising, separation of fine from coarse material in a cyclone separator, and delivery to storage. In the unit system, each furnace was provided with a separate pulveriser which reduced the coal to the desired fineness and fed it by means of a fan directly to the burner; in unit installations drying was usually not required, and the coal was fed direct from the crusher to the pulveriser. The mechanism of the burning of ordinary coal was discussed, and it was shown that the immensely greater surface of pulverised fuel enabled it to burn almost as though it were a gas, combustion being complete with at most 10 to 15 per cent. excess of air, whereas in average mechanical stokers, 50 to 70 per cent. excess was required. Further, any change in the conditions of combustion, *e.g.*, another type of coal, could be dealt with in a few seconds. It was true that fine ash was carried up with the gases from pulverised coal, but the ash was so finely divided that it would probably be spread over an enormous area before reaching the ground. The claim that the ash constituted a nuisance had no foundation in fact, as it had been found impossible to obtain any ash so deposited for examination. The more general use of powdered fuel would mean not only a more efficient use of coal, but also approach to clearer skies.

Mr. H. G. Clinch, chief smoke inspector, Halifax, spoke on the relations between the cost of production and the smoke inspector and said that there were signs of a quickened public interest in the question of smoke abatement. He did not agree that the black smoke was emitted by any other than the factory chimney. The production of black smoke meant inefficiency, and the reason why the manufacturers needed to be spurred on to use their fuel efficiently was that they were too busy with their general business to attend to the boiler plant. Small firms were often bad in this respect, but when they were merged into a large combine, the employment of chemical engineers produced a transformation, not in the interest of public health, but solely for the cause of efficiency. The smoke inspector thus contributed to reduce costs by lowering the cost of fuel, and by reducing the obstacle to sunlight, thus reducing sickness and increasing the vigour of the population. It was admitted that black smoke could not be avoided in certain manufactures, but free discharge into the air should not be permitted any more than the pollution of rivers with trade effluents.

In a paper on "Smoke Abatement and Boiler Room Economies in Relation to the Training of Boiler Foremen," Mr. J. T. Hodgson showed the importance of the personal efficiency and intelligence of boiler firemen in producing boiler-room economies. A careful, skilled man would always make less smoke than a careless, unskilled man, even if the latter had better plant to control. Attention was drawn to the possibility of securing an abatement of smoke by educating firemen by a series of lectures, and an outline was given of subjects for a course of such lectures, ending a specimen examination paper.

Mr. W. H. Casmey read a paper on "Furnace and Tank Boiler Design," in which he claimed that a smoky chimney and a wasteful boiler could be "cured" by simple and inexpensive means, the chief of which was the adjustment of the ratio or furnace area to that of the outlets at the rear of the boiler. The data for keeping a smokeless chimney were given as follows:—Area of furnaces, twice the area of exit from furnace flues; distance from top of bridge to

crown plate, one-third diameter of furnace flue in widest part; distance from back end of boiler to brickwork, equal diameter of one furnace flue; bottom flue depth, half diameter of boiler; width of side flues, one-seventh diameter of boiler.

The Use of Gas in Smoke Abatement

On Thursday morning a visit was paid to the Barton Power Station of the Manchester Corporation, and in the afternoon the use of gas in smoke abatement was discussed.

Sir Arthur Duckham, K.C.B., President of the Institution of Chemical Engineers, who was to have given an address on "Gas Undertakings as Fuel Providers," was unable to be present through indisposition, but his colleague, Dr. Smith, spoke on the contribution that the gas industry might make towards the elimination of the smoke nuisance. Dr. Smith urged that the smoke nuisance was mainly due to domestic smoke, and that gas and coke could be used more cheaply than coal for domestic purposes. Although gas on a heat-unit basis was more expensive, it was cheaper when used over a period, because it was employed only when required. Coke was not as good or as convenient as gas, but as long as solid fuels were used gas undertakings should urge the advantages of coke for domestic use.

"The Fuel of the Future" was discussed by Mr. F. W. Goodenough, who said that for the progress and prosperity of the country it was essential that the fuel used in our homes and factories should—with the minimum cost to the consumer, the smallest demand on our coal reserves, and with the maximum economy in transport—assist the manufacturer to secure the maximum high-quality output, reduce household drudgery to a minimum, preserve the valuable constituents of coal and avoid pollution of the air with smoke. Gas and its companion by-product coke, were, it was maintained, the only fuels that satisfied these requirements. Electricity had an immense and growing field of usefulness, but it was both wasteful and costly to distribute heat derived from coal in the form of electricity. From 80 to 95 per cent. of the heat of the coal used in generating electricity was lost, whereas in a gas-works the loss was less than 25 per cent. In the electrical power station the valuable constituents of coal were lost that were recovered in the gasworks. The question was not solely one of cost, for questions of waste, storage, space, transport had to be considered, but where the cost of gaseous fuel was found to be too high, coke would generally be found the best means of securing fuel efficiency.

Mr. E. W. L. Nicol, A.M.I.E.E., read a paper on "Gas Coke in relation to Industrial and Domestic Smoke Prevention and Fuel Economy," in which he pointed out that the question of smoke prevention was inseparable from that of coal conservation, and that economy in fuel practice necessarily involved the prevention of smoke. There was every incentive to promote improvement in the utilisation of our coal resources, especially in view of our increasing dependence on foreign liquid fuels. Progress could only be made by providing smokeless fuels in adequate quantities and in a form suitable for use in old as well as modern types of heating apparatus. Modern heating apparatus required for efficient operation, not a semi-volatile fuel such as low-temperature coke, but a concentrated fuel with a minimum of volatile matter. Natural smokeless fuels such as anthracite existed in insufficient quantity in this country, and, although it was not suggested that bituminous coal could not be consumed without smoke, such coal caused most of the smoke nuisance. Pulverised fuel could be consumed smokelessly and efficiently, but it had been stated that 50 to 80 per cent. of the ash of the fuel was dispersed from the chimney, and the resulting nuisance would be worse than that of smoke. Oil-firing with cheap tar-oils had many advantages, but fuel-oil was an imported commodity. The favourite panaceas for the smoke nuisance were at present low-temperature fuels and the generation of abundant electricity; but the practical and financial difficulties were almost insurmountable. By treating all bituminous coals as raw materials for making smokeless fuel, fertilisers and other products, an advance would be made. Of the 189 million tons of coal consumed annually, 139 million t. is burned in the raw state. No coal capable of profitable carbonisation should be used in its crude state. The objection advanced against this proposal that it would be difficult to sell the principal secondary product—coke—did not hold good, and the demand for coke should keep pace with production, now amounting to some 8 million t. yearly. The direct and growing influence of coke in mitigating the smoke nuisance could be gauged by the increasing use of coke-fired domestic boilers; whilst in the industrial field, the use of coke for many industrial purposes had proved both practicable and economical. An important use was as a diluent of coal in the sandwich system of fuel blending, thus enabling the smokeless combustion of low-grade coal. The sandwich system was now used in several large power stations of high efficiency. The chief advantages of coke were that there was practically no difference between its gross and net calorific power; it required less furnace volume than coal; it facilitated the use of low-grade coal; it was smokeless, and gave an efficiency of combustion under suitable circumstances about equal to that of pulverised fuel.

(Point was lent to the proceedings by the development of a very thick fog.)

Electricity and Smoke Abatement.

At the afternoon session the Conference met to discuss the use of electricity in smoke abatement. Mr. J. Frith, explaining how electricity could help to solve the problem, said that the substitution of electric power generated in large, well-managed power stations for the small private plant, would not only reduce the total amount of coal burnt to one-tenth, but would reduce the smoke produced by the same proportion. More could be done to utilise the waste heat from fuel-burning electric generating stations, and much smoke could be avoided in the metallurgical industry by the use of electric furnaces. The influence of electricity on the domestic smoke problem was considered by Mr. J. W. Beauchamp,

who pointed out that it was time to consider the design of houses in relation to the equipment. Another paper was that by Prof. M. Walker on "The Use of Power other than that produced by Coal." At the final session, Ex-Bailie W. B. Smith, of Glasgow, gave a popular lecture on "The Cost of a Smoky Atmosphere."

The Exhibition

The *Manchester Guardian* says that for the average citizen the Smoke Abatement Exhibition is a revelation of the incredible waste in which he has indulged as a matter of course from his youth upwards. The various firms that exhibited have certainly done their best to touch the vision of the average citizen, as well as the boiler owner. Amongst the most striking stands is one which shows the innumerable chemical products wasted by the coal burnt in household grates and one which illustrates the damage done by smoke to the health of persons and to buildings. These two stands provide an admirable introduction to a most interesting assembly of smoke-preventing devices, and of means of heating and other appliances for private houses.

The exhibits shown by Sir W. H. Bailey and Co., Ltd., illustrate the complete series of boiler mountings supplied by this firm, including valves of all kinds, fusible plugs, water and steam gauges, vertical boiler feed pumps, air compressors, recording gyrometers, pyrometers for taking the temperature of flue gases and many more besides.

The Crosthwaite Engineering and Furnace Co., Ltd., show a new and improved type of mechanical stoker and self-cleaning furnace, which gives complete combustion of the fuel, elimination of smoke without the need for admitting excess of air, and easy and simple working. The object is to retain the advantages of hand firing without the disadvantages of mechanical stoking. The stoker can be adapted for use with either self-cleaning or fixed furnaces. A special point of the furnace is the new design of grate bar, which will not burn out or warp. Other apparatus by Messrs. Crosthwaite includes coal- or ash-conveying plant, a patent forced-draught furnace designed to burn both small and refuse fuels efficiently, and a variety of heavy machinery.

The Fusion Corporation, Ltd., of Middlewich, exhibit a working model of the "Fusion" low-temperature retort for treating oil shales, peat, sawdust, coal, cannel, or any other bituminous material for the recovery of low-temperature crude oils, and finely divided coke. The coke is said to be highly suitable both for suction gas plant use and powdered fuel firing, as well as for making briquettes. The model of the fusion retort was operating on sand to show the action of the feeder, the travel of the material through the retort, and the discharge of the spent material. In practice the retorts are fired either by hand, producer gas or other suitable means, the ignited gases being led into the combustion chamber and distributed from the combustion chamber by a very ingenious arrangement of small distributing ports which allow of the easy and absolute control of the temperature at any point along the length of the retort. It is claimed that the temperature can be held steady within 10° C. of any predetermined temperature for any desired length of time. The automatic feeder is driven from the rotating tube of the retort itself and, therefore, revolves at a definite speed comparable with the retort; the amount to be passed through the feeder can be adjusted, even whilst the retort itself is in operation. The feeder is also so arranged as to form a seal at the feed end to prevent the ingress of air. Lengths of breaker are laid loosely in the retort tube, and as the tube rotates the breakers fall over and over due to their own weight, giving a hammer and slicing blow to the material being treated, thus keeping the retort shell free from scale or carbon deposit, and reducing the amount of fuel required for heating. The principle of this retort is also applicable to propositions such as the drying of caustic lime sludge, china clay, waste from water-softening plants, sewage tank residue, or other material with very high water contents, and it has also been applied to low-temperature chemical process work and to the slaking of lime. A new type of dust arrestor, on an entirely new principle, was also shown.

Coal users found a good deal of interest at the stand of A. Gallenkamp and Co., Ltd., whose exhibit consists of apparatus necessary for ensuring fuel economy. For a determination of the calorific value of coal, there are the Darling calorimeter, easy to manipulate and inexpensive, or the Mahler-Kroeker bomb calorimeter for highly accurate determinations. Apparatus for determining the contents of moisture, ash, sulphur, volatile matter and fixed carbon is displayed in an attractive manner, and a descriptive pamphlet that was obtainable at the stand provides some useful hints on fuel economy. Amongst other apparatus on show are the Lessing electric coking furnace, for use in estimating coking properties, the Davies crucible furnace for estimating volatile matter, Orsat's apparatus for analysing flue gases, carbon dioxide recorders, low and high temperature assay apparatus for coal as used by the Fuel Research Board, thermometers, pyrometers—everything required to ascertain the value of the coal, and its behaviour under the furnace, so that the twin aims of fuel economy and smoke abatement could be satisfied.

Gibbons Brothers, Ltd., of Dudley, show the Gibbons-Van Marle patent machine for charging and discharging industrial furnaces, which eliminates the waste of time and labour attending the charging of large muffles and furnaces by hand, discharging or charging occupying less than a minute, compared with 10 to 20 minutes with hand tools. The first machine was put to work in Birmingham some three years ago and has worked continuously and with a minimum of attention ever since. Both hand and electrically operated types are made. Gibbons Brothers also make gas-fired regenerative furnaces and muffles suitable for all industrial processes, of particular interest being a new and highly efficient gas furnace. This muffle, which is heated externally only, will attain a temperature of 1500° C. when working on natural draught and burning 900 cb. ft. of gas (430 B.Th.U.) hourly. Bunsen burners and injectors are eliminated, and gas and air are admitted

to the combustion chamber by fireclay ports, both air and gas being pre-heated by a regenerator of ample size. Particular attention has been paid to heat transference and insulation, and the furnace is said to have given surprising results.

The Atritor coal-pulverising and firing machine is exhibited by Alfred Herbert, Ltd., of Coventry, who issue a booklet, "On Pulverised Fuel," which should be consulted by those who wish to study British methods.

The exhibit of Frank Pearn and Co., Ltd., is included in the model boiler house which forms such an interesting feature of the exhibition. A vertical direct-acting pump is shown working under steam at 100 lb. pressure; the valve gear of this pump is designed to ensure that the stroke is full, whilst providing a steam cushion at the end of each stroke so that the pump works steadily without knocking. The pump is capable of delivering 1000 gall. per hour with and against a steam pressure of 200 lb. per sq. in. An electrically-driven vertical treble ram pump is shown that is capable of delivering 1000 gall. per hour against a pressure of 100 lb. per sq. in.; pumps of this type are made by Messrs. Pearn for any capacity and pressure required for boiler feeding when an electric drive is preferred.

The Lea Recorder Co., Ltd., Manchester, shows apparatus for the measurement of coal and water in operation on a Lancashire type boiler fitted with Proctor mechanical stokers. A good check can be obtained in this way on the efficiency of the plant, especially when used in conjunction with the V-notch boiler-feed recorder, also shown in operation. Lea coal meters are also shown for chain-grate stokers, and a model "Cubi-Meter" is in operation to illustrate the volumetric measurement of coal, ores, etc., by this method. Another new feature is the Automatic Sampler for the continuous sampling of liquids of any description.

On the stand of Leigh Smokeless Fuels, Ltd., are pure coal briquettes, smokeless fuels and light and heavy oils. This company, which operates under the patents of Sutcliffe, Speakman and Co. for making smokeless fuel, provides an interesting display of their smokeless fuels, a noteworthy point of its processes being that they combine the advantages of high and low temperature carbonisation. The "pure coal" briquettes, which burn completely and regularly and leave no clinker, are used for industrial as well as domestic heating. According to the temperature of carbonisation, the pure coal briquettes make a valuable smokeless fuel, an artificial anthracite, or a blast furnace coke. The artificial anthracite is recommended for use in anthracite stoves or for suction gas engines, and the blast furnace coke will, it is anticipated, enable a saving of some 3 to 4 cwt. of coke per ton of pig iron made. A plant is being erected at Leigh to manufacture these products, and the company is prepared to grant licences to operate the processes under its patents.

Meldrums, Ltd., of Timperley, exhibit a Meldrum "Koker" type of stoker fitted to a model boiler front. This machine-fired furnace works with an entire freedom from smoke, grit, or noise, and nothing but a slight haze is visible from a chimney serving a dozen boilers fitted with this stoker. Another type of stoker, illustrated by prints, is the "Sprinkler" stoker for installation with a fixed grate. Both types of stoker are suitable for use with natural, induced, forced or balanced draught. The structure of the Meldrum forced draught furnace front is clearly shown by a front mounted on a stand, and a section of the Meldrum patent interlocking fire-bars is also shown. A valvular dead plate, which admits secondary air at the point of combustion when the furnace door is closed, and a split bridge for admission of further secondary air at the bridge, are of interest for promoting smoke abatement, for which there is also the smoke-prevention door to replace the ordinary fire-door on vertical, Cochran, and loco type boilers. Destructor furnaces are a speciality of this firm, and ample information on the many types manufactured is provided. A Meldrum oil burner and a group of pieces of chemical plant made in Meldrum acid-resistant metal complete an informative exhibit.

The model boiler house showing most of the points in a typical Lancashire boiler which require attention for economy, efficiency and smokelessness was a symposium of exhibits by many firms, including Babcock and Willcox, the Chemical Engineering Co., Ltd., A. Gallenkamp and Co., Ltd., E. Green and Son, Ltd. (the "Green" economiser), the Lea Recorder Co., Ltd., Newalls Insulation Co., Ltd., Frank Pearn and Co., Ltd., and several others.

An interesting demonstration of the advantages of fuel oil is arranged by Shell-Mex, Ltd., who have installed a Cochran vertical boiler equipped with Clyde oil-fuel burners (steam jet), thus demonstrating (with the help of a smoke observation apparatus) the perfect smokeless combustion of the fuel. This company claims that when the many advantages of oil are taken into account and given their proper monetary value, Mex fuel oil will generally be found to be considerably cheaper than coal. A well-illustrated selection of literature is available showing the progress made in oil-burning in the principal buildings of London, and there is a booklet describing the oil-fuel installation at the works of J. S. Fry and Sons, Ltd., at Bristol.

The Howden-Ljungstrom air preheaters on the stand of the same name are of importance to those interested in fuel economy and increased steaming capacity. This air preheater can be applied to any type of boiler and design of furnace, and is normally designed to extract 70 per cent. of the available heat in the waste flue gases and transfer it to the air required for combustion. By means of a slowly revolving cylinder containing the heating elements (a large number of thin alternating corrugated and plain steel sheets, which form small triangular channels for the air and hot gases to pass in countercurrent) the heat is transferred continuously. Such a preheater, applied to a Lancashire boiler, gave a fuel-saving of 15·2 per cent. At the same stand is the Howden-Burdon oil-gas furnace.

The Midland Coal Products, Ltd., utilise a method of carbonisation specially adapted to feebly caking,

or a blend of strongly caking and feebly caking coal slacks, and the exhibit is designed to show by stages the products thus obtained. In addition to smokeless fuel, fuel oils and gas, interesting specimens of disinfectants and paints are shown.

The stand of Royles, Ltd., of Irlam, contains samples of the Row indented copper tubes, a working exhibit of the Row air-heater, the Royle hydraulic test pump, the Row storage pattern calorifier, and a series of steam traps and valves.

The Triumph F.D. stoker, exhibited by Triumph Stoker Ltd., is of the sprinkler type, the result being perfect combustion without smoke. For a description of the chief characteristics of this stoker reference may be made to the firm's catalogues, "A" and "F.D."

The Thermal Syndicate could not be absent from a smoke-abatement exhibition, and showed a representative selection of the many products for home and industrial use which are made in Vitreosil.

The Exhibition remains open until the evening of November 15.

PULP AND PAPER INDUSTRY IN CANADA

The International Paper Co. is erecting a new annex to its present mills at Three Rivers, at a cost of over $2,000,000.

The St. Regis Pulp and Paper Co., has purchased a site at Cape Rouge, near Quebec, for the erection of its three mills.

The mills of the Chicoutimi Pulp and Paper Co., which closed down after the bankruptcy of Becker and Co., have resumed operations. Price Bros., Co., Ltd., is commencing the erection of a large mill at St. Joseph d'Alma, Lake St. John, Quebec. The mill will have an initial daily output of 200 tons of paper, increasing to 600 t.

A third paper mill is to be established in Newfoundland in the Handor Valley in the north east portion of the island, with a capacity of 300 t. of newsprint daily.

The annual statement of Spanish River Pulp and Paper Mills Ltd. (Ontario) shows gross profits of $5,038,029 as compared with $4,008,155 on the 30 June, 1923. The gross profit for the past year is equivalent to 26·6 per cent. on the common stock. The working capital stands $9,012,994 and total assets at $44,704,649.

The International Pulp and Paper Co., will expend $5,000,000 on enlarging its paper plant at Three Rivers, Quebec. Three new machines for newsprint will be installed. This will increase capacity to 600 tons of paper daily.

The Quebec Pulp and Paper Corporation has taken over the Saguenay Company, and its main subsidiary the Chicoutimi Pulp Co., both companies which were formerly operated by the Becker interests.

The National Pulp Corporation, Ltd., is to erect a small newsprint mill at Oshawa, Ontario. A company composed of Quebec capitalists is to erect a large pulp mill in the Megiscane river district in Abitibi, Northern Quebec.

THE STREATFEILD MEMORIAL LECTURE

The annual address in memory of the late Mr. F. W. Streatfeild was delivered at the Finsbury Technical College, on November 6, by Mr. Julian L. Baker, the subject being "The Chemist and the Fermentation Industries." The object of the lecture was to stress the economic and scientific importance of the fermentation industries and to show the very fruitful possibilities of these industries for research.

The revenue from beer and spirits alone accounted for, roughly, one-sixth of the total revenue of the country, this large sum being obtained from materials almost wholly derived from agriculture and largely grown in this country.

Following a general description of the processes of brewing, it was pointed out how little we know of what actually takes place, and no real advance could be claimed since O'Sullivan and Brown and Morris, by their work on the action of amylase on starch, set the brewing world thinking. The slow progress made during the last forty years was not surprising, for the difficulties of the investigator were profound owing to the complexity of the changes involved. The work by Brown, Miller, Maquenne, Roux, Ling and the lecturer was outlined, and the conclusion drawn that starch was not made up of a polymerised basal unit, and that Pictet, Carrer and Irvine were probably in error in regarding starch as consisting of a single substance. It thus appeared hopeful that we might soon be in the possession of reliable information concerning one constituent of the barley-corn, though there was still a great deal to be done on the proteins of the barley. Under such conditions it was not surprising that brewing was still regarded as a craft and the brewer as an empiricist.

After describing the work being conducted under the auspices of the Research Scheme of the Institute of Brewing at Rothamsted and elsewhere, the difficulty was emphasised of convincing the industry of the need for research owing to the British instinct to leave well alone. The general trend of the industry, however, was progressive, and firms were beginning to see the necessity that their brewers should be men well-trained in science and engineering. The time was not far remote when the services of chemists would be in greater demand in breweries than at present. Recent work on the production of glycerol lactic acid by fermentation processes was outlined. Enough evidence was adduced to show that the industries based on the activity of micro-organisms were of profound importance to the community, and that the fields of investigation, both academical and technical, in such industries were limitless.

At the conclusion of his address Mr. Julian Baker referred to the recent decision of the City and Guilds of London Institute to close the College in 1926. The withdrawal of the London County Council grant of £10,000 per annum, to take effect in 1926, was largely responsible for the position. He thought the decline in the number of students, given as a reason for the grant withdrawal, had been unduly exaggerated, and was no greater than might be anticipated in view of the action taken in 1920 to close the College and admit no new students in the Session

1920–21. Immediate action was necessary on the part of those who valued the real and practical educational facilities offered by the College for the last forty-six years, due in the first instance to the curriculum provided in chemistry and engineering by its first teachers, Armstrong, Perry and Ayrton. The practical courses unfettered by any particular examination syllabus ought to continue, and it was to be hoped that an influential deputation of manufacturers and educationists would find a way to enable the Institution to continue its work.

After presenting the Streatfeild Memorial Medal to the lecturer, the chairman, Prof. H. E. Armstrong, gave an account of his early work at Finsbury with Perry and Ayrton, and emphasised the value which the training had always had in promoting the application of science to industry. The courses for training chemists and engineers were unique. Chemical engineering was no new subject at Finsbury. All its chemists received training in the principles of engineering as part of the ordinary course.

Mr. A. Chaston Chapman considered that the sound practical training, with freedom from examination syllabuses, the great tradition of its past students and teachers, and the service it had rendered should assure the continuance of Finsbury. Everything possible should be done in order that its work might be continued and developed.

Prof. G. T. Morgan, in arguing for a continuance of its work, pointed out that the good-will of the College and traditions associated with it could not be continued elsewhere; they would be irretrievably lost if it closed.

Prof. Donnan who was unable to be present, expressed his views by letter: "It would have given me great pleasure to express my views on the educational value of the old college, which, in my opinion, did excellent work of real importance for the country. The whole cause of higher education in London is suffering at present from the want of autonomy in the principal Colleges as regards the examination for the B.Sc. degree. The old Finsbury system was and is the only one which produces good results, and is, in fact, the method employed by other civilised countries, with the exception of England. I am, therefore, as you know, a hearty supporter of the system which enabled Finsbury College to produce a long succession of men who have gone forth into the world and done good work, and held high positions in engineering and chemistry.

Mr. F. H. Carr agreed that the training offered at Finsbury was of great value to the industries. He considered that we were suffering greatly from what he would term the respectability of degrees.

Mr. A. J. Chapman, President of the Old Students' Association, described the work now being done by the association to save the college. He felt that where the Council differed from some authorities was on the question of the necessity of a man taking a degree at the end of his training. Finsbury had always held that this only fettered the curriculum, and the reason Finsbury had been such a success in the past was the freedom of the course given there, whereby each of the three departments of the College obtained a good knowledge of the other two. The Old Students' Association had been assured of the inter[est] the four great Institutions took in the matter. Th[e] Institute of Chemistry, Institutions of Civil, Electric[al] and Mechanical Engineers. Many of the City Guil[ds] had been approached, and so also had the manufa[c]turers through their trade organisations. It wa[s] hoped that some means would be found to preve[nt] the closure.

FORTHCOMING EVENTS

Nov. 17. Society of Chemical Industry, *Yorkshir[e] Section*, Great Northern Hotel (Room 15), Leed[s] at 7.15 p.m. "Chemistry of the Distillation [o]f Fatty Acids," by G. F. Pickering.

Nov. 17. University of Birmingham Chemical Society Chemical Lecture Theatre, Edgbaston, Birmingham, at 5.30 p.m. "The Chemistry of Blood," by S. H. Edgar.

Nov. 17. Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W. 1, at 7 p.m "The Production of a Modern Technical Journal," by L. Pendred.

Nov. 17. Institution of the Rubber Industry, Join[t] Meeting with the Society of Chemical Industry, Engineers' Club, Coventry Street, Piccadilly, W., at 8 p.m. "Latex, its Chemistry and the Development of its Industrial Applications," by Dr. A. Van Rossem. B. D. Porritt, M.Sc., will open the discussion on behalf of the S.C.I.

Nov. 17. Faraday Society, Ordinary Meeting, Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1, at 8 p.m.

The following papers will be read:—(1) "The Hydrolysis of Alkali Cyanides in Aqueous Solution," by R. W. E. B. Harman and F. P. Worley. (2) "Note on the Expansion of Water while Freezing" by A. P. Laurie. (3) "The Viscosity of Reversible Emulsions," by S. S. Joshi. (4) "On the Viscosities of Liquids at their Boiling Points," by D. B. MacLeod. (5) "The Kinetic Theory of Evaporation" by D. B. MacLeod. (6) "New Design for Apparatus to Measure the Coefficient of Deviation from Boyle's Law and the Determination of this Coefficient for Acetylene," by J. T. Howarth and F. P. Burt. There will also be an exhibition of physico-chemical Apparatus by Messrs. A. Gallenkamp and Co., Ltd.

Nov. 18. Royal Photographic Society, 35, Russell Square, London, W.C. 1, at 7 p.m. (1) "Note on the Relationship of Photographic Emulsion Fog to Grain Size," by A. P. H. Trivelli, E. P. Wightman, and S. E. Sheppard. (2) "Grain Size and Distribution in Emulsions," by S. E. Sheppard. (3) "Conditions Governing the Behaviour of the Silver Bromide Grains during Development," by L. F. Davidson. (4) "Demonstrations of the Cambridge Photographic Ophthalmoscope and Cambridge Record Measuring Machine," by the Cambridge Instrument Company.

Nov. 18. Institute of Brewing, *Scottish Section*, Caledonian Station Hotel, Edinburgh. "Hot Aeration," by Dr. Clerk Ranken.

Nov. 18. Institution of Civil Engineers, Ordinary Meeting, Great George Street, Westminster, London, S.W. 1, at 6 p.m. "Notes on Modern Practice in Road-Making," by W. J. Hadfield.

Nov. 18. Imperial College Chemical Society, Royal College of Science, South Kensington, London, S.W. 7, at 5 p.m. "The Manufacture of Glass," by Dr. M. W. Travers, F.R.S.

Nov. 19. Society of Glass Technology, Lecture Theatre, Department of Coal Gas and Fuel Industries, The University, Leeds, at 3 p.m. (1) "A Note on the Glass Houses of the Leeds District, in the Seventeenth, Eighteenth and Nineteenth Centuries," by F. Buckley. (2) "A Striking Instance of Fireclay Corrosion through the Action of Saltcake," by Prof. W. E. S. Turner. (3) "A Note on Some Properties of a Sandstone Block after Use in a Glass Furnace," by H. S. Houldsworth. (4) "The Production of Colourless Glass in Tank Furnaces, with Special Reference to the Use of Selenium. Part IV. The Influence of Arsenious Oxide" by A. Cousen and Prof. W. E. S. Turner.

Nov. 19. Institute of Chemistry, *London Section*, 30, Russell Square, London, W.C. 1, at 8 p.m. Discussion to be opened by Dr. J. J. Fox and Mr. V. Stott, on "The Standardisation of Scientific Glassware with particular reference to Units of Volume."

Nov. 19. Society of Chemical Industry, *Bristol Section*, Visit to the New University Buildings. Members will meet at 2.30 p.m. outside the Chemical Department, Woodland Road, Bristol.

Nov. 19. Institute of Chemistry and Society of Chemical Industry, the Caledonian Station Hotel, Edinburgh, at 8 p.m. "The Profession of Chemistry," by Prof. G. G. Henderson.

Nov. 20. Institute of Chemistry, *Belfast and District Section*, Visit to the Linen Industry Research Association at Lambeg. "The Work of the Institute," by Dr. J. Vargas Eyre.

Nov. 20. Institution of Mechanical Engineers, Queen's Hotel, Birmingham, at 6.30 p.m. "Design of an Up-to-date Factory," by F. W. Suffield.

Nov. 20. Chemical Society, Ordinary Scientific Meeting, Burlington House, Piccadilly, London, W. 1, at 8 p.m. (1) "The Sulphur Compounds of Kimmeridge Shale Oil. Part I," by F. Challenger, J. R. A. Jinks, and J. Haslam. (2) "The Interaction of Thiocyanogen and of Hydrogen Sulphide with Unsaturated Compounds. Part II," by F. Challenger and T. H. Bott.

Nov. 21. University of London, King's College, Strand, W.C. 2, at 5.30 p.m. "Scientific Method," by E. S. Russell, M.A.

Nov. 21. Society of Chemical Industry, *Liverpool Section*, the Muspratt Lecture Theatre, The University, Liverpool, at 6 p.m. "Notes on Alloy Metals used in Alloy Steels," by J. L. F. Vogel.

Nov. 21. Institute of Metals, *Sheffield Section*, Conjoint Meeting of Societies at the Sheffield Metallurgical Association's Rooms, 198, West Street, Sheffield, at 7.30 p.m. "Non-Ferrous Metals in the Foundry," by A. Marks.

Nov. 21. Institution of Mechanical Engineers, Joint Meeting with the Liverpool Engineering Society, at 9, The Temple, Dale Street, Liverpool, at 7.30 p.m. "Reducing or Pass-Out Turbines," by W. S. Burge and P. J. Chittendon.

Nov. 22. Institution of Mechanical Engineers, *Midland Section*, Visit to the Birmingham Small Arms Co., Small Heath, Birmingham.

Nov. 24. Institution of Electrical Engineers, Savoy Place, London, W.C. 2, at 7 p.m. "Discussion on the Electrostatic Wattmeter used for Measuring Dielectric Losses in Cables," opened by N. A. Allen.

Nov. 24. Royal Society of Arts, John Street, Adelphi, London, W.C. 2, at 8 p.m. "Modern Colour Problems," by L. C. Martin.

SOCIETY OF CHEMICAL INDUSTRY

SUSPENSION OF ENTRANCE FEE

As an inducement to Chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Society in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

VOL. IX (1924)

This volume is in course of preparation, and an order form will be sent out in due course with the application for the annual subscription for 1925.

The list of subjects dealt with and the names of the authors are as follows:—

Plant and Machinery	S. G. M. Ure.
Fuel	J. W. Cobb and H. J. Hodsman.
Gas—Destructive Distillation—Tar Products	W. B. Davidson.
Mineral Oils	S. J. M. Auld.
Colouring Matters and Dyes	E. H. Rodd.
Fibres, Textiles, Cellulose, and Paper	S. H. Higgins.
Bleaching, Dyeing, Printing, and Finishing	A. J. Hall.
Acids, Alkalis, Salts, etc.	P. Parrish.
Glass	E. A. Coad-Pryor.
Ceramics, Building Materials, and Refractories	W. J. Rees.
Iron and Steel	C. O. Bannister.
Iron-Ferrous Metals	C. A. Edwards.
Electro-Chemical and Electro-Metallurgical Industries	J. N. Pring.
Oils, Fats, and Waxes	H. M. Langton.
Paints, Pigments, Varnishes, and Resins	C. A. Klein.
Indiarubber	D. F. Twiss.
Leather and Glue	D. M. McCandlish.
Soils and Fertilisers	H. J. Page.
Sugars, Starches, and Gums	L. Eynon and J. H. Lane.
Fermentation Industries	H. L. Hind.
Foods	G. W. Monier-Williams.
Sanitation and Water Purification	J. H. Johnston.
Fine Chemicals, Medicinal Substances, Essential Oils	H. King.
Photographic Materials and Processes	W. Clark.
Explosives	J. Weir.

DEATHS

Jackson, Dr. W. Hatchett (elected 1900), of the Radcliffe Library, Oxford, Librarian. On February 21, 1924.

Smith, Henry G. (elected 1902), of "Dunbourne," Shirley Road, Roseville, Sydney, N.S.W., Chemist. On September, 19, 1924.

Spence, John W. (elected 1883), of Darley House, West Didsbury, Manchester, Drysalter. On October 22, 1924.

BRISTOL SECTION

The second meeting was held jointly with the Institute of Chemistry on November 6, in the University Chemical Department, there being an excellent attendance. The certificate of Fellowship of the the Institute was presented, by Mr. C. J. Waterfall, to Mr. E. J. Holmyard, M.A., who then read a most interesting paper on "The Present Position of the Geber Problem."

In considering the history of chemistry we may remember the statement that "in no department is the modern world more deeply rooted in the past than in that of science. The scientific outlook is essentially a living tradition, for the correct application of which a knowledge of its history is essential. Chemistry is at least as surely built on its past as is our religion, our social organisation or our political system." This view was gaining widespread support, and the history of chemistry was now generally regarded as of equal importance with the more practical aspects of the subject.

One of the most important problems in the history of chemistry was that concerned with the development of chemical knowledge in Islam and its transmission thence to Latin Europe in the early Middle Ages. Much interest centred round certain works ascribed to one Geber, which appeared in Latin in the thirteenth century and showed a clear and accurate acquaintance with many fundamental chemical substances and facts.

Evidence was adduced by the lecturer to show that "Geber" was Jabir ibn Hayyan, the great Muslim chemist who flourished under the Caliph Harun al-Raschid of "Arabian Nights" fame. The Latin works were to be regarded, in all probability, not as literal translations from the Arabic, but as free renderings or compilations. The knowledge they contained was, in very large part, to be found in Arabic works by Jabir and others still preserved in the libraries of Europe, India and Cairo.

An excellent set of lantern slides illustrating forms of apparatus and other matters pertaining to Alchemy concluded the lecture, which was productive of a good discussion, in which Drs. Hooper and Rixon, Messrs. Waterfall, Menzies, Jones and others took part.

UNIVERSITY OF BIRMINGHAM CHEMICAL SOCIETY

At the meeting held on November 3, Mr. J. R. Dolphin, B.Sc., delivered a paper on "The Application of Science to the Production of Gems." After dealing with the properties of refraction, pleochroism, hardness and density, the lecturer showed that miscroscopical examination was necessary to distinguish between "synthetic" and real gems. Verneuil's method of producing colourless and coloured corundums was fully described. The colouring agents used in the production of the ruby, yellow and blue sapphires, "synthetic topaz" and "scientific Alexandrite" were dealt with. In conclusion the distinction between "imitation" pearls and the Japanese culture pearl (Mikimoto pearls) were described and illustrated.

CHEMICAL SOCIETY

Consideration of the mechanism of the Walden inversion occupied the greater part of the time at a meeting held on Thursday, November 6. The first paper was read by Dr. J. Kenyon:—

Investigations on the dependence of rotatory power on chemical constitution. Part XXIV. Further experiments on the Walden Inversion. [With H. Phillips and H. G. Turley.]

LÆVOROTATORY lactic acid, which may be assumed to have a lævo-configuration, when esterified gives dextrorotatory ethyl lactate with $[\alpha]_D^{23} + 11{\cdot}29°$. This ester readily yields a *p*-toluenesulphonyl derivative from which dextrorotatory ethyl α-benzoxypropionate with $[\alpha]_D^{20} + 24{\cdot}57°$ can be prepared by interaction with potassium benzoate, whereas, by the action of benzoyl chloride on the same sample of dextrorotatory ethyl lactate, lævorotatory ethyl α-benzoxypropionate with $[\alpha]_D^{20} - 24{\cdot}59°$ is obtained. A complete inversion of *l*-lactic acid is indicated in the first case. Similarly dextrorotatory *a*-bromopropionic ester has been obtained by the interaction of the lævorotatory sulphonic ester with Grignard reagents. This reaction has an important bearing on the relative configurations of *l*-lactic acid and dextrorotatory α-bromopropionic acid and therefore on the theoretical aspect of the Walden inversion. An attempt is made to suggest the possible mechanism of the reactions described on the lines indicated by one of us (Part XVII., *T.*, 1923, 123, 44).

Prof. T. M. Lowry then gave an account of his explanation of:—

The Mechanism of the Walden Inversion.

THE speaker said that none of the older theories had secured general acceptance since it had always been necessary to postulate some entirely novel property of the asymmetric carbon atom, devised expressly in order to explain the phenomena in question. Illustrating his remarks with models, Prof. Lowry described the views of Fischer and of Werner, of Gadamer and Frankland, and exhibited Garner's device, manipulation of which involved a change of configuration of all three radicals P, Q, R, in the scheme $\begin{array}{cc} P & R \\ \multicolumn{2}{c}{C} \\ Q & + \end{array}$. His own conception of the mechanism was based on two propositions—(i) that there are two kinds of valency, one inert and the other active, reaction in organic as well as in inorganic chemistry taking place between ions, either "free" or "bound"; and (ii) that the carbon atom has two stable configurations, the tetrahedral form in neutral atoms easily and reversibly passing into a triangular and planar form when the atom is positively charged. Basing his arguments on the *X*-ray analysis of calcite and basic beryllium acetate, Prof. Lowry applied his two postulates to reactions such as those described in the previous paper. It was necessary to suppose that interchange occurred between an ionised and an esterified radical (involving the inter-conversion of a polar and a non-polar

linking), and that an intermediate additive, although ionic, compound was formed.

Dr. R. H. Pickard disagreed with Prof. Lowry's views. Since the Walden inversion always takes place in solution, reference to the *X*-ray structure of solids was quite beside the point. The previous authors had obtained the first example of a change where the inversion could be definitely ascribed to one stage of the reaction, and they had produced complete inversion without loss of rotatory power. Naturally, the explanation which they put forward must in the first place be special; a general theory such as that evolved by Prof. Lowry must take into account inversions which were complete, and partial. He was certain that much work which had led to racemisation had not found its way into chemical literature. Racemisation is, he said, a phenomenon which is preceded by subtraction; the other reactions are preceded by potential addition.

Dr. G. W. Clough congratulated the first authors on their valuable experimental contribution to the chemistry of the Walden inversion; the transformations of ethyl *p*-toluenesulphonyl-*d*-lactate were of great importance, especially as Freudenberg and Rhino had recently obtained optically active alanine-amide by the action of ammonia on the same compound. He asked whether Dr. Kenyon's theory was generally applicable, and suggested a similar investigation with ethyl phenylmethylglycollate as a crucial test. Prof. Lowry's theory was similar to that of Biilmann, and the question again arose whether an electrically charged carbon atom is asymmetric if it has only three groups attached to it, these groups being in the same plane as the carbon atom. The mechanism might apply to the action of water on active phenylchloroacetic acid, but complete racemisation occurs in this case. The theory apparently had not been applied to any concrete example from the work of Walden, McKenzie, Fischer, or their collaborators; it did not account for the difference in behaviour of an acid and its ester with a given reagent, neither did it indicate at which point in a Walden inversion change of configuration occurs. Finally, Prof. Lowry did not appear to have made any predictions which could be experimentally tested.

Dr. H. Phillips considered that whilst Prof. Lowry's theory suggested a possible mechanism for an abnormal reaction or racemisation, it did not appear to admit the possibility of predominance of the direct displacement reaction, unaccompanied by configurative change, as observed, *e.g.*, by Senter and Drew (*T.*, 1915, **107**, 638) in the formation of phenylaminoacetic acid. The application of either theory to the experimental results just communicated led to the same conclusion, namely that lævorotatory lactic acid has the same configuration as dextrorotatory α-bromopropionic acid, but the mechanism of the Walden inversion proposed by Prof. Lowry also appeared to demand that the action of water on the silver salt of dextrorotatory α-bromopropionic acid was an "abnormal" reaction, and hence to lead to a diametrically opposed conclusion.

Prof. Lowry, in reply, denied that his theory took account only of two alternatives, namely racemisation and complete inversion; his impression was that the facts so far brought forward in criticism were explainable in the manner he suggested.

Dr. E. B. Maxted then read the following paper:—

The adsorption of catalytically poisonous metals by platinum. Part I. The adsorption of lead and mercury.

The adsorption of lead and of mercury from dilute aqueous solutions of their salts has been studied, with the ultimate object of finding the variation in the activity of a platinum catalyst with the actual concentration of such inhibitants on its surface. In these adsorption measurements it was found, both for lead and for mercury, that the adsorbed concentration is directly proportional to the bulk concentration up to a region in the neighbourhood of the complete saturation of the surface of the platinum by the substance adsorbed. With the platinum employed, saturation was obtained with about 27 mg. of lead and about 8 mg. of mercury per gram of platinum. From the results obtained, it would appear that the activity of a platinum catalyst in the presence of such inhibitants is a linear function of the concentration of the poison on its surface.

Dr. W. E. Downey briefly described:—

A spectroscopic study of the luminescent oxidation of phosphorus. [With H. J. Emeléus.]

A spectroscopic examination of the light emitted when phosphorus burns has given the following results. When phosphorus burns in enriched air with a flame temperature of 800°, it shows five broad bands in the ultra-violet portion of the spectrum. Phosphorus burning in air under reduced pressure with a flame temperature of 125° emits five groups of narrow bands. The groups occupy the same positions as the bands obtained with the hot flame. Glowing phosphorus emits the same groups of narrow bands. This latter result contradicts Petrikaln's recent work but agrees with the earlier work of Centnerszwer and Petrikaln.

The President congratulated the authors, and expressed the hope that further papers would be forthcoming.

BRITISH ASSOCIATION OF CHEMISTS

The seventh Annual General Meeting was held at the Imperial College of Science, South Kensington, on October 25. Dr. Herbert Levinstein, retiring President of the Association, was in the chair.

In his address Dr. Levinstein complimented the Council upon the Annual Report, which in his opinion was well expressed and admirably concise. He alluded to those members who, by non-payment of their subscriptions, had seriously hindered the work of the Association, and appealed to all to make it a point of honour to recognise their clear duty in this respect. The report made very clear the unique

advantages that the Association had to confer. It had set up a standard of qualification; it supported substantially those of its members who were unemployed, and it had given, in the current year, legal aid to several of its members. Dr. Levinstein considered that those firms who were members of the Association of British Chemical Manufacturers would in many cases be prepared to give the Association substantial support; since the Association, pledged as it was to maintain a high standard for the profession, was able and willing to assist manufacturers in every possible way. It was greatly to the credit of the Association that it had been the first chemical organisation to wait successfully upon the President of the Board of Trade in connexion with the Dyestuffs Agreement controversy, and it was due, in large measure, to the Association's influence that a serious blow at the dyestuffs' industry of this country had been turned aside.

The general discussion was opened by Mr. Rowell, who said that decided progress had been made, but that a considerable increase in membership was necessary if there were to be any rapid advance. He indicated that Birmingham was preparing a scheme which he claimed had already proved successful on a small scale, and which might, in his opinion, be the more satisfactory as its scope increased. He hoped that the Association would collect information about salaries, so that particulars of minimum salaries paid might be obtained, and employers who paid less than the average amount might be approached with a view to adjustment of the matter.

Officers for the ensuing year were then elected as follows: President, Dr. E. F. Armstrong, F.R.S.; Vice-Presidents, W. E. Kay and F. Scholefield, M.Sc.; Registrar, David Bain, D.Sc.; General Secretary, I. Boodson, B.Sc.; Treasurer, H. E. J. Cory, M.Sc; Editor, H. T. F. Rhodes; Assistant Secretary, A Stewart Mills.

Mr. Knapp (Birmingham) then rose to put the Birmingham resolutions, which he explained were advanced as temporary measures with a view to economy. The first and second of these—that Council Meetings be held on alternate months, and that they be held at Derby, were accepted, but some discussion arose as to the third—that Sections be allowed to send at the Association's expense only one Councillor to each Council Meeting. After some energetic discussion in which Mr. W. E. Kay and the London Delegates took part, the amendment by Mr. E. R. Redgrove, Senior London Delegate, that the words "at the Association's expense" be deleted, was carried.

Mr. W. E. Kay, Vice-President of the Association, then proposed a vote of thanks to the retiring President. He pointed out how much moral and material help Dr. Levinstein had lent to the Association, and how its success had been due, in large measure, to his energy and enthusiasm. The vote of thanks was carried with loud acclamation.

The kindness of Prof. Baker of the Imperial College had made possible a tour of inspection of the laboratories and this took place at the close of the meeting. A very successful dinner was subsequently held at the Engineers' Club.

FARADAY SOCIETY

At the meeting, held on October 22, by the Faraday Society, the Geological Society and the Mineralogical Society, a general discussion was held on "The Physical Chemistry of Igneous Rock Formation."

In his paper on the "Homogeneous Equilibria in Magmatic Melts and their Bearing on the Processes of Igneous Rock-Formation," Mr. P. Niggli surveyed the phenomena in relation to the formation of rock, and gave a diagrammatic representation based on consideration of the homogeneous equilibria in the magma and connecting together a large number of natural phenomena, which thus represented a serviceable basis on which to discuss the laws pertaining to igneous rock.

Mr. A. F. Hallimond contributed a paper on "The Formation of Eutectic and Similar Structures in Silicate Melts," which dealt with the classification of silicate melts, the interpretation of structures, and concluded by suggesting a method of investigation consisting in examining polished surfaces under vertical illumination.

The object of the paper by Prof. C. H. Desch, entitled "The Theory of Crystallisation in Rock Magmas," was to suggest that the theory of crystallisation of rock magmas was best studied by the determination of the equilibrium diagrams of binary and ternary systems, work which has been undertaken with such remarkable success at the Geophysical Laboratory at Washington, combined with a detailed examination of the effects of cooling. For this latter purpose a knowledge of the viscosity of magmas and its variation with temperature and composition was required.

The paper by Prof. J. W. Gregory on "Magmatic Ores" dealt with gold-quartz veins, chromite, the magmatic iron ores, nickel ores in norite, and the intrusive pyritic massives. It pointed to the conclusion that the metalliferous ores formed during the direct consolidation of igneous magmas were at present unimportant; since the non-titaniferous ores which have been regarded as the test cases for magmatic iron ores, the nickel-sulphide ores in norites, the chief masses of chromite, and the great pyritic masses, were apparently deposited from solutions. The waters which had deposited primary ores were probably in most cases of magmatic origin, but the term magmatic as applied to ores should be restricted to its original meaning of direct consolidation from a molten magma.

Mr. J. W. Evans gave a paper entitled "Proposed Researches on the Chemistry and Physics of Igneous Magmas and Rocks" which dealt with research under uniform or hydraulic pressure and the effects of directed pressure, or shearing stress. Emphasis was laid on the theoretical and practical importance of investigating the origin, history and physical and chemical characters of igneous magmas and rocks, not only for determining the fundamental problems of the structure and past history of the earth, but because it had an immediate bearing on the mode of occurrence of metalliferous ores and therefore on the economic problems of mineral production.

Mr. W. A. Richardson, in his paper on "Some Ultimate Problems in Petrogenesis," stated that the science of petrogenesis took its origin and found its first problems in the recognition of affinities shown by rocks associated in the field, in such facts as the existence of petrographic provinces and diaschistic dykes. Since in its earlier stages petrology consisted of a vast mass of descriptive data, it was clear that the only way to bring the accumulated material into order was to limit the problems to definite areas. The extension of systematic surveys has now provided a body of data to which appeal can be made and statistical methods applied. Mr. Richardson concluded his paper by indicating what in his opinion were the chief needs of research in this connexion. They are as follows:—(1) The tabulation of the areas and exposed volumes of visible igneous rocks, so that further estimates of relative volumes could be made; (2) the systematic sampling of rock masses for chemical analysis; (3) investigations on the behaviour of silicate systems in the presence of vapour phases; (4) a more accurate and systematic determination of the temperature gradients in relation to the thermal problems of petrology, and of the geographical distribution of the gradients; (5) organised research into the question of the thermal state of the earth, especially the upper crust.

The paper entitled "Some Physical Properties of Silicate Glasses and their Possible Bearing on the History of Igneous Rocks," by Prof. W. E. S. Turner, dealt with the weathering and corrosion of silicate glasses and the density, thermal expansion and the compressibility of glass.

A "Review of Recent Work on the Origin and Differentiation of Igneous Rocks" was given by Mr. G. W. Tyrrell, who said that petrology may be considered as the natural history branch of physical chemistry. The application of physico-chemical principles to the study of igneous rocks has been hampered owing to the scarcity of exact experimental data on the behaviour of solutions approximating to igneous rocks in composition at high temperatures, but this handicap was now in process of being removed by the intensive and well-directed work of the Geophysical Institute at Washington. The paper also deals with crystallisation-differentiation, influence of water and other volatile constituents in magmatic differentiation, the origin of anorthosite, the origin of the alkaline rocks and the origin of alnöites and ultrabasic lamprophyres.

A cyanide war is apparently developing in North Ontario between the Cassel Cyanide Co., Glasgow, and the American Cyanamid Co. The former is offering sodium cyanide at under 15 cents. per pound, whilst the Cyanamid Co. supplies calcium cyanide at about 12 cents. per pound. It is reported that the American Company is endeavouring to reach an agreement with the Cassel Co., with the object of preventing a serious trade war.

CORRESPONDENCE

IS IT POSSIBLE TO PREDICT THE COURSE OF THE WALDEN INVERSION?

Sir,—At the last meeting of the Chemical Society I quoted Prof. Walden's statement that "We have many theories, too many theories, but we have not yet got *the* theory which will master the Walden Inversion." I also quoted his negative reply to the question, which I put to him in Holland at the van't Hoff Jubilee, whether he expected to find a theory which would enable us to predict the course of these actions. My own view, as I explained to him, is that the Walden Inversion gives us an opportunity of studying the mechanism of chemical change more intimately than does any other phenomenon hitherto investigated; we are therefore much more likely to learn from it, than to be able to use it as a "happy hunting ground" for prophets.

There is, however, another fundamental difficulty, in the fact that the Walden Inversion is essentially a study of *simultaneous reactions*. Of these there are at least two, namely, *direct substitution* and *indirect substitution*; and, in some cases, there may be a third, namely, *autoracemisation*, as distinguished from the racemisation which must result if direct and indirect substitution proceed with equal velocity, so as to give a 50 per cent. inversion. These three actions can all be interpreted by the modified Gadamer mechanism which I described; but, unless one could assign relative values to the three velocity-constants in question, the course of the action could not be predicted, since 40 per cent. of direct with 60 per cent. of indirect substitution would be described conventionally as inversion with partial racemisation, whilst 60 per cent. of direct with 40 per cent. of indirect substitution would be described as involving partial racemisation without inversion.

The examples recently described by the Battersea school owe much of their attractiveness to the fact that one of these actions preponderates over the others so strongly that they have almost ceased to be simultaneous. In cases such as these *qualitative* predictions may some day be possible, *e.g.*, that the action will proceed along Route No. 1 rather than along Route No. 2, perhaps (as I have suggested) on account of the mere bulk of the anions which are being exchanged. In all others, however, the predictions involve *quantitative* statements, which call for much more knowledge than we possess at present of the course of even the most commonplace reactions of organic chemistry. Thus, until we can predict the extent to which nitric acid will act as a nitrating agent, or as an oxidising agent on compounds such as bromocamphor, it is, in my opinion, unlikely that we shall be able to predict whether direct or indirect substitution will preponderate in cases in which both occur.—I am, Sir, etc., T. M. LOWRY

ECONOMY IN THE GENERATION OF STEAM

Sir,—I have read with interest the article by Mr. Chas. F. Wade on "Economy in the Generation and Utilisation of Steam" in the current number of *Chemistry and Industry*, and I note that it is

suggested that the loss due to unburned carbon in the ash of coal may be evaluated from "the difference between the absolute ash as found by proximate analysis, and the percentage of ashes removed." While this is, no doubt, theoretically always true, experience shows that the rule is one which frequently fails. It commonly happens when working with mechanical stokers and mechanical draught that the percentage of ashes removed during a boiler trial is less than that required by the proximate analysis, although there is a considerable percentage of unconsumed carbon in the refuse. This, of course, arises from fine dust carried forward by the gases which lodge in the various parts of the boiler and setting, and is (to a greater or lesser extent) carried clean up the chimney, and spread over the countryside.

The loss caused by combustible in the refuse can therefore be determined approximately only by weighing up such refuse as is removed *via* the ashpits, and by determining the carbon therein by chemical means.—Yours, etc.,

GODFREY W. HIMUS

Dearborn Chemical Co.,
Regent Street, London,
November 10, 1924

EARLY HISTORY OF ANTIMONY

Sir,—In my copy of Van der Linden's "De scriptis medicis" (Nuremberg, 1686) the following bibliographical references to Antimony are given, and some of them might prove of interest. For the sake of brevity, only names, dates and parts of titles are included here:—

Angelus Sala. Op. Med. Chym., 1647, 1650, 1680.
Angelus Sala. Anatomia Antimonii, 1617.
Baptista Codronchius, 1591, 1629.
Basilius Valentinus. Currus . . . 1671 (Kerckringius.) Amsterd.. in 12mo.
Basilius Valentinus. Azoth. . . . 1613 (Earliest publication of Valentinus mentioned by Linden).
Penotus. Tract. de Antimonio., 1594, 1602, 1613. 1616.
Arnold Kerner. Tetras Chymiatrica, 1618 (Erfurt).
Guernerus Rolfinkius. Dissert. Chem., 1679 (Jena).
Hildanus. (Medical), 1646.
Poppius. Basilica Antimonii., 1618 (Frankfort).
Grevinus. De Venenis., 1471 (Plantin., Antwerp).
Stenglius. Questiones 111, 1566.
Philologus. (Medical), 1538, 1545, 1575.
Hoffmannus. Exercitationes, . . . 1685 (Leyden).
Alexander a Suchten. De Secretis Antimonii, 1575 (Basel), 1670 (London).

In the event of further notes on the above being sought, I shall be pleased to furnish all I have found, six works attributed to Joachim Tankius are given as being published between 1604 and 1628. I find no mention of Tholde in the book, but a more thorough search [illegible] be more fruitful.—I am, Sir, etc.,

HAROLD A. AUDEN

Whitehedge Road
Garston

PERSONAL AND OTHER ITEMS

The King has approved of the following awards this year by the president and council of the Royal Society:—A Royal medal to Sir Dugald Clerk, K.B.E., F.R.S., for his application of scientific principles to engineering problems, particularly to the development of the internal-combustion engine. A Royal medal to Dr. H. H. Dale, F.R.S., for his researches in pharmacology and physiology. The following awards have also been made by the president and Council:—The Copley medal to Sir E. Sharpey-Schafer, F.R.S., for his valuable work in physiology and histology. The Rumford medal to Mr. C. V. Boys, F.R.S., for his invention of the gas calorimeter. The Davy medal to Professor A. G. Perkin, F.R.S., for his researches on the structure of natural colouring matters. The Darwin medal to Professor T. H. Morgan, Foreign Member R.S., for his valuable work in zoology, especially his researches on heredity and cytology.

The following is the list of those recommended by the president and council of the Royal Society for election to the Council at the anniversary meeting on December 1:—President, Sir Charles Sherrington; Treasurer, Sir D. Prain; Secretaries, W. B. Hardy and J. H. Jeans; Foreign Secretary, Sir Richard Glazebrook. Other members of the Council are:—Sir F. Andrewes, Prof. J. H. Ashworth, Dr. F. W. Aston, Sir W. Bragg, Prof. S. Chapman, Sir D. Clerk, Dr. H. H. Dale, Prof. F. G. Donnan, Prof. A. S. Eddington, Prof. E. S. Goodrich, Sir T. Holland, Prof. J. B. Leathes, Dr. G. C. Simpson, Prof. J. F. Thorpe, Prof. F. E. Weiss and Prof. T. R. Merton. Lord Crawford and Sir O. Beit have been elected Fellows of the Royal Society under the Statute which permits of elections on the grounds of conspicuous services rendered to science. A donation of £500 has been made by Mrs. Tyndall, widow of Prof. John Tyndall, F.R.S., to be used at the discretion of the Tyndall Mining Bequest Committee, as a fund to meet out-of-pocket expenses incurred by the Tyndall Research Student in carrying out his investigations.

The following awards have been made by the Institution of Civil Engineers:—A Telford gold medal to Professor C. E. Inglis; Watt gold medals to Mr. H. N. Allott and Mr. F. L. Pearce; Telford premiums to Mr. A. J. Martin, Dr. H. E. Hurst, Mr. D. A. F. Watt, and Mr. D. H. Renfry; a Crampton prize to Mr. T. R. Nolan; and a Manby premium to Mr. H. T. Tudsbery. All these awards were for papers read at meetings of the Institution. Other awards for selected contributions included a Telford gold medal to Mr. E. H. Lamb, and premium to Mr. F. O. C. Temple, Mr. H. A. Lewis-Dale, Professor L. N. G. Filon, Mr. C. J. Gyde, and Mr. Wm. Burnside.

By an Order of Privy Council, dated October 30, Prof. E. P. Cathcart, M.D., D.Sc., F.R.S., Professor of Chemical Physiology in the University of Glasgow, has been appointed to the vacancy in the membership of the Medical Research Council, caused by the retirement of Prof. D. Noël Paton, M.D., F.R.S.

The list of awards for Ramsay Memorial Fellowships is as follows:—*British Fellowships*: Mr. Samuel Coffey, Ph.D., University College, London; Mr. A. F. Titley, B.Sc., Phil.D., University of Oxford; Mr. Sidney W. Saunders, B.Sc., University College, London. *Glasgow Fellowships*: Mr. T. S. Stevens, B.Sc., University of Oxford; Mr. Alex. Robertson, Ph.D. (since resigned on appointment to an International Fellowship in New York). *Canadian Fellowship*: Mr. Edward H. Boomer, Ph.D., University of Cambridge. *Danish Fellowship*: Mr. Kai J. Pedersen, University of Bristol. *Dutch Fellowship*: Dr. J. Kalff, University of Manchester. *French Fellowship*: Dr. H. Weiss, Royal Institution, London. *Greek Fellowship*: Dr. Nicolas Oeconomopoulos, University College, London. *Italian Fellowship*: Dr. Antonio Nasini, University of Cambridge. *Japanese Fellowship*: Dr. Kameyama, University College, London. *Norwegian Fellowship*: Mr. Leif Lindemann (provisional). *Spanish Fellowship*: Dr. Miguel Crespi, University College, London. *Swedish Fellowship*: Temporarily vacant. *Swiss Fellowship*: Dr. Walter Feitknecht, Royal School of Mines, London. The total value of the annual amount of the Fellowships that is awarded is approximately £4800, of which approximately £3300 is provided by grants from Dominion and foreign sources.

Mr. J. M. Mullaby, B.A., has been elected to a war memorial studentship in chemistry at Balliol College, Oxford.

With great regret we announce the death of Mr. J. T. Wood, former chairman of the Nottingham Section and a valued contributor to this Journal. He represented the British Section of the Society of Leather Trades Chemists on the Federal Council and was an indefatigable worker in the interests of chemical industry. An obituary will appear in a later issue.

We regret to announce the death of Sir Archibald Geikie, O.M., the doyen of British geology. He was one of the first field geologists in England to recognise the importance of microscopic investigation as as an adjunct to field work, and the author of several standard works.

The Electric Accumulator Regulations, 1924

The Home Office has published a draft of new Regulations under Section 79 of the Factory and Workshop Act, 1901, applying to the manufacture or repair of electric accumulators or parts thereof, containing lead in substitution for the Regulations made under the same section on November 21, 1903. Despite the operation of the existing Regulations, the incidence of lead poisoning among workers engaged in this industry has continued high. Thus, they are designed to extend the Regulations to cover to works in which accumulators are repaired as well as works where accumulators are manufactured. The requirements for securing the application of exhaust ventilation and the maintenance of cleanly conditions, have been strengthened so as to bring them up to the standard required in recent codes of Regulations for other industries where danger of lead poisoning occurs. The Regulations should be brought into force not later than January 1, 1925.

REVIEW

THE CONSTITUENTS OF COAL TAR. By P. E. SPIELMANN. Pp. xii+219. London: Longmans, Green and Co, 1924. Price 12s. 6d.

The author in his latest publication has set up before himself a high standard, and, as we should expect, has gone to great trouble to give his readers the wherewithal to search without difficulty for the origin of the information and data he provides.

The volume has for reference and convenience been divided into five parts. The four sections of Part I deal with tars as generally produced by varying methods of carbonisation. Part II deals with monocyclic and polycyclic compounds. The third part with the oxygen bodies, and the fourth with sulphur compounds. Nitrogen constituents form the last section, succeeded by the Bibliography notes and reference Indices. Two useful charts are inserted to help in estimating the purity of the Benzene fractions.

It is perhaps regrettable that a work on this subject should appear at a time in the history of the coal-tar industry when there is no desire evidenced on the part of those dealing with these products to separate the bodies which he describes. Many of the larger works are now preparing fewer of the special products and concentrating on material for roads.

How would such a book have been welcomed twenty years ago as a companion to the well-appreciated old friend "Lunge." On the other hand, it may be that the appearance of this volume will be a stimulus to the by-product industry, and induce it to attempt a greater variety of pure products, of which this book is in the nature of a "first aid." As the author states in his introduction, this book is for assistance, and does not pretend to be encyclopædic, and to the laboratory staff its great value will be unquestioned. Its appeal is manifestly to those with whom formulæ and their appurtenances, graphic and otherwise, are everyday routine, and a reasonably advanced knowledge of organic, inorganic and physical chemistry is taken for granted. The book contains wisely no reference to the ammoniacal compounds present in most tars. These might well form the subject matter of a further volume, and fairly come in another category.

The author might consider when further editions are called for a more extended article on the subject of pitch. It represents such a large bulk proportion of the constituents that one would have wished for more extended information, even if only the physical qualities and varying nature of the products from the different types of tar were noted. Take, for example, horizontal-retort tar pitch and that containing an abundant mineral matter such as is produced in blast-furnace practice. To dismiss the subject in a few lines seems regrettable.

The book is well written and printed, reflecting credit both on author and publisher, and it will be welcomed as a substantial addition to the libraries of gas and coke works, and also to those engaged in laboratories where the products described are dealt with.

ERNEST F. HOOPER

REPORTS

Report on the Finance, Industry, and Commerce of the United States of America. Dated April, 1924. By J. J. Broderick, H.M. Commercial Counsellor, Washington Department of Overseas Trade. Pp. 136. H.M. Stationery Office, 1924. Price 3s. 6d.

In introductory comments it is remarked how the nature of American trade is changing. Instead of catering for the home market and considering export merely an outlet for surplus production, industry is turning its attention more and more to foreign markets, whilst the import trade is increasing in a still more marked degree, increased imports of raw materials testifying to the growth of manufacturing activity since pre-war years. A Bureau of Foreign and Domestic Commerce has been working since 1913 with continually increasing activity in promoting export trade.

Since about 40 per cent. of the population is directly dependent on agriculture for a living, it is obvious that a period of depression in this industry has far-reaching effects. Such a depression marked 1920, and farmers are still in some measure suffering from it (*cf. Chem. and Ind.*, 1923, 663). Wheat prices at present are very low owing to decreased consumption and competition abroad from Argentina, Australia and Canada, whilst the cotton yield last year was disappointing in spite of the record acreage. The iron and steel industry had a very large output last year, 70,018,000 t. of iron ore being mined. The production of pig-iron, 40,200,000 t., was a record, and that of ingot-steel, 43,619,200 t., was 43 per cent. above the pre-war figure. The export trade, however, was slack and the excess of exports over imports of iron and steel goods continued the downward tendency which has been evident since 1920. In the coal industry 1923 was a year of large production and falling prices, output being estimated at 550 mill. t. against 408 mill. t. in 1922, and this was only partially relieved by increased exports which totalled 19 mill. t. as compared with 11 mill. t. In spite of a strike in the anthracite industry, which led to considerable imports from Britain, production was estimated at 95,650,000 t., 70 per cent. greater than in 1922 and almost a record. An over-estimate of the probable demand led to over-production in the petroleum industry early in 1923, and the effects of the consequent depression are only now showing signs of disappearing, though prospects are considered good. The output of electrical energy shows a continuous increase, being estimated at 66 billion kilowatt hours in 1923.

The copper mining industry has still to meet an unfavourable price situation, though an improvement is being shown in output, which reached 1467 mill. lb. last year, the total refinery production from all sources being 2110 mill. lb. The zinc, lead, and aluminium industries were more active, and magnesite mining has revived considerably. The production of various minerals has been encouraged by the taxation of imports, but in the graphite, chromite, and tungsten industries this course has not led to any progress. Sulphur production increased to 2,035,000 t., exports amounting to 472,525 t. Production and imports of pyrites in 1923 amounted to 181,628 t. and 260,000 t. respectively. Home production of potash is small, and the imports amounted to 231,000 t. The textiles industries had a good year, and the continued growth of the artificial silk industry is noteworthy.

Most branches of the chemical trade enjoyed a good year. Activity in the building trades led to record sales in the paint and varnish industries, whilst manufacturers of fertilisers emerged from a long period of depression. The question of nitrate supply has recently attracted Government attention with regard to the country's dependence on foreign supplies.

Physical and Chemical Survey of the National Coal Resources No. 3. The Lancashire Coalfield, the Arley Seam. Department of Scientific and Industrial Research, Fuel Research Board. Pp. vi+37. H.M. Stationery Office, 1924. Price 2s. 6d.

This Report gives the results of both laboratory tests and large scale operations on Arley coal (chosen because it is widely used), and embodies an account of experiments carried out with this coal by other workers. The coal is bituminous and strongly caking, and is largely employed both for gas making and in the manufacture of coke. For the preparation of metallurgical coke it is often best blended. It is also used for steam raising, and for household use, and is frequently sold blended with other seams. Analysis has proved the consistency of the seam throughout the greater part of the coalfield, and it would appear that the percentage of volatile matter in the coal substance is higher in the top sections, decreases towards the centre of the seam, and increases again at the bottom. This trend is also observable in the ash content, which varies in its composition and fusibility. The behaviour of the coal during carbonisation in the laboratory assay apparatus at a temperature of 600° C. has been studied and much useful information obtained on the general properties of the coal and the yields and qualities of the products. Carbonising tests at 600° C. have also been carried out in H.M. Fuel Research Station in the setting of mild steel horizontal retorts, specially designed for experimental work on low-temperature carbonisation. The results of these tests were in agreement with what might have been forecasted from the results of the laboratory assay. Tests on the steaming of Arley coal have also been carried out at H.M. Fuel Research Station in the setting of Glover-West vertical retorts on 400 tons of coal specially supplied for this purpose, and the main details of the several tests are given in the report. Further experiments and a complete microscopical examination of the seam in two different localities, have been made, and results indicate that the Arley seam is *especially* valuable for coal gas manufacture. From it metallurgical coke may also be made, and coal from certain localities is suitable for use by itself for low-temperature carbonisation, a strong, hard, compact, smokeless solid fuel being obtained. The yields of tar, gas, etc. in each case were satisfactory.

REPORT ON THE ECONOMIC AND FINANCIAL SITUATION OF EGYPT. DATED APRIL, 1924. By E. H. MULOCK, Commercial Secretary, Cairo. Department of Overseas Trade. Pp. 55. H.M. Stationery Office, 1924.

As the result of the successful working of the financial year 1923–4, the volume and favourable balance of trade in 1923, and the good prices obtained for the cotton crop during the year, Egypt is in a prosperous and economically satisfactory condition. Imports in 1923 were valued at £E45,270,941, about £E2 mill. more than in 1922 (*cf. Chem and Ind.*, 1923, 1118), whilst exports reached £E59,853,987, an increase of over £E8 mill. The increase in imports is chiefly accounted for by cotton piece goods, wheat flour, tea, sugar, and coal; decreases occurred in several categories including chemicals and tobacco. The chief articles of import are yarns and textiles, agricultural produce, wood and coal, metals and metal ware, chemical and medicinal products and spirits, beverages, and oils. The countries which mainly contributed to the increase were Italy, which now holds second place after the United Kingdom, Australia, New Zealand, India and other eastern British possessions, Palestine and Russia. The increase in exports is accounted for entirely by cotton, exports of which were valued at £E49,516,369 in 1923, though sugar, cottonseed and cottonseed oil also showed increases which offset decreases in benzine and agricultural products. The principal purchasers of cotton continued to be the United Kingdom and the United States, though France was not far below the latter. British purchases from Egypt were about one-half of the total.

The mining industries continued to show the effects of trade depression, but some signs of revival were apparent, for example, in the petroleum and manganese ore industries; phosphate production was, however, much curtailed.

LEGAL INTELLIGENCE

ALLEGED INFRINGEMENT OF LETTERS PATENT

Mr. Justice Tomlin, in the Chancery Division on October 30, gave judgment in an action by Dr. Meyer Wilderman against F. W. Berk & Co., Ltd., Fenchurch Avenue, E.C., for an injunction restraining them from, as he alleged, infringing his letters patent for an invention relating to "improvements in electrolytic cells for the electrolysis of alkaline salts."—(*Cf. Chem. & Ind.*, Oct. 24, 1924.)

His lordship said that in the process of manufacture used by the Deutsche Wilderman Werke there was employed a mechanical contrivance in the shape of a trough constructed with projections similar to what was contained in the plaintiff's specification. But it did not follow that the importation of potash made under these conditions was an infringement of the plaintiff's patent. He did not know what was the precise function of this contrivance in the making of electrolytic salts, because no evidence on the point was called. He could not think that the employment of, for instance, a patented blow-pipe or a patented hammer employed in the making of some part of a locomotive would necessarily render the locomotive an infringement of the patent. Each case must be determined on its merits, but in this case he did not think that the plaintiff had proved, and he (the judge) was not prepared to hold that the device which was the subject-matter of the invention was of such a character, or was so used in relation to the manufacture of potash, as to render the importation of the potash an infringement of the patent.

As to the plaintiff's right to sue, he held that the plaintiff could not, even if the alleged infringement was proved, maintain the action, because (1) at the date of the alleged infringement the patent was vested in the Custodian of Enemy Property owing to the fact that at that time the plaintiff was a "hostile person" within the meaning of the phrase as defined in the vesting order; (2) that there was nothing in the language of the vesting order which transferred the right of action to the plaintiff; (3) that under Article 309 of the Treaty of Peace, the plaintiff had acquired the character of a resident in Germany at the material date; and (4) that it had not been proved that the plaintiff had ever divested himself of that character.

He was satisfied that the defendants acted in good faith and were not aware of the existence of the patent. The action failed and must be dismissed with costs.

COMPANY NEWS

BRUNNER, MOND AND CO., LTD.

An interim dividend of 7 per cent., being the same rate as that declared a year ago, has been declared for the half-year ended September 30.

LASTENIA NITRATE CO.

At an extraordinary general meeting of the Compania Salitrera Lastenia (Lastenia Nitrate Co.) it was unanimously resolved to transfer assets and liabilities to the Lautaro Nitrate Co. as from October 31. The latter company will, therefore, take charge of the Compania Salitrera Lastenia business as from November 1.

ERINOID, LTD.

Speaking of the company's interests in France and the United States at the ninth annual meeting, the chairman said that the investment in the French company is slightly higher, owing partly to a loan which had been made to that company to provide for additional working capital. Business conditions during the past year in France had been difficult owing to the extreme flexibility of the exchange, but the French company was making a profit. Both the English and French companies are putting a new transparent material on the market for which there should be a large demand. As regards the Société Anonyme Foncière Erinoid, also a French company, the whole of the shares belong to Erinoid, which is

represented on the Board by the same directors as in Omnilith. All the necessary cash capital for the new company to be formed in connexion with the Casein Company of America will be found in the United States, and the allotted shares amount to $166,000, equal roughly to £33,000. The stocks of the company are all paid for, and the bulk of their requirements covered until next spring. The report and accounts were unanimously adopted.

BRITISH GOODRICH RUBBER CO.

A dividend at the rate of 7½ per cent. per annum on the preference shares has been declared, calculated from the dates for payments of instalments to November 30, 1924, less tax, payable on November 30.

GUEST, KEEN AND NETTLEFOLDS

The interim dividend is to be 5 per cent. for the six months ended September 30 on ordinary shares, free of tax, payable on December 19.

BRITISH AMERICAN NICKEL CO.

As the result of an action against the British American Nickel Co. by the National Trust Co. to protect the security of a $6,000,000 bond issue, the Court has ordered the former to be placed in liquidation with the latter. The liquidator's action is said to be an attempt to merge the properties in Quebec and Ontario in one block, all the company's assets being covered by the bond mortgage.

TRINIDAD LEASEHOLDS

The net profit for the year ended June 30 is £205,230 (against £133,240 in 1922–23). The total dividend for the year is 17½ per cent. against 10 per cent., whilst the "carry forward" is increased from £41,749 to £54,180. Capital expenditure during the year totalled £174,743 (against £97,351), of which £109,423 represented cost of well sinking (against £71,949). Working costs per ton were further reduced, whilst the production was 60,158 tons larger at 204,203 tons. Purchases from other companies declined by 886 tons to 122,911 tons. The amount written off for depreciation was £203,744 (against £157,084).

LIGHTING TRADES, LTD.

The trading profit for the year amounted to £12,000, against a trading loss for the previous year of £15,000, a distinct improvement. The closing and relinquishing of the lease of the Dartford factory has necessitated the writing-off of nearly £26,000, and exceptional expenditure of a non-recurrent nature was also inevitable during the year. During the period under review there had been a quantitative increase of 15 per cent. in sales. Continental competition is still very acute. The sale of products such as lamps, burners, glass, etc., has been conducted energetically with satisfactory results.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	.. £45 per ton.
Powder	.. £47 per ton.
Acid Hydrochloric	.. 3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	.. £21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric ..	.. Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	.. £6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	.. Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	.. £7 10s. per ton, packages extra.
Borax, Commercial—	
Crystal	.. £25 per ton.
Powder	.. £26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	.. £5 17s. 6d. per ton d/d.
Copper Sulphate ..	.. £25 per ton.
Methylated Spirit 64 o.p.—	
Industrial ..	.. 2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised ..	.. 3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate .. / Nickel Ammon. Sulphate	.. £38 per ton d/d. Normal business.
Potash Caustic ..	.. £30—£33 per ton.
Potass. Bichromate	.. 5⅜d. per lb.
Potass. Chlorate ..	.. 3d.—4d. per lb.
Salammoniac ..	.. £32 per ton d/d.
Salt Cake	.. £3 10s. per ton d/d.
Soda Caustic, solid	.. Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals ..	.. £5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	.. £24 per ton.
Sod. Bicarbonate	.. £10 10s. per ton, carr. paid.
Sod. Bichromate ..	.. 4½d. per lb.
Sod. Bisulphite Powder 60/62%	.. £17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate ..	.. 3d. per lb.
Sod. Nitrate refd. 96%	.. £13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	.. £9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	6½d.—1s. 2d. per lb., according to quality.
Crimson	1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes White and Dark	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P.	£47 10s.—£52 10s. per ton, according to quantity.
Sulphur Chloride	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

There is a general feeling that the fall in price of acetates during the last few weeks has reached its limit. The tendency is now to stiffen again.

Acetate of Lime—	
Brown	£11 10s. per ton, and upwards.
Grey	£14 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand quiet but price steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. ,, ,, 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 9d. per gall. 60% O.P.
Solvent	5s. per gall. 40% O.P. Firmer.
Wood Tar	£4—£5 per ton. Very quiet.
Brown Sugar of Lead	£41 per ton. Steady market.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d. per lb. Quiet.
Crude 60's	1s. 8d.—1s. 10d. per gall. Market flat.
Acid Cresylic, 97/99	2s.—2s. 1d. per gall. Demand steady.
Pale 95%	1s. 8d.—2s. per gall. Not much enquiry.
Dark	1s. 8d.—1s. 10d. per gall. Market dull.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6½d.—7½d. per gall. Small demand
Unstrained	6d.—6½d. per gall.
Benzole—	
Crude 65's	7½d.—9d. per gall. ex works in tank wagons.
Standard Motor	1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Pure	1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5d.—1s. 6d. per gall. More inquiry.
Pure	1s. 7d.—1s. 9d. per gall. Small demand for home consumption.
Xylol—Coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	8d.—8½d. per gall. Little demand.
Middle Oil, Heavy Oil, Standard Specification	5½d.—6½d. per gall., according to quality and district. Fair business passing. A little more demand for export in bulk.
Naphtha—	
Solvent 90/160	1s. 3d.—1s. 4d. per gall. Demand good.
Solvent 90/190	11d—1s. per gall. Fair inquiry. Local demand good.
Naphthalene Crude—	
Cheaper in Yorkshire than Lancashire. Demand rather better.	
Drained Creosote Salts	£3—£5 per ton. Demand slightly better.
Whizzed or hot pressed	£6—£9 per ton. Demand very poor.
Naphthalene—	
Crystals and Flaked	£12—£15 per ton, according to district.
Pitch, medium soft	42s. 6d.—60s. per ton according to district. Plenty of inquiry. Prospects brighter.
Pyridine—90/160	19s. per gall. Steady demand.
Heavy	11s.—12s. per gall. Market dull.

INTERMEDIATES AND DYES

Business in dyestuffs has been very well maintained this week.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb.
Acid H.	3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1d. per lb. Improved demand.
Acid Sulphanilic	9d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	8d. per lb. naked at works.
Aniline Salts	8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	3s. 11d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4d.—4½d. per lb. Rather quiet.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 3d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 2½d. per lb. d/d. Drums extra.
G. Salt.	2s. 4d. per lb. 100% basis d/d.
α-Naphthol	2s. 5d. per lb. d/d.
Dinitrobenzene	9d.—10d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.

Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine ..	.. 2s. 10d. per lb. d/d.
Monochlorbenzol..	.. £63 per ton.
β-Naphthol ..	.. 1s. per lb. d/d.
α-Naphthylamine	.. 1s. 3½d. per lb. d/d.
β-Naphthylamine	.. 4s. per lb. d/d
m-Nitraniline ..	.. 4s. 2½d. per lb. d/d.
p-Nitraniline ..	.. 2s. 2½d. per lb. d/d.
Nitrobenzene ..	.. 5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene	.. 10½d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 3s. 10d. per lb. d/d.
p-Phenylene Diamine	.. 10s. 2d. per lb. 100% basis d/d.
R. Salt	.. 2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 2d. per lb. 100% basis d/d.
o-Toluidine ..	.. 10d. per lb.
p-Toluidine ..	.. 3s. per lb. naked at works.
m-Toluylene Diamine	.. 3s. 10d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £45 per ton, ex wharf London, in glass containers.
Acid, Acetyl Salicylic	.. 3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P.	.. 2s. 6d. per lb.
Acid Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 4d. per lb., less 5% for ton lots. Market still weak.
Acid, Gallic ..	.. 2s. 9d. per lb. for pure crystal in 2 cwt. lots.
Acid, Pyrogallic, Cryst.	.. 6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	.. 1s. 6d.—1s. 8d. per lb., according to quantity. Slightly firmer.
Acid, Tannic B.P.	.. 2s. 10d. per lb. Forward quotations higher spot value likely to increase.
Acid, Tartaric ..	.. 1s. per lb., less 5%.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 1s. 10d.—2s. per lb. More enquiry.
Amidopyrin ..	.. 15s. per lb.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone.. ..	.. 13s. 9d. per lb. Slightly lower. Quiet steady demand.
Benzonaphthol ..	.. 5s. 3d. per lb. spot.
Bismuth Carbonate	.. 10s. 6d.—12s. 6d. per lb.
„ Citrate..	.. 10s. 3d.—12s. 3d. „
„ Salicylate	.. 9s.—11s. „
„ Subnitrate	.. 8s. 8d.—10s. 8d. „
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Market exceedingly firm and prices advancing. Raw materials dearer. British prices lower than foreign.
Ammonium ..	.. 1s. 11d. per lb.
Potassium ..	.. 1s. 9d. per lb.
Sodium ..	.. 1s. 10d. per lb.
Calcium Lactate	.. 1s. 7d.—2s. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate ..	.. 4s. per lb.
Chloroform ..	.. 2s. 6d. per lb. for cwt. lots.
Formaldehyde ..	.. £48—£49 per ton in barrels, ex wharf London.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.
Glycerophosphates—	
Iron	.. 8s. 9d. per lb.
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. „
Guaiacol Carbonate	.. 9s. 9d. per lb.
Hexamine	.. 3s. per lb. Forward prices higher.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	.. English make offered, 120s. per oz.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. „
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £25 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 60s. per lb. for December delivery. No spot deliveries available.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials ..	.. Market very quiet.
Red oxide ..	.. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. „
White precip. ..	.. 4s. 7d.—4s. 8d. „
Calomel ..	.. 3s. 11d.—4s. „
Methyl Salicylate	.. 1s. 10d. —2s. per lb.
Methyl Sulphonal	.. 22s. 6d. per lb. Slightly weaker.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 2s. 8d. per lb. for B.P. quality.
Paraldehyde ..	.. 1s. 4½d.—1s. 6d. per lb. in free bottles and cases. Supplies plentiful.
Phenacetin ..	.. 5s. 6d. per lb.
Phenazone ..	.. 7s. per lb.
Phenolphthalein ..	.. 5s. 6d. per lb. for cwt. lots. Supply exceeds demand.
Potass. Bitartrate—99/100% (Cream of Tartar) ..	.. 84s. per cwt., less 2½% for ton lots.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Ferricyanide	.. 1s. 9d. per lb. Quiet.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	.. 7½d. per lb. spot. Forward prices higher.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 5s. 3d. per lb.
Saccharin ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. 9d. per lb. for cwt. lots.
Silver Proteinate..	.. 9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb. Supplies of good quality now available.

Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—	
Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash. according to quantity.
Sod. Nitroprusside ..	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	.. 75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate ..	.. Fair demand. Powder 2s.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 5d. per lb. Flake 2s. 6d. per lb.
Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.
Sulphonal.. ..	.. 14s. 6d. per lb. Little demand.
Thymol	.. 16s. 9d. per lb. Firmer market.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. per lb.	
Aubepine	.. 15s. 3d. ,,	
Amyl Acetate ..	.. 2s. 9d. ,,	
Amyl Butyrate ..	.. 6s. 9d. ,,	
Amyl Salicylate ..	.. 3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,	
Benzyl Alcohol free from Chlorine ..	.. 2s. 9d. ,,	
Benzaldehyde free from Chlorine ..	.. 3s. 6d. ,,	
Benzyl Benzoate..	.. 3s. 6d. ,,	
Cinnamic Aldehyde—		
Natural.. ..	.. 18s. 9d. ,,	
Coumarin.. ..	.. 18s. 9d. ,,	Cheaper.
Citronellol ..	.. 17s. ,,	
Citral	.. 8s. ,,	
Ethyl Cinnamate	.. 12s. 6d. ,,	
Ethyl Phthalate ..	.. 3s. 3d. ,,	
Eugenol	.. 10s. ,,	
Geraniol (Palmarosa)	.. 33s. 6d. ,,	
Geraniol	.. 11s. 6d.—18s. 6d. per lb.	
Heliotropine ..	.. 6s. 9d. ,,	
Iso Eugenol ..	.. 16s. ,,	
Linalol ex Bois de Rose..	26s. ,,	
Linalyl Acetate ..	.. 26s. ,,	
Methyl Anthranilate	.. 9s. 6d. ,,	
Methyl Benzoate..	.. 5s. ,,	
Musk Ambrette ..	.. 45s. ,,	Cheaper.
Musk Xylol ..	.. 13s. 6d. ,,	
Nerolin	.. 4s. 9d. ,,	
Phenyl Ethyl Acetate	.. 15s. ,,	
Phenyl Ethyl Alcohol	.. 16s. ,,	
Rhodinol	.. 55s. ,,	
Safrol	.. 1s. 10d. ,,	
Terpineol	.. 2s. 4d. ,,	
Vanillin	.. 25s. 6d. ,,	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 15s. 6d. per lb.
Anise Oil ..	.. 2s. 10d. per lb.
Bergamot Oil ..	.. 16s. per lb. Cheaper.
Bourbon Geranium Oil	.. 35s. per lb. Dearer.
Camphor Oil ..	.. 65s. per cwt.
Cananga Oil Java	.. 11s. per lb.
Cassia Oil, 80/85%	.. 9s. 9d. per lb. Cheaper.
Cinnamon Oil, Leaf	.. 6½d. per oz.
Citronella Oil—	
Java 85/90% ..	.. 5s. 10½d. ,,
Ceylon ..	.. 3s. 8d. per lb.
Clove Oil	.. 8s. per lb.
Eucalyptus Oil 70/75%..	2s. 3d. per lb.
Lavender Oil—	
French 38/40% Esters	32s. 6d. per lb.
Lemon Oil ..	.. 3s. 2d. per lb.
Lemongrass Oil ..	.. 5s. per lb. Dearer.
Orange Oil, Sweet	.. 11s. per lb.
Otto of Rose Oil—	
Bulgarian ..	.. 40s per oz.
Anatolian ..	.. 18s. per oz.
Palma Rosa Oil ..	.. 16s. 6d. per lb.
Peppermint Oil—	
Wayne County	.. 32s. 6d. per lb. nominal.
Japanese ..	.. 21s. per lb. nominal.
Petitgrain Oil ..	.. 9s. 9d. per lb. Dearer.
Sandal Wood Oil—	
Mysore	.. 26s. 7d. per lb.
Australian ..	.. 18s. 6d. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than January 5th, they are on sale at 1s. each at the Patent Office Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on November 20th.

I.—Applications

Carpmael (Farbenfabriken vorm. F. Bayer und Co.). Means for letting off steam from a container. 25,699, 25,700. Oct. 28.

Carpmael (Farbenfabriken vorm. F. Bayer und Co.). Means for running off hot liquids from a container under pressure. 25,701. Oct. 28.

Cross. Refining-materials. 25,525. Oct. 27. (U.S., 31.12.23.)

Eggenhöffner. Manufacture of pulverised substances. 25,681. Oct. 28.

Fuller-Lehigh Co. Furnace. 25,532. Oct. 27. (U.S., 27.10.23.)

Remfry. Purification of liquids. 25,530. Oct. 27.

Smith. Filtering tanks. 25,703. Oct. 28.

Underfeed Stoker Co., Ltd., and Wood. Pulverising and drying of materials. 25,603. Oct. 27.

I.—Complete Specifications Accepted

16,255 (1923). Fulcher and Beldam. Straining or filtering apparatus. (223,627.)

9767 (1924). Ostermann, Sudenburger Maschinenfabrik und Eisingiesserei Akt.-Ges. Mechanical production of colloidal substances. (216,110.)

19,408 (1924). Pintsch Akt.-Ges. *See* II.

II.—Applications

Greenfield. Method of dephlegmation in steam distillation of oils. 25,505. Oct. 27.

Koppers Co. Coking retort ovens. 25,794. Oct. 29. (U.S., 4.1.24.)

Lucas, and V. L. Oil Processes, Ltd. Cracking and separating mineral oils. 25,986. Oct. 31.

II.—Complete Specifications Accepted

13,648 (1923). Illingworth, and Illingworth Carbonization Co., Ltd. Manufacture of carbonised fuel. (223,624.)

19,016 (1923). Pell. Retort apparatus for treating shale, coal, and the like. (223,652.)

19,091 (1923). De Laval Chadburn Co., Ltd., and Johnstone. Centrifugal separators for dehydrating or otherwise purifying oil. (232,656.)

29,890 (1923). Underfeed Stoker Co., Ltd., and Wood. Drying and pulverising fuel. (223,764.)

19,408 (1924). Pintsch Akt.-Ges. Porous charges for containers for the storage of acetylene or like gases dissolved in liquids. (220,645.)

III.—Application

Montgomerie. Production of tar bitumen emulsions. 25,628. Oct. 28.

IV.—Applications

Farbwerke vorm. Meister, Lucius, und Brüning. Manufacture of Bz-2'-oxybenzanthrones. 25,597. Oct. 27. (Ger., 9.11.23.)

Morton Sundour Fabrics, Ltd., Harris, Jones, and Morton. Dyes and dyeing. 26,086. Nov. 1.

Scottish Dyes, Ltd., Smith, Thomas, and Wylam. Colouring-matters. 25,550. Oct. 27.

Sokal (Kalle und Co., Akt.-Ges.). Process for producing sulphur dyestuffs fast to chlorine. 26,091. Nov. 1.

IV.—Complete Specifications Accepted

25,043 (1923). Soc. of Chemical Industry in Basle. Manufacture of naphthalene derivatives and of dyestuffs therefrom. (207,162.)

2378 (1924). Durand und Huguenin Akt.-Ges. Manufacture of disazo-dyestuffs. (210,463.)

V.—Applications

Dreaper. Manufacture of artificial silk etc. 25,491. Oct. 27.

Ellis (Kohnstamm and Co.). Treatment of textile materials. 25,895. Oct. 30.

Heys, and St. Anne's Board Mill Co. Apparatus for removing liquid from paper pulp etc. 25,878. Oct. 30.

Kennedy. Treating paper stock. 25,637. Oct. 28. (U.S., 15.12.23.)

Naylor. Treating fibrous vegetable waste. 25,668. Oct. 28.

V.—Complete Specifications Accepted

11,226 (1923). Kanegafuchi Boseki Kabushiki Kwaisha. Treatment of raw silk. (196,923.)

11,775 (1924). Bergen. Manufacture of threads etc. from viscose. (216,125.)

16,742 (1924). Akt.-Ges. für Anilin-Fabrikation. Manufacture of viscose products. (220,935.)

VI.—Applications

Brandwood. Treatment of yarns with fluids. 25,616. Oct. 28.

Calico Printers' Association, Ltd., and Gemmell. Machines for wet treatment of textile fabrics. 25,672. Oct. 28.

Morton Sundour Fabrics, Ltd., Harris, Jones, and Morton. 26,086. *See* IV.

VII.—Applications

Assoev. Production of aluminium compounds. 26,012. Oct. 31. (Belgium, 21.11.23.)

Soc. Anon. d'Eclairage et d'Applications Electriques. Process for separating krypton and xenon from the atmosphere. 25,715. Oct. 28 (Fr., 26.12.23.)

Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Manufacture of hydrogen. 25,995. Oct. 31. (Fr., 15.5.24.)

VII.—Complete Specification Accepted

4967 (1924). Jahl and Michael. Production of soluble barium salts. (223,800.)

VIII.—Complete Specifications Accepted

10,893 (1923). Duffield. Manufacture of refractory bricks, blocks, or the like from dolomite etc. (223,616.)

14,532 (1924). General Electric Co., Ltd. Readily fusible glasses and enamels. (223,837.)

IX.—Applications

Cyclops Building and Construction Co., Ltd., and Rigby. Induration of concrete. 25,641. Oct. 28.

Douzal. Artificial wood. 25,546. Oct. 27. (Fr., 12.1.24.)

Kirkpatrick. Composition for surfacing roads etc. 26,029. Nov. 1.

Lee. Manufacture of cement. 25,625. Oct. 28.

Montgomerie. 25,628. *See* III.

IX.—Complete Specifications Accepted

22,832 (1923). Bayer. Manufacture of porous building-materials. (203,718.)

28,296 (1923). Soc. Anon. des Chaux et Ciments de Lafarge et du Teil. Manufacture of fused cement. (222,426.)

28,297 (1923). Soc. Anon. des Chaux et Ciments de Lafarge et du Teil. Apparatus for the manufacture of cement by fusion. (222,427.)

X.—Applications

Compagnie Générale des Produits Chimiques des Louvres. Mechanical roasting of ore. 25,799. Oct. 29. (Fr., 30.10.23.)

Landling. Aluminium alloy. 25,639. Oct. 28.

Maas. Treatment of metals. 25,792. Oct. 29.

Metals Production, Ltd., Moulden, and Taplin. Heat treatment of oxidised copper ores. 25,816. Oct. 29.

Sollis. Aluminium alloy. 25,639. Oct. 28.

Voos. Utilising metalliferous refuse. 25,934. Oct. 30.

X.—Complete Specifications Accepted

34,760 (1922). Grah. Process for the electrodeposition of chromium. (223,611.)

11,082 (1923). Borchers and Stimson. Purification of alloys containing iron and chromium, molybdenum, or uranium. (223,617.)

11,389 (1923). Borchers and Stimson. Production of alloys containing iron and chromium, molybdenum, or uranium. (223,622.)

16,068 (1923). Hyde and Turner. Manufacture of iron manganese alloys. (223,626.)

24,912 (1923). Comp. des Forges de Chatillon Commentry et Neuves-Maisons. Thermic treatment of steel and alloys susceptible of tempering. (211,441.)

26 872 (1923). Fassotte, and Comp. des Metaux Overpeltlommel. Roasting ores. (223,741.)

438 (1924). General Motor Research Corporation. Alloy articles. (216,484.)

XI.—Applications

Collino. Electrolytic cells. 25,828. Oct. 29. (Italy, 22.11.23.)

Holmboe. Electrodes for electrolytic decomposition apparatus. 25,819. Oct. 29.

Kirkaldy. Electrodes. 25,880. Oct. 30. (U.S., 30.10.23.)

Markiewicz and Römer. Dry cells or batteries. 26,017. Oct. 31.

XI.—Complete Specifications Accepted

34,760 (1922). Grah. *See* X.

18,883 (1923). Western Electric Co., Ltd. (Western Electric Co., Inc.). Electric insulating-materials. (223,644.)

25,707 (1923). Pouchain. Electrolyte for electric accumulators. (205,517.)

XIII.—Complete Specifications Accepted

18,586 (1923). Tarassoff. Production of resin-like condensation products. (223,636.)

30,585 (1923). McLean. Manufacture of resinous or like preparations. (209,720.)

XV.—Application

Jordan. Tanning leather. 25,982. Oct. 31.

XV.—Complete Specification Accepted

11,361 (1923). Nance. Tanning. (223,621.)

XVI.—Application

Stötzel. Production of manure. 25,585. Oct. 27. (Ger., 3.11.23.)

XVIII.—Application

Rigby. Products containing yeast preparations. 26,024. Nov. 1.

XIX.—Application

Zpovak. Manufacture of meat substitutes etc. 25,685. Oct. 28.

XX.—Application

Binz and Räth. Production of heterocyclic compounds. 25,935. Oct. 30.

IX.—Complete Specifications Accepted

19,012 (1923). Nederlandsche Gist- en Spiritusfabriek. Producing a non-peroxidising ether. (219,272.)

19,026 (1923). Nederlandsche Gist- en Spiritusfabriek. Process of producing chemically-pure, toxic free, narcotising ether. (219,273.)

2276 (1924). Chemosan Akt.-Ges. Production of solutions of mercury derivatives of hydroxysulphobenzoic acids and their homologues, suitable for use in therapeutics. (215,316.)

XXI.—Application

Liesegang, and Rotopulsor A.-G. Photographic gelatin layers. 25,579. Oct. 27. (Ger., 26.10.23.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*Argentina*: Artificial silk yarns, (497); *Belgium*: Ammonium carbonate, (487); *British India*: Paints, (India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); Iron and Steel (Directors of the Madras and Mahratta Railway Company, Ltd., 25, Buckingham Palace Road, London, S.W. 1); *Canada*: Hardware, (481); *Cuba*: Linseed oil, (499); *Egypt*: Iron, lead, brass, copper, rubber, hardware, oils, (495); *France*: Copper sulphate, (488); *Norway*: Leather, (493); *South Africa*: Hardware, (482); Metals, ores, (484); *United States*; China clay, (496), Paper, (B.X./1304), Leather, (B.X./1314).

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during October, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 543, of which 452 were from merchants or importers. To these should be added 25 cases outstanding on October 1, making a total for the month of 568. These were dealt with as follows:—Granted, 424 (of which 378 were dealt with within seven days of receipt); referred to British makers of similar products, 96 (of which 73 were dealt with within seven days of receipt); referred to Reparation Supplies available, 36 (all dealt with within two days of receipt); outstanding on October 31, 1924, 12. Of the total of 568 applications received, 487 or 86 per cent. were dealt with within seven days of receipt.

Amalgamation of German Dye Agencies in Japan

Owing to the new requirements for licences for the importation of dyestuffs into Japan, the selling agencies of all the German dye manufacturers in Japan have formed a joint distributing agency, comprising a manager, five commercial directors, two technical directors, and two directors specialising in sales of indigo. All the different laboratories will now be merged in one large central laboratory, staffed by fifteen German chemists, and over one hundred Japanese technical men. It is not known whether other chemical products will be included in the amalgamation.

The Danish Chemical Market

There is a good market for chemicals in Denmark, as the greater part of the supplies has to be imported. The chief consuming industries are soap, oils and fats, soda, paint and varnish, matches, fertilisers, textiles and leather. Imports of the chief chemicals in 1922 were as follows:—Soda ash, 12,172 tons (1923); hydrochloric acid, 1567 t.; sulphuric acid, 1100 t.; tanning extracts, 2340 t.; alum, 760 t.; chloride of lime, 400 t.; rosin, 1250 t.; raw phosphate, 100,000 t. Germany is the chief source of imported chemicals, followed by England, Belgium, and Sweden in the order named.—(*U.S. Com. Rep., Oct.* 6, 1924).

Glass Industry in Czechoslovakia

Conditions continue favourable in the glass industry of Czechoslovakia and exports to America and Great Britain remain at a high level, but there is a tendency to develop the home industry and to become independent of imports. Belgian competition is also being felt. England re-exports Czechoslovakian glass to Canada, South America and to China, but the Chinese market has of late become dull, enormous quantities of glass purchased by Chinese dealers after the Japanese earthquake having actually been sold at a loss. The hollow glass trade is now working at 60 per cent. of pre-war capacity, owing to the volume of business with England, Japan and the United States. The manufacture of bottles is reported as being 50 per cent. larger than last year.

Trade Notes from Canada

The exports of Canada to Germany have increased from \$5,735,268 for the twelve months ending August 31, 1922, to \$11,557,950 in the succeeding twelve months, and to \$17,755,519 in the year ending August 31 last. Imports from Germany have also increased during these periods respectively, as follows: \$1,933,030, \$3,928,991, and \$5,986,732. The leading commodities sold by Canada to Germany during the past year were flour, grain, automobiles, nickel and asbestos. The principal imports were incandescent lamps, toys, dyestuffs and tanning material, cacao butter, porcelain, cutlery, glass and textiles.

The maple sugar and syrup production of Canada for 1924 is valued at slightly under \$6,000,000, of which slightly over \$4,000,000 is credited to Quebec.

The sugar beet crop of Western Ontario is the largest on record. The refineries at Chatham and Wallaceburg, Ontario, are operating.

The Quebec Rubber Company is erecting a plant for the manufacture of rubber goods in Quebec city.

Foreign Company News

La Société des Produits Chimiques et Electrométallurgiques d'Alais, Froges et Camargue is negotiating with the French Government for the installation at the Toulouse Powder Factory of plant to produce 120 metric tons of synthetic ammonia by the Casale

process, of which the company holds the French rights. The Toulouse Powder Factory is now being utilised, as we have already announced, by the Office National Industriel de l'Azote, a plant for the synthesis of ammonia by the Haber Process being in course of installation, as a sequel to the vote of the French Parliament ratifying the agreement with the Badische Anilin und Soda Fabrik.

The Société Alsacienne de Produits Chimiques has purchased a process for the synthesis of hydrocarbons, with the object of contributing to the national production of fuel. The patent belongs to a company which provided practically the whole of the fuel for heavy transport in Germany during the war.

The Société des Charbonnages de Millam, which owns large deposits of lignite, is studying the distillation of lignites. New distillation plant are being erected for the production of tar, benzol and other by-products.

The Société Alsacienne de produits chemiques has recommenced the manufacture of synthetic camphor at its Vaugoin works near La Rochelle, which has been suspended for two years.

The Cie. Belge pour les Industries chimiques made a profit of 2,213,674 francs during the last working year, compared with 1,543,232 francs during the preceding year. The dividend is 10 francs., against 7·50 francs.

Notes on Plant and Products

Colour makes a universal appeal, and one of the first duties of the manufacturer who produces it is to see not only that it matches perfectly, but that it is reasonably resistant upon exposure to light. Until recently the only way of testing the fastness of a colour was to expose a dyed sample on a roof or facing a southern light, or to some kind of "artificial daylight," methods which were open to objection on the grounds of slowness if not of reliability. The most recent device for testing the fastness of colour is the "Fade-Ometer," an application of the violet carbon arc which has been developed as a means of giving definite, quantitative information on the fastness of colour to light because it possesses "the maximum speed of operation" whilst "retaining the all-important property of similarity to sunlight in fading quality." Messrs. A. D. Lang, Ltd., of 42, Berners Street, London, W. 1., who possess a most interesting series of tests carried out for various firms showing the standard nature of the results obtained with the Fade-Ometer, furnish another valuable aid to the colour maker and user in the Macbeth Colour Identification and Macbeth Daylight Lamps, which are used to give high illumination for critical examination of colours. No attempt is made to "standardise" the ever-varying daylight, but a series of colour filters is provided which enables any daylight equivalent to be utilised. The Macbeth lamps have received approval from the National Physical Laboratory for colour matching and colour identification, and their use is constantly [illegible].

PUBLICATIONS RECEIVED

FLUXES AND SLAGS IN METAL MELTING AND WORKING. A General Discussion held by the Faraday Society and the Institute of Metals, April, 1924. Pp. 113—208. Reprinted from the Transactions of the Faraday Society, Vol. XX, Part 1, August, 1924. Price 7s. 6d.

THE MINERAL INDUSTRY OF THE BRITISH EMPIRE AND FOREIGN COUNTRIES, STATISTICS 1920—1922. Iron and Steel. Imperial Mineral Resources Bureau. Pp. vi+49. H.M. Stationery Office, 1924. Price 2s.

TRANSACTIONS OF THE INSTITUTION OF MINING AND METALLURGY, THIRTY-SECOND SESSION, 1922–23. Vol. XXXII. Pp. lxx+304. London: The Technical Book Shop, 1923.

A COMPREHENSIVE TREATISE ON INORGANIC AND THEORETICAL CHEMISTRY. By J. W. Mellor, D.Sc. Vol. V. B, Al, Ga, In, Tl, Sc, Ce and Rare Earth Metals, C. (Part I). Pp. x+1004. London: Longmans, Green and Co., 1924. Price £3 3s.

CHEMISTRY AND ATOMIC STRUCTURE. By J. D. Main Smith. Pp. 221. London: E. Benn, Ltd., 1924. Price 12s. 6d.

THE CONSTITUENTS OF COAL TAR. By P. E. Spielmann. Monographs on Industrial Chemistry. Pp. xii+219. London: Longmans, Green and Co., 1924. Price 12s. 6d.

ALLEN'S COMMERCIAL ORGANIC ANALYSIS. Vol. II. Fifth edition, revised and in part rewritten. Edited by S. S. Sadtler and E. C. Lathrop and C. A. Mitchell. Pp. ix+807. London: J. and A. Churchill, 1924. Price 30s.

REPORT OF TEST BY THE DIRECTOR OF FUEL RESEARCH ON PARKER LOW-TEMPERATURE CARBONISATION PLANT INSTALLED AT BARUGH, BARNSLEY. At the Works of Low-Temperature Carbonisation, Ltd. Pp. iv+24. Department of Scientific and Industrial Research, H.M. Stationery Office, 1924. Price 9d.

A SYSTEMATIC HANDBOOK OF VOLUMETRIC ANALYSIS, OR THE QUANTITATIVE DETERMINATION OF CHEMICAL SUBSTANCES BY MEASURE, APPLIED TO LIQUIDS, SOLIDS AND GASES. By F. Sutton, F.I.C., F.C.S. Eleventh edition, revised with numerous additions by W. L. Sutton and A. E. Johnson. Pp. xii+598. London: J. and A. Churchill, 1924. Price 35s.

COMBUSTION IN THE GAS PRODUCER AND THE BLAST FURNACE. By A. Korevaar. Pp. xii+177. London: Crosby Lockwood and Son, 1924. Price 15s.

OUTLINES OF ORGANIC CHEMISTRY. By E. J. Holmyard, M.A. Pp. xii+466. London: E. Arnold and Co., 1924. Price 7s. 6d.

THE LIFE OF LORD RAYLEIGH, J. W. STRUTT, F.R.S. By R. J. Strutt, Fourth Baron Rayleigh, F.R.S. Pp. xii+397. London: E. Arnold and Co., 1924. Price 25s.

THE EXTRA PHARMACOPŒIA OF MARTINDALE AND WESTCOTT, revised by W. H. Martindale and W. W. Westcott. Pp. xxxviii. 1163. Eighteenth edition, Vol. I. London: H. K. Lewis and Co., Ltd., 1924. Price 27s. 6d.

A SYSTEM OF PHYSICAL CHEMISTRY, by W. C. McC. Lewis, M.A., Vol. III. QUANTUM THEORY, with certain appendices by J. Rice, M.A., A. McKeown, M.Sc., and R. O. Griffith, M.Sc. Pp. x+407. Third edition. London: Longmans Green and Co., 1924. Price 15s. net.

COLOUR AND METHODS OF COLOUR REPRODUCTION, by L. C. Martin. With chapters on Colour Printing and Colour Photography by W. Gamble. Pp. xiii.+187. London: Blackie and Son, Ltd., 1923. Price 12s. 6d.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

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The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

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EDITORIAL

THERE is no doubt that the Chemical Industry Dinner was a great success. It was no mere dinner; it was a banquet of which any society or aggregate of societies would have been proud. The speeches, briefly reported in cold print, lose their charm and their sparkle; some of Mr. Coley's remarks had a curious felicity which was delightful; we wish we could reproduce more of Dr. Cullen's speech and could adequately thank Mr. Percy Ashley for his flattering observations about our journal. Sir Richard Glazebrook, Mr. Woolcock and most of the other speakers testified to the growing feeling of co-operation and united among chemists and industrialists. For this we think the Society of Chemical Industry and the Chemical Industry Club are entitled to the bulk of the credit. Circumstances have also helped them; a generation or so ago, chemists were so few and so scattered that it was impossible to create a standard of chemical public opinion. To-day this exists; it is true it is in its infancy, but the observant may watch it growing and taking shape. We have ourselves witnessed many of the significant steps: in industry, the growth of Brunner Mond and Co. and their allied companies; the fusion of interests which led to the prosperity of the United Alkali Company; the fusion which has formed the British Dyestuffs Corporation, not yet a complete success commercially but destined to become so; the formation of the Association of British Chemical Manufacturers; in science we have seen the Federal Council and the Bureau of Chemical Abstracts; on the social side, the Club. Each of these events or organisations has had its effect, and so have others we have not mentioned, and the effect tends to greater efficiency, greater service to industry and to science, a widening of interest on the part of all those who are in any way concerned in science. Without such influences as these, the chemical exhibit at Wembley and Chemistry in the XXth Century would have been of much less importance; these also are stepping stones to higher things. There is a real and definite advance going on in the profession and industry of chemistry. Each one of us can do so little; but if we all do what little is in our power how much will be accomplished! Probably, one of the next stages in the march of chemistry should be the much-discussed scheme of a Chemistry House. Addison said: "'Tis not in mortals to command success, but we'll do more, Sempronius, we'll deserve it." If chemists deserve Chemistry House, they will get it.

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Really, we ought to know better than to quote poetry; it is apt to be misunderstood. If in our youth we had known what was in store for us we should probably have carefully treasured some odd phrases of Dumas, of Williamson, Frankland and Berzelius, and these would now come naturally into our minds whenever we took a pen or pencil in hand. Alas! regardless of their doom, the little victims play! In those tender and impressionable years we were permitted, and even encouraged, by our thoughtless parents to read as much English literature as we wished, far more than we could understand, but not more than we could enjoy. We shall, we fear, never quite free ourselves from the taint; the wool once dipped in the dye never regains its lost hue. Poetry is sometimes looked upon with suspicion; the grave amongst us think it is, perhaps, undignified. Some chemists who sat near us at the dinner objected quite definitely to a lapse on the part of the Club Secretary who quoted two lines about the presence of ladies. We think Mr. Williams would have been wiser if he had avoided such dangerous ground. Our critical friends found fault with Mr. Williams for quoting poetry at all, and especially poetry of such poor quality. And yet Milton was once regarded as one of our best poets, and "L'Allegro" as one of his most beautiful and popular effusions. Had he but known how fastidious modern chemists are in their literary tastes he would, we are sure, have been more careful. But it is probably too late now to alter his poems so as to make them more acceptable to modern minds and modern scientific erudition. We must put up with them as they are and Mr. Williams and ourselves

may learn wisdom, as others do, by making experiments and noting the results.

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In mathematics there exists an infinite gradation between zero and any given number; in politics there is every variety of opinion between the most stereotyped Die-hard who believes that every institution which is old is necessarily good, and the Bolshevist who believes that every institution which is old is necessarily bad. So, too, in the great field of human knowledge; the various sciences pass imperceptibly into each other. The differences between the English language, the Dutch, Flemish, Frisian, Danish and Swedish are bridged by intermediate dialects. Mathematics, Physics, Chemistry and Engineering are not isolated subjects, but each has points of contact with all the others. Biology, Agriculture, Chemistry and Medicine are equally closely related, and no one can have a real knowledge of any one science who does not realise the points of contact, the common ground, the interdependence of many important branches of the one subject on many points in the others. Whether Sir Ernest Rutherford considers himself a chemist is of no consequence; he claims he knows no chemistry and he ought to know. But he knows that the work he has done has thrown an immense amount of light on all the conceptions of chemical elements and chemical action which are of fundamental importance. Chemistry can advance but slowly without the help of our Rutherfords, Moseleys and Astons. The opening of the Ramsay Laboratory of Chemical Engineering is a significant fact in the better understanding of science. Chemistry, Physics and Engineering have, in chemical industry, an intimate relationship; there must be a numerous band of men who have an adequate knowledge of the main essentials of these three subjects. In some, chemistry will predominate; in others, physics or engineering. The chemical engineer may differ in his mode of life and mode of thought from the chemist and from the civil engineer, but he is essential to our development, and he has come to stay. In these circumstances it is essential that he shall have the best facilities for his theoretical education in places where subjects are taught with the accuracy which is expected in a modern university. His practical education, we presume—for we do not profess to know—he will learn by experience, often bitter, and by the exercise of his wits and common sense, that is assuming——. At South Kensington and at University College he will have the best opportunity of getting his theoretical knowledge and making experiments. The new Laboratory at University College represents the highest educational advance in chemical engineering, and should prove of great importance to chemical industry. The opening was performed by H.R.H. Prince Arthur of Connaught, and was approved by the Chief Government Chemist, the President of the Society of Chemical Industry, by the new Professor of Chemical Engineering, Prof. Williams, by the Chairman of University College, and by the Chairman of Messrs. Brunner Mond and Co., Ltd., a combination of social, academic, scientific, and industrial influence which will be of the utmost value to the new Chair.

CRUSHING AND GRINDING.—PART I

By S. G. URE, M.A., B.Sc., M.I.Chem.E.

The subdivision of solids forms an important pa in many industrial processes, and as the mat rials to be reduced vary considerably, a very lar number of different machines have been invent for the purpose. Subdivision may be employed increase the surface and so cause a chemical reacti to be completed in the minimum time, or, if the bo being broken is non-homogeneous, to detach one co stituent from another and so permit of their separ tion, or to produce a saleable commodity. The r duction in size may be effected by the application a compressive or crushing force, as in the jaw type crusher, or a shearing force, as in machines of tl grinding or attrition type. Many machines such those of the roll, hammer, and impact types mal simultaneous use of those forces to reduce the size the material fed into the machine. In another ty beam action is employed, the force being applied an unsupported point in the material between tl two fixed points upon which it rests.

Since there is such a variety of crushing an grinding machinery to choose from, the selection the proper machine requires a knowledge of th physical properties such as the hardness, structu and moisture content of the material to be sul divided. The first of these factors affects not onl the strength and the speed of the machine, but als governs the use of special devices to protect th wearing parts from abrasive action. The structure o the material must also be taken into account, a machines which could easily reduce a brittle materia might be totally incapable of handling a fibrous o soft substance. Again, as it has been found tha materials containing above 5 per cent. and under 5 per cent. of moisture form a pasty mass which, whe the particles are reduced to the proper size, prevent them falling freely from the machine, to ensur efficiency this point must receive attention in th design or selection of the machine.

Other important conditions which must be remembered during selection are, the size of the pieces to b fed into the machine, as will be seen later in the discussion on the areas of the opening of the jaw an gyratory crushers, and the size of the product whicl is desired. In some cases the production of fine particles is the object in view, whilst in other cases thes fine particles are undesirable and have to be removed before the crushed product can be passed on to the next stage of the process. One must also know the amount of material to be treated per day and any special conditions under which the machine may have to work or relating to its transport to the site.

The purchase of a satisfactory machine will, therefore, be best ensured by submitting a representative sample of the material to be crushed or ground, together with full information regarding the output required and the conditions under which the machine will have to work to makers of plant of this type, so that they may be able to obtain accurate information regarding capacity, output per hour, and power required for driving the machine as well as other points influencing the design and efficient working.

The two laws connecting the energy required and the sizes of the material before and after subdivision are known as Rittinger's law and Kick's law. The former assumes that the new surface produced during the process of crushing or grinding is a measure of the energy consumed in the process, the subdivision of the material being produced by the application of a shearing stress. Practical results show that the amount of work done compared with the area of fractured surface is constant for coarse sizes, but the amount of new surface produced in fine grinding is greater than the energy required by the above law. This is attributed to the possibility of the production of incipient fractures during the coarse crushing stage. Rittinger's law expressed mathematically takes the form—

$$H = C\left(\frac{1}{d_2} - \frac{1}{d_1}\right)$$

where H = power required, d_1 the diameter or linear dimensions of the pieces of material fed into the machine, d_2 the diameter or linear dimensions of the product obtained, and C a constant which is dependent upon the material. Kick's law states that equal amounts of energy are required for the reduction of equal quantities of material through the same reduction range. It is based on the assumption that direct pressure of constant amount per unit area is applied to subdivide each particle which breaks up into smaller particles of similar shape. This law may be written

$$H = b \log \frac{d_1}{d_2}$$

where H represents the power required, d_1 and d_2 the diameters or linear dimensions of the particles entering and leaving the machine respectively, and b is another constant, which must be determined experimentally as it depends on the type of machine and the material which is being crushed. Accurate facts are not represented by either of these laws, and it is possible that when a satisfactory expression is developed it will lie between the two. Some writers divide machinery of this type into three classes—breakers, crushers, and grinders—whilst others adopt four classes. Preliminary crushers or breakers which can crush material varying in size from 2 to 60 ins. belong to the first class, whilst if the feed consists of pieces ranging between $1\frac{1}{2}$ and 2 ins., the machine is placed in the second group. The limits of the size of particles admitted to fine crushers are from $1\frac{1}{2}$ to $\frac{1}{2}$ in. and the product must be capable of passing through a 10-mesh screen. The last class, termed fine pulverisers, are supplied with material varying from $\frac{1}{2}$ to $\frac{1}{4}$ in., and are able to produce a product which can pass through a 200-mesh screen.

Jaw Crushers

Many well-known engineering firms, such as Edgar Allen and Co., Ltd., The Fraser and Chalmers Engineering Works of the General Electric Co., Ltd., Hadfields, Ltd., Sandycroft, Ltd., the Sturtevant Engineering Co., Ltd., Vickers, Ltd., to mention only a few, manufacture jaw crushing machinery. The Blake crusher, illustrated in Fig. 1, is a well-known type of jaw crusher. It consists of a rectangular frame, made of cast-iron or steel, provided with two sets of bearings on the sides to support the swing stock and eccentric shafts. Hanging from the swing stock shaft is the swing stock to the one side of which the swing jaw faces are fastened and having on the other side a groove in which is fitted a set of toggle bearings, and at the lowest edge of this face an eye to which is attached one end of the draw-back rod. Suspended from the eccentric shaft is the pitman, consisting of a rectangular casting made of cast iron or steel bored and bushed at its upper end to fit the eccentric shaft, and carrying on either side at its lower end a groove fitted with toggle bearings. At the non-crushing end of the frame there is an adjusting wedge whose position can be altered by two bolts passing through the frame. In front of this wedge is a second wedge-shaped block termed the adjusting toggle-block, which can only be moved in a horizontal direction by raising or lowering the adjusting wedge. The outer face of this adjusting toggle block is grooved and fitted with a set of toggle bearings.

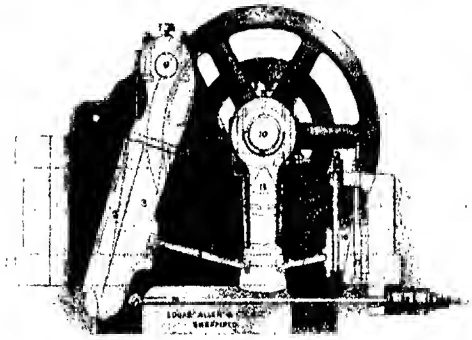


Fig. 1

Blake Crusher by Edgar Allen and Co., Ltd.

Two sets of toggles are used, one extending between the toggle bearings on the swing jaw and the front set on the pitman, and the second set stretching between the rear set on the pitman and the bearings in the adjusting block. Since the toggle bearings on the pitman are at a lower level than the bearings on the swing jaw and the adjusting block, when the pitman is raised the swing jaw moves towards the front end of the machine upon which is mounted the fixed jaw plates. The parts of the frame which are exposed to the abrasive action of the material between the jaws are protected by check plates. Formerly the main frame was always made of cast iron, but cast steel is now used in a number of machines, especially in the larger-sized ones. The replacement of cast iron by steel in the manufacture of crushing machinery has resulted in a considerable saving in weight, an important point in portable machines, and reduces the cost of transport. Machines made of steel, half the weight of a similar machine made of cast iron, would be three times as strong. When cast-steel frames are used, the best makers take great precautions to ensure that the sides are parallel to each other and at right-angles to the ends, thus

providing for a uniform distribution of stresses through the frame. The eye of the pitman is bushed with brass or babbit-metal, but the latter is to be preferred,

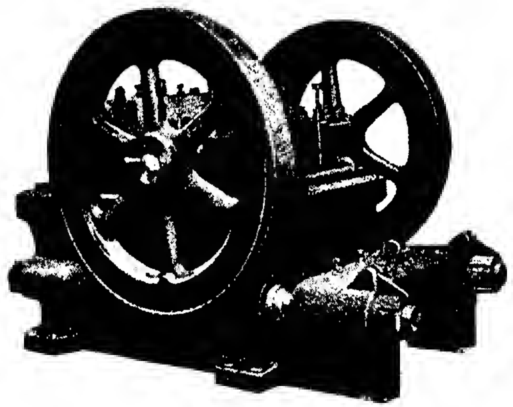


Fig. 2
Bigelow Crusher by Sandycroft, Ltd.

Sometimes, especially in the larger machines, the pitman is made in two portions, the cap and the stock, so that the pitman can be removed without the withdrawal of the eccentric shaft. The jaw faces may be made of chilled cast iron or manganese steel and every care should be taken to ensure that they are properly bedded on their respective seats. Those surfaces of the cast-iron frame, swing plate, and chilled cast-iron jaws which come into contact can be easily machined as can be the carbon-steel frames and swing plates, but manganese steel has to be ground to obtain true surfaces. Several types of manganese-steel jaws are manufactured. In one, the jaw plate is cored internally leaving a flat surface at the back for grinding, whilst another plate is cored at the back to form pockets which are usually filled with spelter to form the bedding surface. In the third type the jaw is cast solid and accurately ground on the back, whilst the fourth type consists of a manganese-steel shoe to which is fitted a cast-iron back, the joint between the steel and cast iron being formed of spelter, the cast iron only in this case being machined. The angle formed between the crushing surfaces is called the angle of nip, and the larger

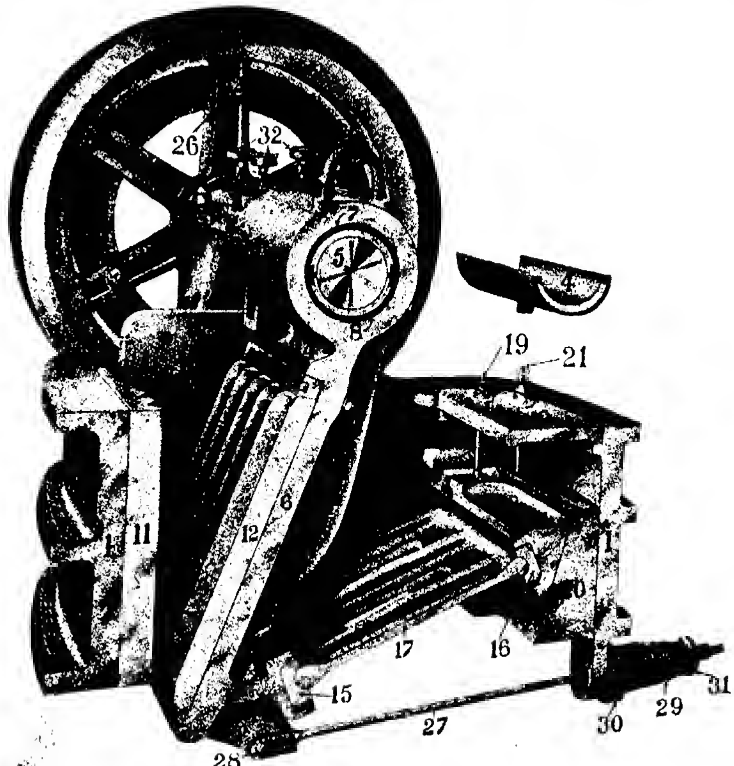


Fig. 3
Samson Crusher by Hadfields, Ltd.

since being softer than brass the scouring action of particles entering between the shaft and the bush is practically eliminated. A method of adjusting the wear on the pitman is shown in the illustration.

this angle the greater will be the opening at the top of the jaws. If it exceeds a certain amount, termed the critical value, the material will not be crushed, but will be forced out of the machine by the closing

of the jaws. The safe angle of nip about 32° is always [illegible] the critical angle to prevent the material from being [illegible] the jaws. A small size machine having a [illegible] g and 6 in. broad when working on hard limes[illegible] running at 250 revolutions per minute, can cr[illegible] from 3 to 5 tons per hour to pass through a 2½-in. ring. The largest size has

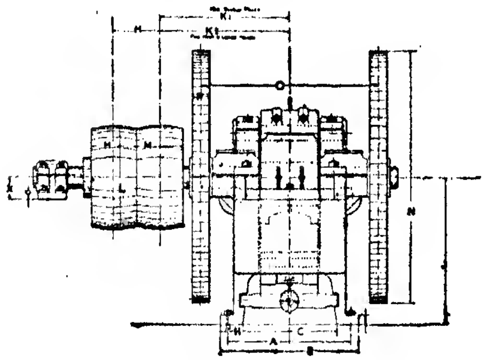


Fig. 4

Dodge Crusher by Frazer and Chalmers Engineering Works

a jaw 6 ft. long, the opening between the jaws at the top being 4 ft. Running at about 120 revolutions per minute, this size can crush 400 tons per hour to 8-in. cubes. In the larger machines the bearings and eccentric are water cooled, and the frames are built up of carbon-steel castings, the faces of which are accurately machined and then bolted together.

The Bigelow crusher, illustrated in Fig. 2, is a double toggle machine very similar to the Blake. Here, however, the toggle bushes at the bottom of the pitman are above the level of the toggle bushes on the swing plate and adjusting block. The crushing, therefore, is accomplished during the descent of the pitman, which is thus subject to compressive stress during the working period, and as the weight of the pitman is added to the driving force, the turning moment is not so variable as in the ordinary type. In the machine illustrated, the adjustable toggle block rests on a machined surface projecting from the back of the frame, and the opening of the jaws is adjusted by two strong steel side rods, each of which passes through a hole in the front end of the frame and a hole at the outer end of the toggle block. During the period of crushing, therefore, these rods relieve the frame from tensile stress. It will be observed that the back toggle plate is made of two portions riveted together. These rivets are designed to shear should any uncrushable material, such as a piece of iron, fall between the jaws, and thus save the machine from injury. Another form of crusher is the Samson or single toggle machine, a sectional view of which is shown in Fig. 3. As will be seen from this illustration the swing stock is again pivoted above the frame of the machine, but here the shaft supporting the swing stock is connected to the driving wheels and forms the eccentric for moving the swing stock. With such an arrangement a pitman is unnecessary, and as the motion of the swing stock varies from circular at the top to elliptical at the foot, the major axis of the ellipse being vertical, it is necessary for the driving pulley to rotate downwards towards the crushing opening so that the material may be carried down between the jaws. These are adjusted by moving the wedge-shaped block at the back of the machine.

Machines of this type are made in sizes varying from 10 in. by 6 in. to 20 in. by 10 in. opening, and at their normal running speed of 250 revolutions per minute can reduce from 3 to 5 tons in the smaller machines or 10 to 15 tons in the largest size of hard limestone per hour to pass through a 2½-in. screen. If such machines are used as secondary crushers or granulators crushing the same material to pass through a ¾-in. mesh, the output becomes 3 tons for the smallest machine to 7 tons for the largest machine.

In all the machines mentioned so far the swing stock is pivoted above the frame, but in the Dodge crusher, Fig. 4, the swing stock is pivoted at its lowest point. The swing stock shaft is carried by movable bearings which are fitted in recesses in the side plates, and are moved by means of adjusting screws so that the opening of the jaws can be varied and the wear compensated. The swing stock is of the bell crank lever type, and is specially strengthened and actuated at its outer end by an eccentric. The eccentric rod which communicates the motion from the eccentric to the swing stock terminates at its upper end in a cylindrical surface which fits into a cylindrical groove cut in the end of the swing stock piece and forms a joint permitting the jaws to move in the manner described above. The weight of this swing stock keeps the stock in contact with the end of the eccentric rod. Machines of this type are made having openings varying from 4 in. by 6 in. to 11 in. by 15 in., their capacities when running at 275 and 210 revolutions per minute respectively being for the

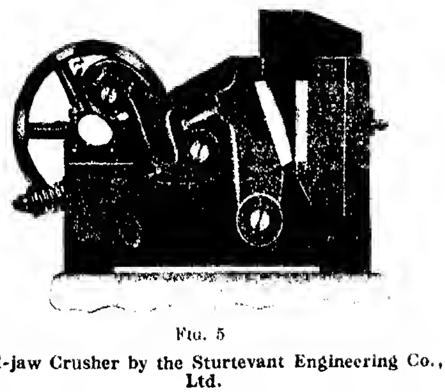


Fig. 5

Roll-jaw Crusher by the Sturtevant Engineering Co., Ltd.

smallest sizes about 1 ton per hour, and for the larger sizes 8 to 10 tons per hour when reducing to nut size.

Figure 5 shows a roll-jaw fine crusher, made by the Sturtevant Engineering Co., Ltd., which works on the Dodge principle. Here the pivot of the swing stock is again at the lower end, but is placed much

lower and behind the end of the jaw face so as to give considerable movement at the point of minimum opening of the jaws and a clear fall for the crushed material. The swing stock is driven, in contrast to the method adopted in the previous machine, through a toggle extending between one bearing on the back of the swing stock near the top end and a second mounted on a rocking lever. This rocking lever pivots at its lower end on a shaft carried on two adjustable bearings housed in suitable recesses in the sides of the machine, whilst the upper end is fitted with a roller resting on a cam mounted on the driving shaft. Smooth manganese steel jaws are fitted on this crusher, whilst the sides of the frame are made of steel plates and the ends, rocker arm and swing stock of cast steel. As the machine is intended for fine crushing the toggle plate is sometimes made of cast iron to prevent damage due to the admission of pieces of excessive size. Such machines are made in sizes varying from a 4 by 8 to a 7 by 24-inch opening. A machine of the first size is capable of crushing, when running at 350 revs. per minute, 10 cwt. of iron pyrites per hour when the jaws are set ¼-in. apart, and the latter machine can handle 3 tons per hour when the jaws have ½-inch opening to 6 tons per hour, when the opening is increased to 1 inch, the speed of running in each case being 150 revolutions per minute. The cam and roller device is introduced to give smooth action and easy running. Since the movement of the swing stock in the Blake type of crusher is greatest at the lower (outlet) end of the machine, there is little danger of packing, but this freedom of passage of material through the machine often results in an inequality of product. On the other hand the movement at the outlet of the jaws in both the Samson and Dodge types of crushers is small, and therefore a more uniform product is likely to be obtained, but this small movement does not permit of a ready discharge of the material, which is therefore liable to pack unless attention is paid to of crusher. In addition of this type have their own p. periphery of th operation as intermediate crushers b the an the large Blake or gyratory machines and the crushing rolls or ball mills.

Disc Crushers

Disc crushers embody an entirely different crushing principle which is extremely simple and at the same time very effective. Two types of machine are manufactured: the Symons horizontal disc crusher, for which Hadfields, Ltd., hold the patent rights for the British Empire, and the Symons vertical disc crusher, which is manufactured in this country by Sandycroft, Ltd. Fig. 6 represents a sectional view of the horizontal type. The main frame carries three coaxial bearings, of which the first two carry a hollow outer shaft rotated by a pulley mounted between the bearings. One end of this shaft is made in the form of a hollow hemisphere to the flange of which is bolted a spider or frame to which is fixed a concave disc with the concave side facing the shafting and having a hole in the centre through which the material is fed into the machine. Facing this disc is a second concave disc mounted on a hemispherical bearing resting in the cup of the hollow shaft. This hemispherical end is pressed on a second shaft which passes through the outer shaft and terminates in an eccentric carried by the third or eccentric bearing. To this eccentric is fixed a second pulley, which is usually driven at twice the speed of the driving pulley and in the opposite direction so as to increase the number of crushing nips. The eccentric is not attached to the second shaft and does not cause it to rotate, but simply gives it a gyratory motion. The two crushing discs rotate at the same speed and in the same direction.

The bearings are dust-proof, and forced lubrication is maintained by means of an oil pump driven from the eccentric pulley. The discs are enclosed in a hood made in two portions which are hinged on

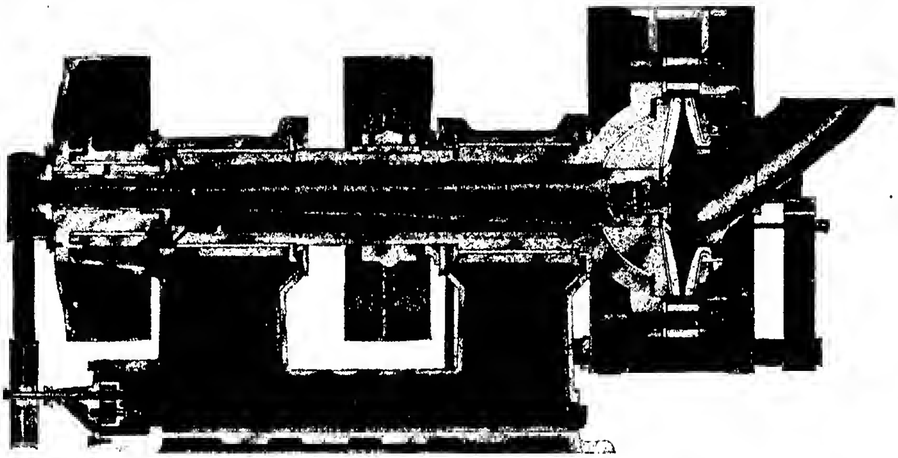


Fig. 6

Horizontal Disc Crusher by Hadfields, Ltd.

the rotary fine ert. main frame, thus enabling it to be eas...ance, we inspection or repair of the crusher. Lining the hood round the portion facing the opening between the discs is a series of segments forming a channel rectangular in cross section. The rods carrying the hood are also used to support the spout through which the material enters the space between the discs. The action of the machine is extremely simple, for on entering the space between the discs the material is thrown outwards and becomes wedged between the discs, in which position crushing is produced by the gyratory motion of the inner disc. This action is repeated until the pieces are sufficiently reduced to be thrown out by centrifugal force through the space between the outer edges of the discs which can be adjusted by means of bolts carried on the spider. The crushing discs are made of manganese steel and are found to undergo very slight but uniform wear, since there is no grinding action; the makers attribute this to a slight differential motion between the plates. This crusher is made in four sizes in which the diameters of the crushing discs vary from 48 to 18 inches. The largest size machine running at 100 revolutions per minute is capable of crushing 70 to 90 tons per hour to pass through a 2½-inch ring, whilst the smallest size can crush 6 to 8 tons per hour to pass through a ½-inch ring when running at 200 revolutions per minute. These machines are capable of crushing round silica pebbles when wet. The Symons vertical disc crusher illustrated in Fig. 7 is formed of a base upon which are mounted two hollow concentric cylindrical pedestals. The inner and longer pedestal is surrounded at its upper end by the sleeve of the lower table, which is supported on roller bearings resting on the top of the outer pedestal. The table is rotated through bevel gearing mounted on the counter-shaft of the machine and carries a number of spider bolts to which are attached the spider plate and upper spring plate, which in turn support the upper disc plate. This adjustable plate is conical in shape and carries the upper crushing face on its under surface. Inside the inner pedestal is a shaft which is rotated by a second bevel gear driven by the counter-shaft of the machine. The tail shaft of a circular convex rolling-wedge shaped like a mushroom fits into a hole drilled eccentrically in this shaft. The flat surface of the wedge rests upon the table and rotates with it. On the top of the wedge rests the upper disc plate made concave on the under surface to fit the wedge but flat on top to carry the lower disc. The rotation of the shaft carrying the stalk of the wedge causes the latter to move relatively to the table and thus produces an undulating motion in the lower disc and crushing face. The material enters the machine through a central hole in the upper disc plate and is thrown by centrifugal force into the tapering portion between the discs. Wedged in this position the material is crushed by the wave motion given to the lower disc. When the material has been crushed sufficiently it is discharged at the peripheries of the plates into the surrounding casing. The opening between the discs is adjusted in the following ingenious manner: the inner vertical surface of the upper spring plate and the outer vertical surface

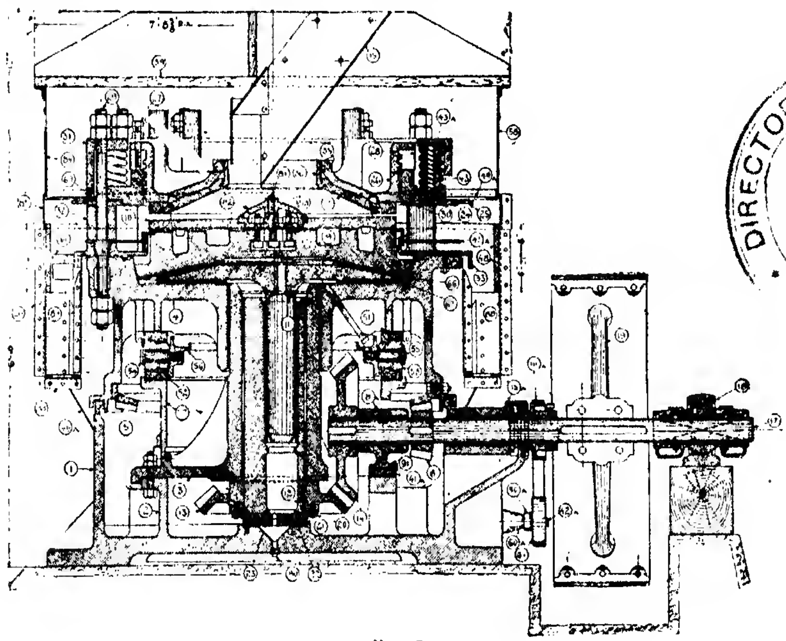


FIG. 7

Symons Vertical Disc Crusher by Sandycroft, Ltd.

of the upper disc plate are screwed to fit each other; the upper disc plate is rotated by means of one of the two turnbuckles fastened at one end to the bolts carrying the spider plate and at the other to lugs cast on the upper disc plate. After this adjustment the second turnbuckle is put in position and in addition the adjusting bolts are screwed up thus preventing any further relative motion between the plate and the spider. A 48-inch Symons vertical disc crusher is capable of reducing 100 to 120 tons of material from 5-in. to 1-in. cubes per hour, or 90 to 100 tons of 3 to 4-in. cubes to ½-in. cubes in the same time or 20 to 35 tons from 1½-in. to 2½-in. cubes to ¼-in. cubes in the same time. Springs are fitted between the spider plate and the upper spring plate which operate when any hard material is accidentally admitted to the machine.

Machines of the disc type are continuous in their action and therefore have a more uniform turning moment than the jaw type [illegible]. In addition the area of discharge at the [illegible] crushing surfaces more nearly equals the area of the opening at the feeding end of the machine, and therefore there is little danger of the packing of the machine.

Gyratory Crushers

Another type of crusher manufactured by firms such as Edgar Allen and Co., Ltd., Fraser and Chalmers Engineering Works, Hadfields, Ltd., and Vickers, Ltd., is the gyratory crusher, of which Fig. 8 is a sectional illustration. At the outset it should be stated that the crushing cone does not rotate as is commonly supposed. The erroneous idea that the crushing cone rotates may be due to two causes, namely, either the slight rotation of the cone when the machine is running light caused by friction between the rubbing surfaces of the driving mechanism, or the confusion of the action of this machine

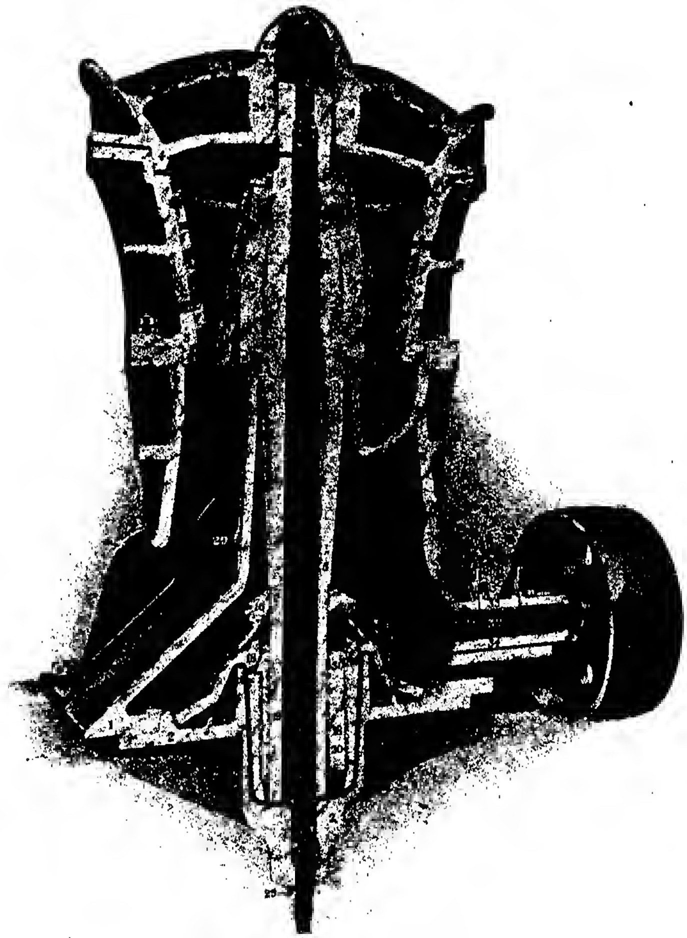


Fig. 8

Gyratory Crusher by Hadfields, Ltd.

with the rotary fine crusher, which, although very similar in appearance, works on an entirely different principle, as will be shown later. The machine has a cast-iron base shaped like a truncated cone, which converges upwards and is divided internally into two portions by an inclined plate having a tubular piece extending upwards concentric with the axis of the cone. The removal of the wall of the cone for a little way above the bottom of this inclined plane provides an outlet for the crushed material from the machine, whilst provision is made for a bearing at the bottom of this casting immediately opposite this outlet. Bolted to the upper flange of this casting is a second truncated cone converging downwards and having internal conical liners made of manganese steel, the surfaces of which may be either smooth or corrugated.

To the upper flange of this second cone is bolted a third, also converging downwards, and provided with two spider arms to support a spider cap concentric with the axis of the machine. This spider cap is fitted with a bush through which passes the central shaft supported in a footstep bearing carried by the bed plate of the machine. Surrounding this central shaft is the main shaft, at the upper end of which the cast steel centre is fixed. The lower end of the main shaft passes through an eccentric placed in a suitable housing in the bed-plate of the machine, and connected at its upper end to a bevel wheel driven by a second bevel wheel mounted on the shaft carried by the bearing at the bottom of the lower casing. A manganese steel mantle is securely fixed to the outer surface of the cast steel centre. The counter shaft rotates the eccentric, by means of the second bevel wheel and causes the lower end of the main shaft to describe a circle without rotating the shaft itself, thus giving the motion of a conical pendulum to the main shaft and mantle. The material to be crushed is fed into the top of the crusher, and falling into the wedge shaped annulus formed by the concaves and the mantle is crushed by the movement of the latter.

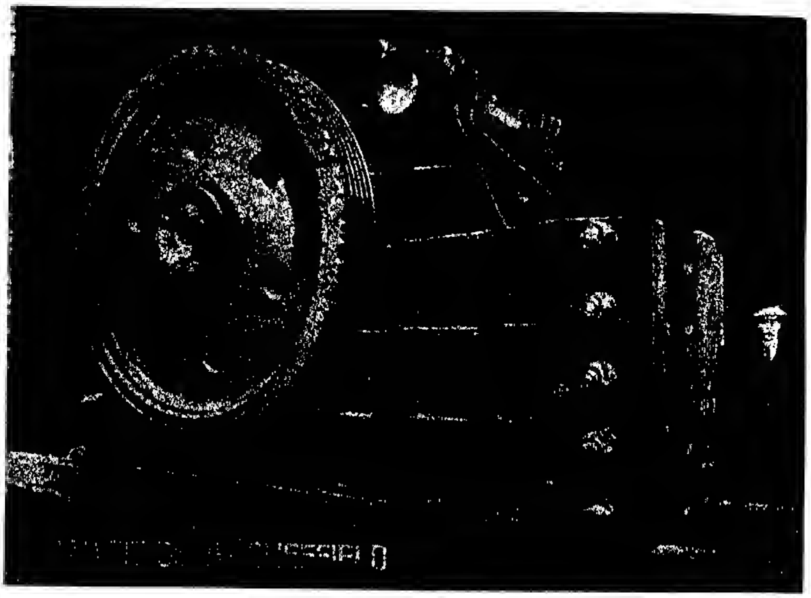


FIG. 9

Large-size Blake Crusher

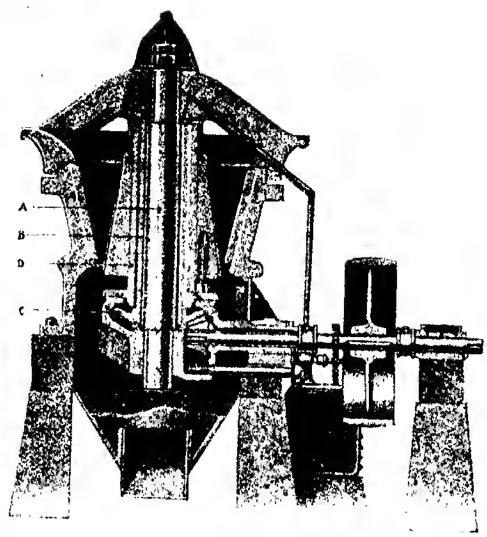


FIG. 10

Symons Gyratory Crusher by Frazer and Chalmers Engineering Works

On the release of the pressure the material drops further into the annulus, and is again crushed, the process being repeated until the particles are sufficiently small to pass through the opening between the bottom of the concaves and the bottom of the mantle. The material, falling through this opening, slides down the inclined plane, and is discharged from the machine.

The Symons gyratory crusher, made in this country by Fraser and Chalmers Engineering Works, and illustrated in sectional view by Fig. 10, is very similar to the gyratory crusher described above. In this machine, however, the centre shaft is carried in fixed bearings and is surrounded between the bearings by an eccentric sleeve, which is rotated by bevel gearing. Surrounding this eccentric sleeve is the head lining to which the mantle is fixed. In this case also the mantle does not revolve around the central shaft, but approaches to and recedes from the concaves by the rotation of the eccentric sleeve, the movement being equal throughout the length of the crushing head instead of gradually decreasing towards the top. The makers state that this machine requires less head room, gives greater stability and freedom from vibration and better distribution of the crushing stress, thus making for a reduction in weight with a corresponding lessening in cost. The gyratory crusher, being continuous in its action, produces a more uniform torque on the driving shaft. Like the disc machines, but not to the same extent, the outlet area from the crushing surfaces, on account of the increased diameter, approaches the inlet area, and thus tends to prevent packing of the machine. The inlet to the machine is in the form of an annulus, and thus prevents blocks of material from entering the crushing space, which could easily enter between the jaws of a Blake crusher having the same inlet area.

If the material is supplied in very large blocks it is necessary to install a Blake crusher for preliminary treatment before the material is allowed to enter the gyratory machine. The capacity of gyratory crushers also depends upon the nature of the material to be crushed and the size of the product desired, but machines have been constructed having capacities varying from 5 to 500 tons per hour. The horse-power required by the gyratory crusher is considerably less than that used in a Blake machine when both machines are reducing a similar quantity of the same material per hour to the same degree of fineness. The size of product obtained from these machines usually varies from $4\frac{1}{2}$ to $1\frac{1}{2}$ ins. in diameter.

PULP AND PAPER INDUSTRY IN CANADA

The Wayagamack Pulp and Paper Co., Three Rivers, Quebec, has received a loan of £400,000, under the Trade Facilities Act from the British Government and is expending the money in the purchase of machinery in Great Britain for the purpose of expanding the present plaut.

THE CHEMICAL INDUSTRY DINNER

The joint Dinner of the Society of Chemical Industry and the Chemical Industry Club was held at the Edward VII Rooms, Hotel Victoria, London, on November 14. Mr. W. J. U. Woolcock, C.B.E., President of the Society of Chemical Industry, was in the chair, and over 300 ladies and gentlemen were present.

It is impossible to give the names of all; many members of the Council of the Society and of the committee of the Club were present, and the guests and persons occupying official positions included Sir Richard T. Glazebrook, K.C.B., F.R.S.; Mr. H. E. Coley, Chairman of the Club; Sir Arthur Duckham; Sir Robert Robertson; Sir Frederick Nathan; Mr. Percy Ashley, of the Board of Trade; Mr. D. Milne Watson; Mr. G. Rudd Thompson; Mr. W. S. Hale, the Master of the Tallow Chandlers' Company; Prof. C. G. Henderson, the President of the Institute of Chemistry, and Mr. A. Chaston Chapman, the President of the Chemical Industry Club.

"Chemical Industry and the Profession of Chemistry" was proposed by Sir R. T. GLAZEBROOK, who, after referring to the book, "Chemistry in the XXth Century, prepared for the Wembley Exhibition, said there was no doubt whatever that there had been a complete change in the life of the world as the result of the development of scientific methods and their practical applications. Of the sciences which had led to that change, chemistry was not the least. The productiveness of human labour at present was dependent on the advance of scientific knowledge, and in this chemistry was playing no small part. How large a part chemistry was playing had been shown in an admirable manner at the Wembley Exhibition. It could not be denied that the progress of chemistry had been of the greatest importance to the world as one of the means by which human labour was made productive. He himself was a physicist and confessed to being taken aback when he first heard on the committee of the Royal Society, which dealt with the pure science exhibit, that such distinguished men as Rutherford, the Braggs and J. J. Thomson were regarded as chemists. He had lunched with Rutherford that day and asked him if he liked being called a chemist, and Rutherford's reply was that if the chemists liked to give that name to one who knew no chemistry he did not mind. The Royal Society Committee was enormously assisted by Mr. Woolcock in its work, although it was possible that at first he rather felt a little doubtful as to how far the Royal Society Committee was in earnest. The distinction between chemistry and physics had vanished, and the complete chemist must be a physicist. As a matter of fact, the chemist must be much more. He must be a person trained to reason, doubting all things, ready at all times to discuss, he must have a wide vision and a fertile imagination guided and controlled by his reason and by his results of experience. He must be apt at experiments and ready to iuterpret their meaning. Such men were needed in industry, and if the Society of Chemical Industry and

the chemical industry and the work of professional chemists were to flourish, such men must be forthcoming, and they would be forthcoming so long as the ideas set forth in the Exhibition at Wembley inspired their work.

MR. D. MILNE WATSON said it was a great privilege to him to reply to the toast so eloquently proposed by Sir Richard Glazebrook. He was very glad to be present as an industrialist and as a guest of the Society of Chemical Industry of which he hoped soon to be a member. The conjunction of science and industry exemplified in that dinner showed the progress that had been made in the last few years in bringing scientific chemists and industrialists together. He believed the work of the Society of Chemical Industry was of great importance. He had been immensely impressed with the scientific exhibition at Wembley, and speaking as a manufacturer he felt that without that scientific exhibition the individual exhibits at Wembley would have lost a great deal of their meaning. There had been a very great extension of chemical plants during the War, but in the impoverished state of the world now it would take many years to get the work of all these plants absorbed. The hope of the future was that there should be closer working between science and industry; indeed he believed that was the only hope, if the trade and commerce of this country were to regain their former position.

PROF. G. G. HENDERSON also replying to the toast said it was significant that the "profession of chemistry" should have found a place in the toast list. Not many years ago it would have been ludicrous to have talked of the profession of chemistry. There were at that time many distinguished chemists but no profession as such. The position now was entirely different, and this great change could be attributed to at least three factors, two of which were more recent, and one more remote. One of the more recent factors was the Great War. The second factor was that wonderful display in the chemical exhibit at Wembley, which they owed to one man, their Chairman that evening. The third and more remote factor which had contributed so greatly to the improvement of the chemical profession was the quiet and continuous work of the Institute of Chemistry carried on for the last half-century. But they were not satisfied with the position which the profession occupied at the present moment, and they would not be satisfied until chemistry ranked at least equal to any other profession in the country. That stage had not yet been reached, and in attempting to do so, two steps were obvious. The first was that they must speak with one voice as a united profession, and that could only be realised by having some central organisation with central headquarters. The second step was equally obvious; it was essential to make the general public realise the part played by chemists in the common life.

MR. A. CHASTON CHAPMAN, F.R.S., who proposed "The Society of Chemical Industry," said that he welcomed the opportunity of offering to the great Society, which the Club looked upon as its parent, an expression of its warm and filial regard and to express the hope that the close connexion which had always existed between them would for ever continue. The Society was one of the great trinity of Chemical Associations which represented in such an admirable manner British chemistry. There was now a greater degree of co-operation in the whole of the industry and profession than ever before, and the Chemical Industry Club was anxious to help in any way it could to develop this co-operation.

MR. W. J. U. WOOLCOCK said the Society of Chemical Industry was flourishing; its duty was to publish scientific papers, and there were certain things which it could give to its members in return for their membership, but generally speaking the members of the Society knew that they were supporting something which stood for an ideal and which commercially could not be reckoned as an asset. They knew that the Society stood midway between science and industry. They knew that in this country there were millions of people who required to be educated in the value of science to the nation. They knew that they were responsible for proving to every industrialist that he could be more efficient, and that in the fight for markets and the maintenance of British trade there was no industry that could not be improved by a better appreciation of science and by a bigger influx into the works of the chemist. He was delighted that Professor Henderson had got so near and yet did not mention Chemistry House by name. He knew that that great project had Professor Henderson's fullest sympathy, and he could speak with certainty to the same effect for the President of the Chemical Society, and for Mr. Chaston Chapman. They were not going to hurry the matter, but he assured them that if there was less talk about Chemistry House at the moment there was more thought and a greater attempt to crystallise ideas at the present moment than had ever existed before. The past year had shown in a remarkable way the degree of co-operation among learned bodies and, better still, among individual sciences. There was a greater degree of co-operation than had ever existed before. Never again could it be asserted that there was any difficulty whatever in getting scientists to work together. It was untrue. It was the easiest possible thing in the world.

MR. C. S. GARLAND, proposing "The Chemical Industry Club," said it was with the greatest pleasure that he coupled with the toast the name of Mr. Coley, because it was to Mr. Coley that the genesis of the Club belonged. He had worked extremely hard to bring the Club into being, and a few years ago the idea that chemists could fraternise together was appalling. However, the Chemical Industry Club had shown what chemists could do in this matter.

MR. H. E. COLEY, replying to the toast, referred to the progress of the Club, and claimed that it had justified its existence. His remarks about the success of the Club were much appreciated.

The final toast, that of "The Guests," was proposed by DR. W. CULLEN, in an amusing speech.

MR. PERCY ASHLEY, in reply, said nothing was more important to the country than that its industries should be so organised that they could speak authoritatively to the Government and to Government Departments, and give a clear indication of

what industry thinks to be its requirements and as to the manner in which the State might help. The Government and its Departments desired to get at the truth; they wanted to help industry, but industry must indicate clearly and unanimously the lines upon which help could be given.

OPENING OF THE RAMSAY LABORATORY OF CHEMICAL ENGINEERING

On November 12, H.R.H. Prince Arthur of Connaught opened the Ramsay Laboratory of Chemical Engineering at University College, London. Sir R. Robertson, who presided, said in this country technical chemists were lacking who could transfer a laboratory operation to large-scale work. After discussing the training, he urged chemical manufacturers to afford facilities similar to those provided in the United States, where it was a practice to take students to works.

Prince Arthur of Connaught, in declaring the laboratory open, said the ceremony was the final act in the provision of a worthy memorial to that great man of science, Sir William Ramsay, who, from 1887 to 1913, held the Chair of General and Inorganic Chemistry at that college. After his death in 1916 a large circle of friends and colleagues not only in this country but in all parts of the world, decided that a fitting memorial should be raised to his memory. The appeal was of an international character, and met with a ready response from all parts of the British Empire and the world. The memorial had taken two main forms: (1) The foundation of Ramsay Memorial Fellowships in Chemical Science, and (2) the foundation of a Ramsay Laboratory of Chemical Engineering. The success of the first half of the scheme was shown by the fact that the Fellowship Trusts were now administering 16 scholarships held by carefully-selected Fellows from various countries. Professor E. C. Williams was appointed a year ago to the Ramsay Chair of Chemical Engineering, and it was under his guidance that the laboratories had been reconstructed and equipped. He was gratified to learn that, apart from the support given to the movement by the Ramsay Memorial Fund, which handed over a sum of £26,979, the Laboratory of Chemical Engineering had enlisted the ready and generous support of many of the great firms of this country which were connected with the chemical industry. A sum of approximately £1390 a year for five years had been provided in this way. Even now further financial support was needed if the department was to be enabled to rise to its full possibilities.

Mr. W. J. U. Woolcock, C.B.E., president of the Society of Chemical Industry, said the opening of the Ramsay Laboratory marked a step forward. The hybrid nature of the chemical engineer had delayed immediate recognition, but the new and pioneer laboratory was likely to produce men who would in time be recognised as worthy to rank with members of both the chemical and engineering professions. He was delighted to find how Prof. Williams laid stress on the ability to plan large-scale commercial operations, and the laboratory would enable training to be given not only in that direction but in the designing and operation of chemical plant. A number of individuals and firms engaged in chemical industry had shown in a practical manner their interest in the work, and he hoped this interest would grow. For the complete training of the students some works experience was required, but it was unusual for manufacturers to admit students to their works. It was done in the newer countries, and the possibility of doing it should be kept in mind.

FORTHCOMING EVENTS

Nov. 24. Royal Society of Arts, John Street, Adelphi, London, W.C. 2, at 8 p.m. "Modern Colour Problems," by L. C. Martin.

Nov. 25. Society of Dyers and Colourists, *Leeds Junior Branch*, Visit to Messrs. Brotherton and Co. Stourton Tar Works, commencing at 2.30 p.m.

Nov. 26. Royal Microscopical Society, 20, Hanover Square, London, W. 1, at 7.30 p.m., Joint Meeting with the Institution of Structural Engineers. (1) "The Elementary Principles of Microscopical Illumination: Self-Luminous Objects," by J. E. Barnard. (2) "Application of Microscopy to Cement Research," by H. J. Deane.

Nov. 26. Institute of the Rubber Industry, *Manchester and District Section*, the Textile Institute, 16, St. Mary's Parsonage, Manchester, at 7.30 p.m. "Treatment of Rubber previous to Vulcanisation," by Dr. S. S. Pickles.

Nov. 26. Society of Chemical Industry, *Glasgow Section*, 39, Elmbank Crescent, Glasgow, at 7 p.m. "The Future Prospect of a Clean Atmosphere," by ex-Bailie W. Brownhill Smith.

Nov. 26. Institute of Chemistry, *Leeds Section*, The University, Leeds, Annual Meeting. Address by Prof. Cobb.

Nov. 26. Institute of Chemistry, *Birmingham and Midland Section*, Annual General Meeting and Address by Prof. G. T. Morgan, F.R.S.

Nov. 27. Society of Dyers and Colourists, *Midlands Section*, Joint Meeting to be held at Nottingham with the Society of Chemical Industry. "Acetate Silk," by G. H. Ellis.

Nov. 27. Institute of Brewing, *Yorkshire and North Eastern Section*, Queen's Hotel, Leeds. "1924 Barleys," by C. E. Sutcliffe and H. M. Chubb.

Nov. 28. University of London, King's College, Strand, W.C. 2, at 5.30 p.m. "Scientific Method," by Prof. E. W. MacBride.

Nov. 28. Institution of Mechanical Engineers, Storey's Gate, London, S.W. 1, at 7 p.m. "Centrifugal and Rotary Pumps," by G. L. Ponsford.

Nov. 28. Institution of Mechanical Engineers, *Yorkshire Section*, Visit to Messrs. Steel, Peech and Tozer, Sheffield, followed by paper on "The Effect of Repetition Stresses on Steels," by Prof. F. C. Lea.

Nov. 29. Society of Dyers and Colourists, *West Riding Section*. "The Dyeing Properties of some Azo Derivatives of Tetra Hydro Naphthalene," by Dr. F. M. Rowe and V. Tarbott.

SOCIETY OF CHEMICAL INDUSTRY

SUSPENSION OF ENTRANCE FEE

As an inducement to Chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Society in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

MEMBERS ELECTED, November 14, 1924

Antonoff, Dr. George, 6, Featherstone Buildings, High Holborn, London, W.C. 1. Research Chemist.

Baldwin, John W., 211, New Buckingham Street, Holderness Road, Hull. Engineer.

Barclay, T., Charford Mills, Saltley, Birmingham. Director.

Buckley, Robert, 179, Bedford Road, Rock Ferry, Birkenhead, Cheshire. Analytical Chemist.

Coxon, Thomas, Mill Lane, Billingham, Stockton-on-Tees. Chemist.

De Blois, William H., 570, Claremont Avenue, Westmount, Quebec, Canada. Chemical Engineer.

Denchar, John L., The Castner Kellner Alkali Co., Ltd., 257, Royal Liver Buildings, Liverpool. Director.

Edwards, Percival R., Rodway View, Staple Hill, Bristol. Chemist.

Hampson, Cyril C., c/o C. P. A., Ltd., Low Mill Print Works, Whittle-le-Woods, Chorley, Lancs. Works Chemist.

Hazeley, Edward, 7, George Eliot Road, Foleshill Road, Coventry. Chemist.

Hewer, Miss Dorothy G., 18, York Terrace, London, N.W. 1. Analytical Chemist.

Holliday, Major Lionel B., c/o L. B. Holliday and Co., Ltd., Deighton, Huddersfield. Aniline Dye Manufacturer.

Jack, William, 13, Willowbank Crescent, Glasgow, C. 3. Chemist.

Lorimer, James D., 117, Queen Street, Montreal, P.Q., Canada. Broker.

Lant, James G., c/o Anglo S. American Meat Co., San Martin 235, Buenos Aires, Argentine. Analyst.

McLaren, William, The Laboratory, 20, Laverockbank Road, Edinburgh. Fuel Technologist.

Metzis, Josef, A. G. "Galicia," Drohobycz, Poland. Manager.

Peak, Alfred E., "Greylands," Alderley Edge, Cheshire, Director.

Ridsdale, Noel D., 3, Wilson Street, Middlesbrough. Analytical Chemist.

Roswarne, Joel A. H. T., c/o "Bovril," Ltd., 148-166, Old Street, London, E.C. 1. Chemist.

Russell, John, 2, The View, Roundhay, Leeds. General Secretary, Brotherton and Co., Ltd.

Smith, Leonard E., 6, Greenway Road, Redland, Bristol. Chemist.

Southall, Reginald B., c/o The National Oil Refineries, Ltd., Llandarcy, Glam., S. Wales. Works Chemist.

Speight, Jacob, Moor House, Rishton, Lancs. Managing Director.

Starey, Arthur Wm., The Glaxo Manufacturing Co., Ltd., Port Fairy, Victoria, Australia. Chemist.

Stern, Harold J., 17, Croxteth Grove, Sefton Park, Liverpool. Chemist.

Wallis, Kenneth, 56, Harlaxton Road, Grantham, Lincs. Works Chemist.

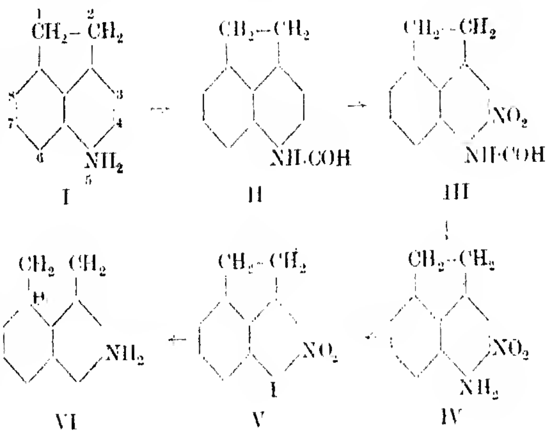
Wilson, Harold, 9, Egerton Avenue, Urmston, Manchester. Assistant Chemist.

BIRMINGHAM SECTION

The first meeting of the session was held on November 11, at the University of Birmingham, Prof. G. T. Morgan, F.R.S., this year's chairman of the Section, presiding. Four papers on researches from the chemical department of the University were presented :—

1.—"Studies in the Acenaphthene Series. Part I. 4-Aminoacenaphthene," by Prof. G. T. Morgan and H. M. Stanley. Hitherto only one of the four theoretically possible aminoacenaphthenes has been described, namely, 5-aminoacenaphthene (I) discovered by Quincke (*Ber.*, 1888, **21**, 1455).

4-Aminoacenaphthene (VI) has now been obtained by the following series of operations :—



The acyl derivatives of 5-aminoacenaphthene nitrate in position 4, but the nitroformyl compound being the most readily hydrolysed is employed in the foregoing synthesis. The nitrobenzoyl-5-aminoacenaphthene on reduction gives an anhydro-base, acenaphthene-4N : 5-benzenyldiamine (VIII). 5-Iodoacenaphthene on nitration furnishes two isomeric nitro-compounds, A (m.p. 180°) and B (m.p. 151–153°). The less fusible isomeride is 5-iodo-6-nitroacenaphthene since on reduction it yields 5-aminoacenaphthene. The more fusible isomeride is still under examination. The properties of the two aminoacenaphthenes were contrasted in a table.

2. "Researches on Residual Affinity and Co-ordination. Part XXIII. Interactions of Trimethylstibine and Platinic, Platinous and Palladous Chlorides," by Prof. G. T. Morgan and Victor E. Yarsley. By the interaction of trimethylstibine and chloroplatinic acid in alcoholic solution a portion of the antimony compound is oxidised to trimethylstibine dichloride and two co-ordination derivatives of bivalent platinum are obtained: bistrimethylstibinedichloroplatinum, $[2SbMe_3, PtCl_2]$, a yellow substance crystallising from organic solvents: tetrakistrimethylstibineplatinous platinochloride $[4SbMe_3, Pt.]PtCl_4$, an orange compound insoluble in organic media and converted into the preceding monomeric derivative at 60° or on long exposure to light at the ordinary temperature. Excess of trimethyl-

stibine converts the foregoing compound slowly into tetrakistrimethylstibineplatinous chloride, $[4SbMe_3, Pt]PtCl_2$, which is soluble in water, giving with aqueous potassium platinochloride a precipitate of the orange tetrakistrimethylstibineplatinous platinochloride, thus confirming the constitution of the latter as an analogue of the green salt of Magnus. The dichloride reacts with chloroplatinic acid and palladous chloride to furnish respectively tetrakistrimethylstibineplatinous platinichloride and palladochloride, $[4SbMe_3, Pt]PtCl_6$ and $[4SbMe_3, Pt]PdCl_4$. Bistrimethylstibinedichloropalladium,$[2SbMe_3, PdCl_2]$, is obtained from palladous chloride and trimethylstibine and when the latter reagent is in excess tetrakistrimethylstibinepalladous chloride, $[4SbMe_3, Pd]Cl_2$ is produced.

3. "Observations on the Higher Fatty Acids," by G. T. Morgan and Arthur R. Bowen.

(i) *The higher saturated fatty acids of Cacao Butter.*—The object was to investigate the acids of cacao butter as a source of eicosanic acid. According to Traub and Graf, cacao butter contains the saturated fatty acids arachidic, stearic, palmitic and lauric, but not theobromic acid, $C_{64}H_{128}O_2$, which had previously been reported by Kingzett. Hehner and Mitchell obtained pure stearic acid by repeated recrystallisation of cacao butter acids from alcohol. Ehrenstein and Stuewer (*J. pr. Chem.*, 1923 (ii), **105**, 199) have recently pointed out that arachidic acid from arachis oil is in all probability an *iso*docosanic acid, whilst the acid in rambutan tallow (from the seeds of *Nephelium lappaceum L.*) is the normal eicosanic acid. For comparison, pure *n*-eicosanic acid was prepared by potash fusion of erucic acid (Fitz, *Ber.*, 1871, **4**, 444) and a series of mixed melts with pure stearic acid worked out. The fatty acid from rambutan tallow (Ceylon) was also prepared and its identity with *n*-eicosanic acid confirmed. Recrystallisation of the saturated fatty acids of cacao butter from alcohol at 25° to 0·3 per cent. of the original weight resulted in the isolation of pure stearic acid. Heintz's method for the separation of higher fatty acids through the fractional precipitation of their magnesium salts was practised on the saturated acids of cacao butter until these were reduced to 1·8 per cent. of the original weight. This final residue was pure stearic acid.

(ii)—*The Existence of Bimolecular Complexes of the Fatty Acids.*—The curve obtained by plotting the melting points of *n*-eicosanic acid : stearic acid mixtures indicates evidence of compound formation of the composition 1 mol. $C_{20}H_{40}O_2$: 1 mol. $C_{18}H_{36}O_2$. The corresponding stearic acid : palmitic acid curve has been worked out with great accuracy by de Visser (*Rec. Trav. Chim.*, 1898, **17**, 182), who deduced from his results that "mixed crystals" were formed in the vicinity of the 50 per cent. mixture. However, there appears no foundation for this conclusion and the curve clearly shows evidence of compound formation. Möller and Shearer (*Chem. Soc. Trans.*, 1923, **123**, 3156) have shown that the higher fatty acids themselves are bimolecular, which result is confirmed by the work of Garner and Randall (*Chem. Soc. Trans.*, 1924, **125**, 881).

GLASGOW SECTION

The meeting on November 14 was held jointly with the Glasgow Section of the Institute of Chemistry, the Ardeer Chemical Club, and the Glasgow University Alchemists' Club, at Ardrossan. Mr. Wm. Rintoul presided and on behalf of the Ardeer Chemical Club, welcomed the visitors from Glasgow. The chairman, in introducing the lecturer, said the meeting was unique; it was the first occasion on which a paper was to be read at a joint meeting of the Societies held at Ardrossan, and it was an experiment which he hoped would be repeated. Mr. J. G. Roberts—of Messrs. Shanks, Barrhead—then delivered a paper, entitled "Chemical Pottery."

The ideal stoneware clay is one which, tempered with water, can be kneaded to such a plasticity as will give the greatest ease in working and the greatest uniformity in structure; a clay which will not shrink unduly on drying and firing, and that will burn to a dense semi-vitreous body at a moderate temperature, without losing its shape. Pots made of such material are liable to break when subjected to changes in temperature. Fireclays can be used to make vessels which will withstand sudden change of temperature, but these, on firing, remain porous, thus rendering necessary the use of a glaze if the finished article is used for the storage of liquids. Common salt is used to glaze stoneware jars, drain pipes and vessels for purely chemical purposes, while powdered galena gives the common yellow glazed joint. If pin-holes and unglazed patches be present, and the vessels be used for storing liquids and acid, iron compounds are dissolved resulting in the contamination of the stored liquid. Vessels, especially those of large size, whether made from clay bodies, or fused silica, are liable to break when under strain.

The methods adopted in manufacture vary according to the size and shape required. Those of small size and of circular form can be produced by the potter's wheel: those of large size are more easily made by pressing or building-up with plastic clay: while the production of "slip"—a mobile suspension of clay in water produced by deflocculating the clay with alkali or silicate of soda—and the subsequent casting in plaster of paris moulds, renders the production of vessels of uniform shape and thickness possible. The size of vessels made by casting is limited by the weight of slip (100 gall. of slip weighs almost one ton) used, the difficulty of getting the clay to stand up in the mould after removing the excess of slip, and the cost of moulds. A straight-sided vessel, such as a picric pot, has been cast up to a capacity of eighty gallons.

The greatest difficulty in the commercial production of chemical pottery lies in the varieties of shape and the comparatively small number of any one type of article required. Few articles, however, cannot be produced provided the initial difficulties in technique are overcome.

Porcelain may be regarded as the greatest triumph in the art of pottery. It is a composite body made up of quartz, china clay and felspar, and is produced usually from the mineral "pegmatite," a quartz and felspar rock which is comparatively free from iron

compounds. Ball clay is sometimes added when large articles are made, to give increased plasticity and strength to the unfired body. Manufacture comprises mixing, sieving, electro-magnetic separation of iron, filtration, wedging or casting, and firing.

The chemical composition of a particular porcelain may easily be found, but the manufacture of such an article is difficult owing to the obscure chemical and physical reactions. The chemical reactions are not allowed to go to completion, but are arrested at a particular stage, and, unlike many other processes, the difficulties are to be found in the unknown chemistry of "incomplete reactions." The physical condition of the ingredients are no less important than the chemical composition and variation of these conditions leads to disaster. Thus, quartz, for example, changes its crystalline form when heated and can exist in a metastable form in three distinct forms as quartz, cristobalite and tridymite, while each variety has two modifications—the alpha and beta forms. All these transformations are accompanied by expansion and take place below the melting point. Clay, again, breaks up below its melting point and when calcined to about 1000° C. forms a new-unidentified crystalline substance. At a higher temperature the so-called sillimanite is formed. No good heat resisting porcelain contains unchanged quartz, but always contains the needle shaped crystals supposed to be sillimanite, $Al_2O_3.SiO_2$.

Malinovszky produced these crystals upon the large scale, and the process, as developed by W. Smith, is known as the carbonised clay process of heating raw clay with coal. The carbonised clay has a high conductivity for heat and possesses the important property of hardness. It also results in the production of the afore-mentioned crystals, and in the separation of iron compounds. Brown and Greig have recently reported that the composition of the crystals is $3Al_2O_3.2SiO_2$ so that they are not sillimanite; they suggest the name "Mullite" as the crystals were identified in some natural rocks from Mull. Should the technical difficulties of manufacture be overcome the production of an excellent neutral refractory for temperatures up to 1800° C. is assured. Porcelain is thus regarded as a heterogeneous substance, composed of interlacing crystals embedded in a glassy matrix, and the lower the proportion of basic oxides, the more refractory does the body become.

The properties of special bodies such as fused silica, alumina, zirconia and artificial spinels were also commented upon.

In replying to the discussion, Mr. Roberts said that many of the troubles in the manufacture of pottery were due to the colloidal nature of the raw materials, together with the fact that equilibrium conditions were never obtained during the process. When sodium chloride was used, the glaze was a solid solution. He agreed that the recent work of Bingham and Green on plasticity was very valuable but the plastometer had not yet been perfected which could replace "the potter's thumb." The process was still "an art," but he looked forward with eagerness to the day when accurate determinations of plasticity would be possible.

The lecturer was accorded a hearty vote of thanks, and the thanks of the visitors were conveyed to the Ardeer Chemical Club for their hospitality by Prof. Wilson, on behalf of the Glasgow Sections of the Society, and Institute of Chemistry, and by Mr. Kerr, Hon. Secretary of the University Alchemists' Club.

MONTREAL SECTION

On the occasion of the visit of Dr. E. F. Armstrong, F.R.S., to Montreal, on October 14, he was entertained at an informal dinner at the Engineers' Club. The evening was spent pleasantly in discussing the affairs of the Society, both in England and Canada. It was brought out during the evening that a chemist coming from England to Canada must be prepared to finance himself for some considerable time until he can work himself from a lowly position into a remunerative one, just as graduates of Canadian Universities are obliged to do. Among those present were:—Messrs. J. B. Bell (chairman of section), C. F. Bardorf, J. R. Donald, N. N. Evans, C. R. Hazen, F. W. Horner, R. Job, C. G. Kertland, P. Le Cointe, M. C. C. McFee, H. W. Matheson, Dr. R. F. Ruttan, C. H. Wardleworth, and W. B. Woodland.

On October 20, the Bursary Committee, composed of Mr. J. R. Donald, Dr. Ruttan, and Prof. P. Lecointe, made a report at the opening meeting, submitting rules and regulations governing the bursary. This bursary is for the sum of fifty dollars, which is subscribed by the members of the Montreal Section, and is no charge on the funds of the parent Society. The bursary is awarded for the best paper on pure chemistry or chemical engineering written up from the practical experience of undergraduates in chemical works of various kinds during the summer vacation between their third and fourth years at college.

At the meeting which was held subsequently, Mr. J. A. Dresser pleaded for the development of industrial chemistry in Canada. The reason for the unfavourable trade balance in the mineral industry was that Canada was selling her raw products and buying back the manufactured article. A remedy for this adverse position would be manufacture on a larger scale, particularly in the chemical industry. The world looked to the chemist: every unit constituting modern civilisation was the work of the chemist; and the chemist held the world at his mercy.

In the ensuing discussion, Mr. J. R. Donald said metallurgy was of special significance to Montreal, which was in a mineral district. Major G. C. Dunanney said he believed Canada was on the eve of a great mining expansion, incident to the profound impression made upon the British intellect of the potentialities in this field revealed by the Canadian pavilion at Wembley: but it must remain with the technicians to blaze the trail. Mr. H. W. Matheson spoke briefly of the mining industry and its effect on the trade balance, and the possibilities of factories in Canada for making pigments. Sir Stopford Brunton emphasised the urgency of developing non-metallic industry. This industry was perhaps less spectacular

than gold mining, yet he believed it more essential as a national trade stabiliser. He concluded with a strong plea for the utilisation of Canadian water power by Canada, which he warned was in a fair way towards monopoly by the great corporations of the U.S.A. Mr. C. S. Bardorf said that raw kieselguhr was worth 5 cents a pound, but when worked up as a cosmetic it sold at 10 cents an ounce. Mr. A. Neighorn deplored the exportation of raw products instead of utilising them to build up industries. The chemists were not being utilised.

NOTTINGHAM SECTION

The third meeting of the session was held on November 5, Mr. G. J. Ward, chairman of the section, presiding.

Mr. C. E. Pickard, A.I.C., read a paper on "Observations on the Laboratory Testing of Enzyme Bates." Mr. Pickard outlined the various methods adopted for evaluating enzyme bates, and pointed out that the results obtained depend largely on the conditions of the tests, and only when comparative tests are made under absolutely identical conditions can the results furnish information of value.

The addition of ammonium chloride, ammonium sulphate or common salt to the proteolytic enzymes renders the enzyme about three times as active as when tested in the absence of these salts. The curve of activation by ammonium chloride is of the same type as the ionic dissociation curve of this salt, and beyond a certain point further increase in the ammonium chloride added produces no corresponding increase of activation of the enzyme. In practice the use of large quantities of ammonium chloride produces a too-rapid falling of the skins and the enzyme action is thereby inhibited.

Certain salts of the alkaline earths besides acting in some instances as "buffers," produce sudden changes of enzyme activity by converting inactive zymogens into active enzymes. This activating action of, say, the calcium ions varies with the origin of the pancreatin tested; different bates may possess different quantities of inactive zymogens. Any method used for the testing of bates must be preceded by (*a*) a complete qualitative analysis for bodies of physiological interest; (*b*) complete qualitative analysis for organic and inorganic substances; and (*c*) careful consideration of the influences of the results on subsequent work. No single method can be postulated as the best. Concentrations used in laboratory tests must be analogous to those used in bating. The bate solution should seldom exceed 1 per cent. and should act on at least two hundred times its weight of substrate. The relative quantity of substrate is small and lies under the grain layer, being reached only with difficulty by the enzyme. The bating activities follow the linear law and the use of slightly increased quantities of enzyme (without delimer) increases the velocity of reaction. Further increase in the quantity of enzyme results in the attack of other constituents of the skin substances such as collagen. The opinion that laboratory tests should be carried out on excess of substrate assumes that the whole skin and not merely the elastin and albuminous contents act as substrate. Laboratory methods cannot indicate the refinements of bating such as soft, silky grain, and "feel" which characterise a correctly bated skin. It is concluded that whilst the various laboratory methods provide working information of value, such as the control and standardisation of the proteolytic activities of bating materials, their results as criteria of relative bating efficiencies, must be accepted with considerable reserve.

In the discussion Mr. Law stated that he was of the opinion that of the tests put forward the gelatin substrate method was the nearest approximation to that operating in a natural skin. Mr. Dunford enquired as to the possibility of liquefying glues by trypsin or other enzymes, to a definite stage and producing a liquid glue without destroying its adhesive power. The chairman asked why tests could not be carried out on a small scale, identical with trade conditions. Dr. Prideaux enquired whether the conversion of an inactive bate into an active one by calcium ions was due to the formation of a soluble complex with calcium salt similar to casein in milk resulting in the corresponding increase in the dispersion of the enzyme.

In reply Mr. Pickard stated that glues could be liquefied and the resulting glue retained to a lesser degree its adhesive properties; the diminution in adhesive power may be due, however, to such impurities as fats in the enzyme. Satisfactory tests could not be made on small pieces of skin and the skins themselves showed considerable variation in character. A very marked increase in enzyme action is produced by very minute amounts of calcium salts and hence the increased activity could not be attributed to increased dispersion due to the presence of soluble calcium salts.

SOUTH WALES SECTION

On November 7 at the Technical College, Cardiff, Mr. Donald Brown, of the Ely Paper Works, Cardiff, read a paper on paper making. Mr. G. H. Clegg was in the chair.

The lecturer dealt very fully with the details of fibre treatment from tree to finished product. The theoretical aspect of cellulose hydration was considered and also the practical difficulties occurring owing to the variation of this factor. The problem of scientific control was also discussed, and it was pointed out that in the paper-making industry, as in many others, scientific methods of control were only slowly superseding rule-of-thumb methods. The question of paper tinting was dealt with, and the difficulty of securing standard products with English dyestuffs was pointed out. The lecture was amply illustrated by slides and by specimens of papers produced by various processes. In the discussion which ensued the problems of bleaching, silica content of grasses, and the use of loading materials were discussed at length, and the meeting concluded with a vote of thanks to the lecturer for his lucid exposition of the process.

SOCIETY OF PUBLIC ANALYSTS

At the meeting held on November 5, Mr. G. Rudd Thompson, President, in the chair, the following papers were read:—

"On Certain New Methods for the Estimation of Small Quantities of Arsenic and its Occurrence in Urine and in Fish," by H. E. Cox, Ph.D., M.Sc. The methods and results of the Swedish Commission on chronic arsenical poisoning have been carefully tested and the conclusion reached that the nitric and sulphuric acid digestion process described by Bang and Ramberg gives higher and more accurate results than the older wet combustion method adopted by the Joint Committee of the Society of Public Analysts and the Society of Chemical Industry in 1902. The iodine titration method of Bang is not reliable, but Ramberg's bromate method gives satisfactory results if the amount of arsenious oxide to be estimated is not less than 0·01 mg.; below this amount the Marsh-Berzelius process following Ramberg's method of destruction is preferable. It is found that normal urine may contain quantities of arsenic which have been thought to be associated only with chronic arsenical poisoning; amounts present in the urine of persons on known diets varied from 0·0 up to 0·58 mg. per litre. Large excretion of arsenic is due to the eating of fish and it is shown that fish, especially plaice, may contain arsenic up to 3 parts per million. The eating of such fish leads to the appearance of quantities of arsenic in the urine within twenty-four hours.

"Estimation of Cadmium in Brass," by A. T. Etheridge, M.B.E., Ph.D. The preliminary electrolytic separation of copper and lead is effected as described by the author (*Analyst*, 1924, 49, 371). The liquid containing cadmium, zinc and other metals is treated with sulphuretted hydrogen in acid solution, sulphides are taken up, precipitated next in alkaline solution, and again treated as before in both acid and alkaline solution, and a final acid precipitation then leaves pure cadmium sulphide which is weighed after conversion into sulphate. Though the method is tedious, the purity of the product is ensured with great accuracy within 0·05 per cent. cadmium in brass.

"The 'Hoyberg' Method of Milk and Cream Testing," by N. C. Wright, B.A., and J. Golding, D.S.O. The "Hoyberg" method for determination of fat in milk and cream has been tested under carefully controlled conditions against gravimetric estimations. For milk testing the method has been found to give low and variable results, and to be unreliable for routine estimations, particularly in the hands of unskilled workers, for whose use it is chiefly designed. For cream testing, the results show a greater degree of accuracy, the errors being chiefly due to the fact that the cream is measured by volume and not by weight.

"An Apparatus for the Catalytic Dehydrogenation of Alcohols," by Stanley G. Willimott, Ph.D., B.Sc. The usual laboratory methods for the preparation of aliphatic aldehydes are shown to be unsatisfactory. An improved dehydrogenation apparatus is described, the chief advantages being: (*a*) The quantity of alcohol vapour entering the dehydrogenation tube is controlled by regulation of the boiling. The vapour passes through a heated copper spiral, and entering the tube at 300° C. is readily dehydrogenated by the copper catalyst. (*b*) The introduction of the preheater prevents liquid entering the tube with consequent cracking. (*c*) Heating of the air-bath is facilitated by employing an ordinary combustion furnace; asbestos sheeting maintains the temperature uniform.

BIOCHEMICAL SOCIETY

A meeting was held in the Physiological Department, St. Bartholomew's Hospital, E.C.1, on November 10, 1924, when the following papers were communicated:—

"On the Micro-estimation of Urea in 0·2 c.c. of Blood," by Garfield Thomas. 0·2 c.c. of blood removed from the finger is collected in a carefully calibrated pipette, and washed into a test tube with about 0·5 c.c. of water. 0·03 g. of soya bean meal is added, and this is followed by one small drop of caprylic alcohol. The tube is stoppered and placed in a water-bath at 45°—50° C. for 20—30 minutes. On removal, 0·3 grain anhydrous potassium carbonate is added and 0·5 c.c. of a saturated solution of potassium carbonate. Air freed from ammonia is then drawn through the blood into a tube containing 5 c.c. of $N/150\ H_2SO_4$. After 30 minutes the tubes are disconnected and 4 c.c. of the acid solution is removed, and titrated with $N/150$ NaOH, using a micro burette graduated into 1/100 c.c. and having a capillary outlet. Each 1/100 c.c. of sulphuric acid neutralised by ammonia corresponds to 1 mg. of urea in 100 c.c. of blood. A correction of 4 mg. of urea per 100 c.c. of blood is deducted from the value obtained on account of the ammonia liberated from the soya bean.

"The Excretion of Salicyluric Acid after the Ingestion of Sodium Salicylate by the Human Subject," by E. Holmes. Sodium salicylate was taken by the mouth, in single doses of from 2—5 g. The urine was extracted with ether after treatment by alkaline lead acetate and sulphuretted hydrogen. Crystalline material was obtained by this method, which was partly soluble and partly insoluble in hot benzol. The benzol-soluble part was identified as salicylic acid, and the benzol-insoluble portion was identified as salicyluric acid. 57 per cent. to 60 per cent. of the ether extractable salicyl appears as salicyluric acid. This percentage does not vary with the dose over the range of dosage investigated. The figures were checked by the use of Hanzlik's distillation method.

"The Effect of Irradiation of the Environment with Ultra-Violet Light upon the Growth and Calcification of Rats Fed on a Diet Deficient in Fat-Soluble Vitamins," by E. Margaret Hume and H. Henderson Smith. Rats fed on a diet deficient in fat-soluble vitamins cease to grow normally after two or three weeks. Irradiation with ultra-violet light, within approximately the first 90 days on deficient diet, causes a temporary resumption of

normal growth. The authors have previously published a paper showing that the same effect can be obtained when rats are kept in glass jars, which have previously been irradiated, and they then ascribed the growth-promoting effect to the irradiated air present in the jars. Webster and Hill were not able to confirm this result, and the authors have since found that the growth-promoting effect does not occur unless sawdust is present in the jars during irradiation. Sawdust was present in their previous experiments but its possible complicity was completely neglected. When sawdust is present in the jars during irradiation, rats grow as well as ones irradiated directly; when it is not present, the growth is similar to that of untreated controls. Calcification of the bones is found to be directly proportional to the amount of growth in such an experiment.

"The Effect of Insulin on Cholesterolaemia," by G. A. Harrison. Insulin removes the hypercholesterolaemia of diabetes mellitus. Nitzescu and others have shown that insulin does not affect the blood cholesterol of normal dogs. The writer was unable to influence the hypercholesterolaemia of two children by insulin therapy. The first case (age $4\frac{1}{2}$) was suffering from nephrosis, the second (age 9) from non-diabetic xanthoma. Both had normal blood-sugar curves and no glycosuria. The blood-cholesterol in the first varied from 347 to 544 mg. per 100 c.c. plasma with insulin, and 337 to 570 mg. without insulin. The corresponding figures for the second case were 325–496 with, and 444–520 without insulin. The xanthoma nodules, which were rich in cholesterol, were uninfluenced by the insulin (3 weeks treatment). It is concluded that so far there is no evidence against the accepted hypothesis that insulin reduces the hypercholesterolaemia of diabetes indirectly through its action on carbohydrate metabolism.

The following papers were also read:—

"Observations on Glucose and Levulose Tolerance Tests," by R. L. Mackenzie Wallis. "The Carbohydrate Enzymes of Some Starch-free Monocotyledons," by R. E. Chapman. "The Determination of the Molecular Weight of Casein by Millon's Reagent," by W. H. Hurtley. (*a*) "Demonstration of Colour Tests for Cystine"; (*b*) "An Improved Murexide Test," by W. H. Hurtley.

POWER DEVELOPMENT IN CANADA

The Nova Scotia Power Commission has awarded contracts for the hydro-electric development, at Ruth Falls, on East River, Sheet Harbour.

An American syndicate proposes erecting a large cotton mill, at the Grand Discharge, to utilise the cheap power and also plentiful supply of cheap labour which is available in the district.

The British Columbia Electric Railway Co. is installing a second power plant at Alouette Lake. The estimated cost is $2,000,000, and 11,500 h.p. will be developed.

CORRESPONDENCE

THE CHEMICAL SOCIETY

Sir,—Being fully conscious of the very considerable difficulties of the position of the Chemical Society at the present time, and with a genuine desire to avoid captious criticism, I should like to make a few comments on the subject.

It seems to me that members in general must regard their subscription to the Chemical Society as, to some extent, philanthropic, for, if one may assume that the first object of the Society is the advancement of Chemical Science by publication of new work on the subject, it follows that many members must be willing to receive a Journal, the whole contents of which cannot be of interest to them. They are probably not wholly of interest even to the most versatile of the purely scientific members. But to publish the present large output of chemical work, the Society must economise its funds, and there are still ways in which this might be done.

(1) At present, money is wasted in printing abstracts of papers which have already appeared in the Journal itself, so that certain papers are really published twice over, perhaps to the exclusion of others.

(2) The Council, in spite of strong reasons to the contrary, publishes in the Proceedings a long and absolutely useless list of titles of papers which have been received by the Society. This, besides wasting the Society's funds, prejudices these papers in two different ways, because (*a*) the process of publication is now so enormously slow that the appearance of a title in the Proceedings may easily warn an investigator in some other country, where publication is a little more expeditious, to hasten his work and get it out while the British paper is undergoing the very protracted ordeal previous to publication: and (*b*) the Council often attempts to force upon an author certain alterations, chemical or grammatical, to which the author cannot agree. The paper is then very gravely prejudiced for publication in any other journal.

(3) Economy might also be achieved by abolishing the summaries and conclusions which often appear at the end of papers. These summaries at the best are very misleading, since an author often takes a much more sanguine view of his work than do other people, and its seems absurd to print over again at the end of a paper what has already been dealt with in full. In the current (October) number of the Journal the omission of these summaries would save no less than 148 lines—more than three pages—which could quite easily be better utilised.

(4) Another economy might be effected by discontinuing the issue of the abstracts of papers which are to be read at forthcoming meetings of the Society. If funds are sufficient for the purpose, the issue of such abstracts is very useful to those who are able to attend the meeting and wish to take part in the discussion. They are, however, a mere luxury: it is infinitely more important to spend this money on the publication of original work.

(5) Taking account of the facts (i.) that London members are able to use the Society's rooms and

attend the meetings of the Society, and (ii.) that they have easy access to the library, it seems to me very reasonable that they should pay a higher subscription than provincial members, in just the same way that town members usually pay a higher subscription to a club than country members. The raising of the subscription of the London members by, say, 33 per cent., would, I am sure, not be objected to by them, although, when I made this proposal at a Council meeting some time ago, it was surprising, considering the practical nature of the suggestion, how little enthusiasm it aroused.

If, however, the effects of such an increase and of the economies mentioned above were still insufficient to enable the Society to fulfil its proper functions, the best plan is for the Council to face the matter boldly and raise the subscriptions all round—including, of course, the increased rise for London members—to such an extent as would make it possible for the Society to carry on its legitimate work.

But the foregoing suggestions deal merely with matters of immediate importance. If the Council wishes to popularise the Society and gain new members rather than lose old ones, some other fundamental and much more important reforms must be carried out.

(1) In a Society which is supposed to represent the chemical interests of the whole country, the dominance of London members is out of all proportion to their numbers, and it is of the utmost importance that the management of the Society shall be placed as soon as possible on a very much more democratic basis than it is now. At present half and, in effect, more than half—at least of the ordinary members of the Council—are drawn from a narrow circle close round London, and since it is manifestly impossible for provincial members to attend Council meetings as regularly or as easily as those resident in the neighbourhood of London, it is clear that the management of the Society is chiefly in the hands of those London members who really represent only a small minority of the members of the Society.

In addition, this dominance of London interest is greatly favoured by the fact that any alteration of a bye-law, even if approved by the Council, must be passed by a two-thirds majority at a meeting held in London in rooms which, at the best, could only contain about one-twentieth part of the members of the Society, and under circumstances which would make any attempt on the part of provincial members to exert an influence on the affairs of the Society quite impossible. It would only be fair that the number of representatives on the Council for the London district, as distinct from other districts, should be merely in proportion to the number of members resident in these districts.

(2) Another matter which seems to me of considerable importance is the status of the publication committee. The bye-laws of the Society say nothing about a publication committee, and yet the Council annually appoint a committee to which is handed over a very large share of the business of the Society, this committee being virtually elected, for the reasons mentioned above, by the London members of the Council, and it is responsible to nobody. In my view, the Council itself ought to be the publication committee, and if the Council is not able to undertake this vitally important task, representatives should be elected for the purpose, *directly by the members of the Society*.

(3) The delay which occurs at present in the publication of papers communicated to the Society has become a scandal. This is certainly unnecessary, and is merely due to the amazingly inelastic methods which characterise the Society. Even papers which are approved by referees and which ultimately appear in the Journal, practically in their original form, are now taking some five to six months in passing through prolonged and entirely useless editorial ordeals. I believe that this could, to a very large extent, be remedied; but, although suggestions to improve matters in this respect have been made, the Council of the Society seems to be too impervious to new ideas even to give them a trial.

It is to be hoped that other members of the Society will express their views on these matters.

T. S. Patterson

Organic Chemistry Department,
University of Glasgow
November 14, 1924

THEORY OF SUBSTITUTION IN AROMATIC COMPOUNDS

Sir,—During a recent discussion (*cf. Chem. and Ind.*, p. 1057), I said that the theory of induced polarities assumed that, when oxygen and nitrogen are both present, the former is the negative key-atom. Prof. Lapworth (this vol., p. 1109) disagrees with this, also (this vol., p. 769) with a similar statement previously made by Prof. Ingold (*Trans.*, 1924, **125**, 93), and bases his objection on a quotation from one of his own papers (*Mem. Manchester Lit. and Phil. Soc.*, 1920, **64**, III, p. 5). This, I find, reads in the original: "These two atoms" (divalent oxygen and tervalent nitrogen) "are as a rule, much more *effective* than the halogens, and when they are in competition, the *influence* of the oxygen usually appears greater than that of nitrogen." (The italics are mine.) Quite obviously, this paragraph merely expresses what Prof. Lapworth considers to be *observed* effects and influence *i.e.*, experimental facts; it does not deal in any way with *postulates* of the *theory*, and, therefore, cannot be adduced either in support or refutation of what Prof. Ingold and I have stated.

The corresponding postulates of the theory can, however, be gathered from publications by Prof. Robinson. Thus (Robinson, *Trans. Faraday Soc.*, 1923, XIX, 506): "Now it seems axiomatic that the more perfect or stable octets will retain their electrons more firmly than neighbouring systems in which the stability factor does not operate so advantageously. Relative high octet stability is, therefore, synonymous with relative electronegativity. As a rough guide it was suggested that the less the electrons are restrained, for example, by functioning as covalency electrons, the more stable are the octets." Further (Kermack and Robinson, *Trans.*, 1922, **121**, 435, note, and 430): "The relative normal

instability of the free electrons of the nitrogen atom accounts for the facility with which it enters into conjugated systems." "Ammonium salts will be more readily formed and more stable than oxonium salts." "The stability of free electrons in an octet appears to be the greater the larger their number, the extreme case being represented by the chlorine ion." "The tendency to form an octet is the greater the more nearly it is formed."

Now, when we compare competing tervalent nitrogen, divalent oxygen and fluorine, we find for the number of free electrons, the relative pre-formation of the octet, and also for the absence of "restraint" of the electrons through absence of "covalency bonds," the sequence :—

$$N < O < F$$

Accordingly, for the "relative stability" of the free electrons, the relative "tendency to form an octet," and the relative electro-negativity, that is the relative *postulated* tendency to function as a key atom when competing, we obtain the sequence :—

$$N < O < F, \textit{always}.$$

If, *actually*, this postulate is fulfilled only "usually" as between nitrogen and oxygen, and "as a rule" not at all between halogen and the other two, this proves, not so much that the critics of the theory of induced polarities are ignorant with regard to it, as that the theory itself is, to say the least, useless.

Prof. Lapworth, finally, asserts, without adducing the slightest proof, that my own theory of aromatic substitution is untenable. Well, I neither hold a brief for my theory, nor am I pledged to it as an article of faith, nor do I regard it in the light of a patent medicine which I must persuade others to swallow, and I am, therefore, in a position to make a sporting offer: My aromatic substitution theory and the theory of induced polarities shall, respectively be abandoned, the former when the *first*, and the latter when the *five hundredth* well-authenticated fact clearly running counter to its postulates will have been pointed out—and remained unanswered.

Fleet, Hampshire B. Flürscheim

PERSONAL AND OTHER ITEMS

The session of 1924–25 has opened in the Honours School of Chemistry at the University of Birmingham with an attendance of thirty-two students. In the Research School of Chemistry there are now twenty-eight post-graduate research workers, an unprecedented number in this department of the University. A Salter Research Fellowship, tenable at the University, has been awarded to V. E. Yarsley, B.Sc., by the Salters' Institute of Industrial Chemistry. A Lord Kitchener Memorial Scholarship has been extended to A. E. Rawson, B.Sc., for research in chemistry and chemical bacteriology. A Priestley Scholarship for chemical research has been granted to A. F. Chrisman, B.Sc.

The Institute of Physics has elected the following corporate members: Fellows—L. F. Bates, J. H. Field, C. Hughes. Associates—D. Gunnaiya, A. Subrahmaniam.

The Perkin Medal for 1924 has been awarded to Dr. H. K. Moore, chief chemist and chemical engineer for the Brown Co., and the inventor of the Moore and Allen electrolytic cell for the production of chlorine and caustic soda.

We are glad to learn that Prof. J. W. Hinchley, who recently underwent an operation for appendicitis, is making satisfactory progress. Prof. Hinchley has long been a tireless supporter of the Society of Chemical Industry and of its Chemical Engineering Group, and also took a leading part in the formation of the Institution of Chemical Engineers. All will join in wishes for his speedy recovery.

We understand that Prof. Liveing is making a satisfactory recovery from his recent accident at Cambridge.

At a meeting of the Council of the Birmingham University, the following appointments were made :— S. H. Edgar, B.Sc., and A. W. Binns, B.Sc., to be Teaching Scholars in the Departments of Chemistry and Electrical Engineering respectively, for the session 1924–25. F. J. Paton, M.Sc., to be Student Demonstrator in the Department of the Bio-Chemistry of Fermentation for the session 1924–25.

The "Smithells Fund"

Owing to the generous support which has been received, the fund raised through the University of Leeds, with the object of signalising the distinguished services of Prof. Arthur Smithells, now totals £2462, of which £1137 was subscribed by the gas industry. The commission to paint a portrait of Prof. Smithells, for presentation to the University, was placed with Mr. Fiddes Watt, R.A., and when this and other expenses have been met, a sum will be available for establishing, in the name of Prof. Smithells and on his advice, a scholarship of approximately £100 per annum within the University. The presentation of the portrait to the University will be made in the Great Hall, at 5 p.m., on November 25, when Prof. Smithells and the artist, Mr. Fiddes Watt, are expected to be present. All subscribers to the fund and the readers of this Journal will be welcome at the meeting.

Pulp and Paper in Canada

The Skeena Lumber Co., Ltd., financed by a syndicate of Minneapolis, U.S.A., capitalists, has acquired the Kleanza Co., Ltd., at Usk, Northern British Columbia, including its extensive forest limits and mineral claims, and proposes to erect a pulp and paper mill on the property.

Copper in Canada

The total production of copper in Canada during 1923 was 86,881,537 lb., or more than double that of 1922 (42,879,818 lb.). The copper refinery of the Consolidated Mining and Smelting Co., at Trail, B.C., was idle throughout the entire year.

The production of metals of the platinum group for the year 1923, in Canada, was as follows :— Platinum, 1217 oz. ($141,826); palladium, 1732 oz. ($138,560); rhodium and iridium, 304 oz. ($45,000). They were derived almost wholly from the nickel ores of Sudbury district.

Celotex Factory in Queensland

American interests have decided to establish a "celotex" factory in Queensland, to cost £300,000, which will probably be the first of several plants to make building material from sugar-cane refuse. The owners will buy sugar-cane waste from the mills at a price between 15s. and 20s. a ton, which it is thought will compensate the mill for its loss as fuel. The Premier of Queensland has invited the principals of Messrs. Dahlberg and Hutchinson, the representatives of the American owners of the patent rights for celotex, to send representatives to Queensland to inspect sites in which the Government will give assistance.

Flax-growing in the United Kingdom

The Board of Trade has appointed a Committee to consider and report on what steps can be taken to bring about the growing of flax seed and flax in the United Kingdom on a commercial scale. The members of the Committee are:—Sir Frank Warner, K.B.E. (Chairman); Mr. W. Norman Boase, C.B.E.; Mr. J. G. Crawford; Sir A. D. Hall, F.R.S.; Mr. A. L. Hetherington; Sir T. H. Middleton, K.B.E., C.B., LL.D.; and Mr. H. Mead Taylor, C.B.; together with a representative, to be appointed later, of the Ministry of Commerce of Northern Ireland. Communications should be addressed to the Secretary of the Committee, Capt. S. E. J. Brady, Board of Trade, Great George Street, London, S.W. 1.

Humidity in Cotton Cloth Factories

The Home Secretary has appointed a committee to consider and report whether any, and if so what, modifications of the existing statutory regulations governing the use of artificial humidity in cotton cloth factories are desirable and practicable. The members of the committee are: J. Jackson, O.B.E. (chairman), L. Bates, J. Cross, Dr. A. W. Crossley, C.M.G., C.B.E., F.R.S., G. Green, Dr. L. Erskine Hill, M.B., F.R.S., J. Hindle, H. Roberts, F. Scarisbrick, C. Speak, J. Stuttard and D. R. Wilson. The secretary of the committee is Mr. T. P. Threlkeld, of 72, Bridge Street, Manchester, to whom any correspondence should be addressed.

Beet-Sugar Industry

Spalding, in the Fens, has been selected as the site of a new beet-sugar factory to be built at a cost of £300,000 by the Anglo-Scottish Sugar Beet Corporation, Ltd. The Fenland soil is admirably suited for the cultivation of beet.

Synthetic Ammonia in France

At the State Powder Factory at Toulouse, a plant for the synthesis of ammonia by the Haber process is being erected and the French Government is negotiating with the Société des Produits Chimiques d'Alais for the erection in the same factory of a plant to produce 120 metric tons a day by the Casale process. The Société de la Grande-Paroisse, however, has instituted proceedings to contest the validity of the Casale patents and it is believed that the Société des Produits Chimiques d'Alais intends to proceed against the former company.

Mineral Output in Tasmania, 1923

The aggregate value of minerals raised during the year was £1,219,546, being an increase of £206,041 as compared with 1922. The principle decreases were in carbide, £70,789; silver, £37,098; and osmiridium, £15,870. The following are the amounts of the various minerals produced in 1923:—Gold, 3,684.124 oz.; osmiridium, 673.423 oz.; silver, 638,601·61 oz.; lead, 4,784.057 t.; copper, 6064·7 t.; tin, 1160·39 t.; coal, 80,718 t.; wolfram, 96,86 t.; shale, 1101 t.; iron pyrites, 11,882 t.; carbide, 3236 t.; and limestone, 100,113 t.

The Ph.D. Degree in Australia

The University of Melbourne is discussing a proposal to establish the degree of the Ph.D. in order to encourage higher studies and research. In Melbourne the encouragement of research has been mainly dependent upon a grant of £2000 a year from the State Treasury. This grant was discontinued during the war, and it was not restored until the University Act was passed. The great influx of undergraduates which followed after the war made it impossible to give any attention to research. The need for students who have been trained in methods of research has increased, however, in Australia, just as it has in other countries, and many of the manufacturing industries will require for their direction, technologists capable of holding their own with the highly trained technologists of competing countries. In order to meet the criticisms that "a cheap doctorate" was being set up, the requirements of the proposed degree are to be "more exacting than those of most of the English Universities," and the standard prescribed is in fact so high that none but a very able student could expect to attain to it.

BRITISH INDIA

Second Sugarcane Forecast, 1924-25

From reports received from provinces and states which contain on an average 93 per cent. of the total area under sugarcane in India, the area is estimated to amount to 2,600,000 acres, compared with 2,787,000 acres at the same time last year, or a decrease of 7 per cent. Conditions have not been quite favourable, but the crop is on the whole reported to be fair.

First Groundnut Forecast, 1924-25

Madras, Burma and Bombay, which comprise 89 per cent. of the total area under groundnut in India, report the total area sown to be 2,163,000 acres (1,687,000 acres in 1923-24). Weather conditions have been favourable and the condition of the crop is reported to be good.

Second Forecast, Sesamum Crop, 1924-25

The total area so far reported for the present season is 3,205,000 acres, as against 3,016,000 acres this time last year, an increase of 6 per cent. The present condition and prospects of the crop are fairly good.

REVIEW

STANDARD METHODS OF TESTING PETROLEUM AND ITS PRODUCTS. Pp. x+100. Report published by the Institution of Petroleum Technologists. London: W. Speaight and Sons, Ltd., 1924. Price 6s.

No one who is technically associated with the petroleum industry could fail to appreciate the work carried out by the Committee of the Institution of Petroleum Technologists in their attempt to standardise the methods of testing.

No one could undervalue the importance of standardisation of tests. The Committee, which was responsible for collecting, comparing and evolving the tests as contained in this volume, was composed of gentlemen of such standing and high attainments in the petroleum industry that the recommended methods of testing are bound to be adopted by all interested in the trade.

If it were not for the fact that, for instance, the distillation test was to be made standard, one might conceivably have some objections as to the somewhat unscientific tolerances allowed, both in temperature and in percentages of distillate taken off, also as to the method of obtaining the initial boiling point of a liquid like petrol, but as long as everyone in the industry carries out the tests by the same standard method it will, presumably, enable the purchaser to compare the values of various petrols without any back thoughts as to variation of tests. On the corrosion test (I.P.T. Serial Designation—G. 32), one notes that the Committee of the Institution of Petroleum Technologists was only concerned with ascertaining the degree of corrosion if the gasolene contains dissolved elementary sulphur or corrosive sulphur compounds. Since, however, considerable quantities of gasoline on the English market contain chlorine compounds with a deleterious effect on steel and iron, the copper dish test would not give the same results, and it would be interesting if the Institution of Petroleum Technologists' Standardisation Committee worked out a method for testing both the percentage of chlorine present and the effect on iron and steel.

N. A. ANFILOGOFF

COMPANY NEWS

CASSEL CYANIDE CO., LTD.

A final dividend of 9d. per share has been recommended by the directors of this company, making, with the interim dividend paid in June last, 1s. per share for the year, less tax, payable on December 11.

LIVERPOOL NITRATE CO., LTD.

The annual report for the year to June 30, 1924, shows a gross profit of £188,235, an increase of £55,628. The net profit was £108,157, after providing for all charges, including stoppage and reopening expenses of £17,342, repairs and renewals £6617, and £21,812 compensation to the nitrate pool. A final dividend of 3s. per share is proposed, making 22½ per cent. on an issued capital of £350,000, compared with 15 per cent. on £292,275, leaving, after writing off properties £24,283, and placing £24,669 to reserve, a balance of £16,704 to go forward, against £18,529 brought in. The reserve now amounts to £150,000, and the share premium reserve is £98,637.

REPORTS

REPORT OF H.M. ELECTRICAL INSPECTOR OF MINES FOR THE YEAR 1923. Mines Department. Pp. 21. H.M. Stationery Office, 1924. Price 6d.

The Report gives a summarised description of the fatal accidents to which the use of electricity was a direct or a contributing cause, that occurred during the year ending December 31, 1923. It also includes certain comments upon the non-fatal electrical accidents and dangerous occurrences covering the same period of which information has been received. The following summary, from the annual returns, shows the position as compared with the preceding year as to the use of electricity at all mines under the Coal Mines Act, 1911:—

	1922	1923
Number of mines at work	2,911	2,902
Number of mines using electricity	1,557	1,598
H.P. motors in use above ground	552,148	611,607
H.P. motors in use below ground	688,026	753,138
Total	1,240,174	1,364,745

During the year 1923, there were 14 fatal accidents, causing the loss of 15 lives, two of which occurred above and 12 below ground.

THIRD ANNUAL REPORT OF THE SECRETARY FOR MINES FOR THE YEAR ENDING DECEMBER 31, 1923, and the ANNUAL REPORT OF H.M. CHIEF INSPECTOR OF MINES FOR THE SAME PERIOD WITH A STATISTICAL APPENDIX TO BOTH REPORTS. Mines Department. Pp. 195. H.M. Stationery Office, 1924. Price 6s. 6d.

This report, which marks the completion of the third year of the existence of the Mines Department, contains in addition to the report of the Chief Inspector of Mines, a review of matters outside his province. Part 1 is devoted to a review of the coal-mining industry during 1923, and of the operation of the National Wages Agreement; and colliery developments, legislation, including the Mines (Working Facilities and Support) Act, 1923, and the Royal Commission on Mining Subsidence, are also dealt with. The mines working under the Coal Mines Acts in Great Britain numbered 2902 and there were 369 mines working under the Metalliferous Mines Regulation Acts, and 5431 quarries working under the Quarries Act, 1894. Workers employed at all mines in Great Britain and the Isle of Man during 1923 numbered 1,236,185, and in addition 74,438 were employed at quarries under the Quarries Act. Of the persons employed at mines, 988,892 worked underground and 247,293 above ground. The numbers of persons killed and injured in accidents was 1387 and 218,891 respectively, the former being 227 more and the latter 28,642 more than in 1922, including

1297 fatal and 212,256 non-fatal accidents at coal mines.

The output of minerals in the United Kingdom is shown in the appended table :—

	1923 Tons		1922 Tons
Coal	276,000,560	..	249,606,864
Iron ore and ironstone.. ..	10,875,211	..	6,836,507
Tin ore, dressed (Black Tin) ..	1,760	..	650
Lead ore, dressed	12,499	..	11,079
Zinc ore, dressed	2,124	..	1,620
Tungsten ore, dressed	2	..	3
Uranium ore	4	..	393
Copper precipitate	138	..	167
Manganese ore	2,021	..	250
Chromite	546	..	595

	1923 Tons		1922 Tons
Minerals for chemical and allied industries ;			
Arsenic (white) and arsenic soot	1,605	..	978
Arsenical pyrites	729	..	354
Iron pyrites	6,908	..	5,669
Bog ore	17,839	..	32,189
Ochre, umber, etc.	10,293	..	9,036
Salt	1,976,796	..	1,871,397
Barytes and witherite :			
(*a*) Not ground	15,402	..	17,672
(*b*) Ground	28,095	..	23,277
Celestine (Strontium Sulphate)	6,346	..	4,711
[illegible]osum	317,676	..	257,460
C[illegible] clay	720,533	..	666,834
M[illegible] lay	18,270	..	12,984
Potters' clay	210,445	..	166,357
China stone	51,343	..	38,921
Felspar	3,246	..	830
Felsite	38,155	..	51,775
Calcspar	9,083	..	6,453
Alum shale	4,859	..	2,487
Soapstone	186	..	50
			lb.
Jet		.	130
			Tons
Oil shale	2,860,633	..	2,603,996
Petroleum	136	..	125
	Cb. ft.		Cb. ft.
Natural gas	100,000	..	100,000
Minerals used in making and steel making and other smelting processes ;			
	Tons		Tons
Fluorspar	49,031	..	33,343
Ganister (including silica rock, silica stone and silica sand used as refractories) ..	591,348	..	279,882
Moulding and pig-bed sand..	430,605	..	195,345
Fireclay	2,120,310	..	1,824,201
Minerals for building and road-making and for all other purposes ;			
Limestone	11,431,552	..	9,418,678
Chalk	3,598,354	..	3,024,448
Sandstone	2,282,858	..	2,140,301
Slate	205,147	..	231,410
Clay and shale	8,500,730	..	6,407,715
Chert, flint, etc.	87,125	..	54,151
Gravel and sand	2,517,354	..	2,058,539
Igneous rocks	6,747,046	..	5,927,964

Coal.—The average commercial pithead price of all coal in 1923 was 19s. 9½d. per ton, or about 1s. per ton more than in 1922, and the average declared value of coal exported for the year was 25s. 2d. per ton f.o.b., or 2s. 7d. more than in 1922. The total quantity of coal shipped abroad was 78 million tons, and of coke 4 million t., greatly exceeding the quantities exported during the previous year. The coal available for consumption in Great Britain was 168¾ million t., including 23¼ million t. used at the mines or supplied to the miners, but not including coal used in making coke and patent fuel subsequently exported. The output of coal was 276,000,000 t. (249,606,864 t. in 1922). With the exception of holiday periods and the period from the end of June to the middle of September, the weekly output of coal never fell below 5¼ million t. : in one week in April, it rose to 5,825,000 t. and in one week in December, to 5,956,000 t.

Iron.—The output of pig iron was 7,440,500 t., from an average of 203 furnaces in blast compared with 4,902,300 t. in 1922, with an average of 132 furnaces, and 10,260,300 t. with 338 furnaces in 1913. During the first six months 439,676 t. was exported, but during the latter half of the year exports fell to 286,150 t., the total for the year being 725,826 t. (excluding ferro-alloys). In 1922 the corresponding figure was 651,079 t., and for 1913, 945,262 t. The steel output for the year was 8,481,800 t., an increase of 44 per cent. on that for 1922. The number of persons employed in the mining and quarrying of iron ore and ironstone at the end of each quarter of the year 1923 . as 15,775, 16,296, 15,488 and 15,413.

Tin.—The production of dressed tin ore ("black tin") for the four quarters of the year showed a progressive increase, being 175 t., 330 t., 527 t., and 727¼ [illegible]., respectively, or a total for the whole year of [illegible],60 t.

Lead.—Of some t[illegible]nty mines in operation during the year, six produced 82 per cent. of the total output of dressed lead ore, which was 12,499 t.

Zinc.—The production of zinc ore (45 per cent. metal) remained small in 1923, amounting to only 2124 t. Although this was an increase of 31 per cent. on the output of 1922, it was only 12·28 per cent. of the production of 1913.

Minerals used in the Chemical and Allied Industries showed almost without exception an improvement in production. The total amount of white arsenic and arsenic soot was 1605 t., and of barytes 43,497 t. The output of oil shale in 1923 continued to improve, the tonnage rising by 10 per cent. to 2,860,633 t.

Minerals used for iron and steel making and other smelting processes.—The returns under the head of limestone and dolomite show that of 11,431,552 t., 3,461,964 t. or 30 per cent. were used for fluxing purposes and 372,760 t. or 3·3 per cent. for refractory purposes. The export of fluorspar remained active.

Part III of the Report deals with health and safety in the mining and quarrying industries, and Part IV with the washing and drying accommodation at mines.

A decree has been passed at Oxford University to make a grant of £3000 towards the expense of erecting a block of buildings between the departments of physiology and bio-chemistry, to act as a lecture room, library and workshop for both of these departments.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 10s. per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate / Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¼d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphite conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	6½d.—1s. 2d. per lb., according to quality.
Crimson	1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes White and Dark	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P.	£47 10s.—£52 10s. per ton, according to quantity.
Sulphur Chloride	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

There is a general feeling that the fall in price of acetates during the last few weeks has reached its limit. The tendency is now to stiffen again.

Acetate of Lime—	
Brown	£11 10s. per ton, and upwards.
Grey	£14 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand quiet but price steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 9d. per gall. 60% O.P.
Solvent	5s. per gall. 40% O.P. Firmer.
Wood Tar	£4—£5 per ton. Very quiet.
Brown Sugar of Lead	£41 per ton. Steady market.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d. per lb. Quiet.
Crude 60's	1s. 8d.—1s. 10d. per gall. Market flat.
Acid Cresylic, 97/99	2s. per gall. Fair business at slightly easier prices.
Pale 95%	1s. 8d.—1s. 11d. per gall. More enquiry.
Dark	1s. 8d.—1s. 10d. per gall. Market dull.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6½d.—7½d. per gall. Small demand
Unstrained	6d.—6½d. per gall.

Benzole—

Crude 65's ..	.. 7½d.—9d. per gall. ex works in tank wagons.
Standard Motor	.. 1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Pure	.. 1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90% ..	.. 1s. 5½d.—1s. 7d. per gall. More inquiry.
Pure ..	.. 1s. 7d.—1s. 9d. per gall. Small demand for home consumption.
Xylol—Coml. ..	.. 2s. 3d. per gall.
Pure ..	.. 3s. 3d. per gall.

Creosote—

Cresylic 20/24%	.. 8d.—8½d. per gall. Little demand.
Middle Oil ..	.. 5¼d.—6¼d. per gall., according to quality and district. Market firmer.
Heavy Oil ..	..
Standard Specification	

Naphtha—

Solvent 90/160	.. 1s. 3d.—1s. 4d. per gall. Demand good. Higher prices probable.
Solvent 90/190	.. 11½d.—1s. 1d. per gall. Demand maintained.

Naphthalene Crude—

Cheaper in Yorkshire than Lancashire. Demand rather better.

Drained Creosote Salts	£3—£5 per ton. Demand slightly better.
Whizzed or hot pressed	£6—£9 per ton. Demand very poor.

ohthalene—

Crystals and Flaked ..	£12—£15 per ton, according to district.
Pitch, medium soft	.. 42s. 6d.—60s. per ton according to district. Plenty of inquiry. Prospects brighter.
Pyridine 90/160	.. 18s. 6d.—19s. per gall. Steady demand.
Heavy	.. 11s. 6d.—12s. per gall. More inquiry.

INTERMEDIATES AND DYES

Business in dyestuffs has increased considerably and the outlook is decidedly better.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 7d. per lb.
Acid H.	.. 3s. 10d. per lb. 100% basis d/d.
Acid Naphthionic	.. 2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	.. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic	.. 9d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil ..	.. 8d. per lb. naked at works.
Aniline Salts	.. 8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base ..	.. 3s. 10d. per lb. 100% basis d/d.
Benzyl Chloride 95%	.. 1s. 1d. per lb.
p-Chlorphenol ..	.. 4s. 3d. per lb. d/d.
p-Chloraniline ..	.. 3s. per lb. 100% basis.
o-Cresol 19/31° C.	.. 4d.—4½d. per lb. Rather quiet.
m-Cresol 98/100%	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline ..	.. 3s. per lb.
Dichloraniline S. Acid	.. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol ..	.. £85 per ton.
Diethylaniline ..	.. 4s. 3d. per lb. d/d., packages extra, returnable.
Dimethylaniline ..	.. 2s. 2½d. per lb. d/d. Drums extra.
Dinitrobenzene ..	.. 9d. per lb. naked at works.
Dinitrochlorbenzol	.. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine ..	.. 2s. 10d. per lb. d/d.
G. Salt.	.. 2s. 3d. per lb. 100% basis d/d.
Monochlorbenzol ..	.. £63 per ton.
α-Naphthol ..	.. 2s. 4d. per lb. d/d.
β-Naphthol ..	.. 1s. per lb. d/d.
α-Naphthylamine	.. 1s. 3½d. per lb. d/d.
β-Naphthylamine	.. 4s. per lb. d/d.
m-Nitraniline ..	.. 4s. 2½d. per lb. d/d.
p-Nitraniline ..	.. 2s. 2½d. per lb. d/d.
Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene	.. 10d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 4s. per lb. d/d.
p-Phenylene Diamine	.. 10s. per lb. 100% basis d/d.
R. Salt	.. 2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 2d. per lb. 100% basis d/d.
o-Toluidine ..	.. 10d. per lb.
p-Toluidine ..	.. 2s. 10d. per lb. naked at works.
m-Toluylene Diamine	.. 1s. per lb. d/d

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £45 per ton, ex wharf London, in glass containers.
Acid, Acetyl Salicylic	.. 3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P.	.. 2s. 6d. per lb.
Acid Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric ..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 4d. per lb., less 5% for ton lots. Market still weak.
Acid, Gallic ..	.. 2s. 9d. per lb. for pure crystal in 2 cwt. lots.
Acid, Pyrogallic, Cryst.	.. 6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	.. 1s. 6d.—1s. 8d. per lb., according to quantity. Slightly firmer.
Acid, Tannic B.P.	.. 2s. 10d. per lb. Forward quotations higher spot value likely to increase.
Acid, Tartaric ..	.. 1s. per lb., less 5%.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 1s. 10d.—2s. per lb. More enquiry.
Amidopyrin ..	.. 15s. per lb.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone	.. 13s. 9d. per lb. Slightly lower. Quiet steady demand.
Benzonaphthol ..	.. 5s. 3d. per lb. spot.
Bismuth Carbonate	.. 8s. 6d.—10s. 6d. per lb.
„ Citrate ..	.. 8s. 6d.—10s. 6d. „
„ Salicylate	.. 8s. 6d.—10s. 6d. „
„ Subnitrate	.. 7s. 9d.—9s. 7d. „
	According to quantity. Prices again reduced owing to fall in the metal.
Borax B.P. ..	.. Crystal £20, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Very scarce and dear. Prices uncertain.
Ammonium ..	.. 2s. 1d. per lb.
Potassium ..	.. 1s. 11d. per lb.
Sodium ..	.. 2s. per lb.
Calcium Lactate ..	.. 1s. 7d.—2s. per lb., according to quantity. Fair demand and steady market.

Chloral Hydrate	4s. per lb.
Chloroform	2s. 6d. per lb. for cwt. lots.
Formaldehyde	£48—£49 per ton in barrels, ex wharf London.
Glycerophosphates—Calcium, soluble and citrate free	Fair business passing. 7s. per lb.
Glycerophosphates—	
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. ,,
Guaiacol Carbonate	9s. 9d. per lb.
Hexamine	3s. per lb. Forward prices higher.
Homatropine Hydrobromide	25s.—30s. per oz.
Hydrastine hydrochlor	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£25 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	60s. per lb. for December delivery. No spot deliveries available.
Synthetic	26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials	Market very quiet.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	1s. 10d.—2s. per lb.
Methyl Sulphonal	22s. 6d. per lb. Slightly weaker.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 8d. per lb. for B.P. quality.
Paraldehyde	1s. 4½d.—1s. 6d. per lb. in free bottles and cases. Supplies plentiful.
Phenacetin	5s. 6d. per lb.
Phenazone	6s. 9d. per lb. Cheaper owing to competition.
Phenolphthalein	5s. 6d. per lb. for cwt. lots. Supply exceeds demand.
Potass. Bitartrate—99/100% (Cream of Tartar)	84s. per cwt., less 2½% for ton lots.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Ferricyanide	1s. 9d. per lb. Quiet.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	7¼d. per lb. spot. Forward prices higher.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 3d. per lb.
Saccharin	[illegible]3s. per lb., in 50-lb. lots.
Salol	[illegible]s. 9d. per lb. for cwt. lots.
Silver Proteinate	9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P.	2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Fair demand. Powder 2s.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 5d. per lb. Flake 2s. 6d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.
Sulphonal	14s. 6d. per lb. Little demand.
Thymol	16s. 9d. per lb. Firmer market.

PERFUMERY CHEMICALS

Acetophenone	12s. per lb.		
Aubepine	15s. 3d.	,,	
Amyl Acetate	3s. 6d.	,,	Much dearer.
Amyl Butyrate	7s.	,,	Dearer.
Amyl Salicylate	3s. 3d.	,,	
Anethol (M.P. 21/22° C.)	4s. 6d.	,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d.	,,	
Benzyl Alcohol free from Chlorine	2s. 9d.	,,	
Benzaldehyde free from Chlorine	3s. 6d.	,,	
Benzyl Benzoate	3s. 6d.	,,	
Cinnamic Aldehyde—Natural	18s. 9d.	,,	
Coumarin	18s. 9d.	,,	
Citronellol	17s.	,,	
Citral	8s.	,,	
Ethyl Cinnamate	12s. 6d.	,,	
Ethyl Phthalate	3s. 3d.	,,	
Eugenol	10s.	,,	
Geraniol (Palmarosa)	33s. 6d.	,,	
Geraniol	11s. 6d.—18s. 6d. per lb.		
Heliotropine	6s. 9d.	,,	
Iso Eugenol	16s.	,,	
Linalol ex Bois de Rose	26s.	,,	
Linalyl Acetate	26s.	,,	
Methyl Anthranilate	9s. 6d.	,,	
Methyl Benzoate	5s.	,,	
Musk Ambrette	50s.	,,	Dearer.
Musk Xylol	13s. 6d.	,,	
Nerolin	4s. 9d.	,,	
Phenyl Ethyl Acetate	15s.	,,	
Phenyl Ethyl Alcohol	16s.	,,	
Rhodinol	55s.	,,	
Safrol	1s. 10d.	,,	
Terpineol	2s. 4d.	,,	
Vanillin	25s. 6d.	,,	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 10d. per lb.
Bergamot Oil	16s. per lb.
Bourbon Geranium Oil	35s. per lb.
Camphor Oil	65s. per cwt.
Cananga Oil Java	11s. per lb.

Cassia Oil, 80/85%	.. 9s. 9d. per lb.	
Cinnamon Oil, Leaf	.. 6½d. per oz.	
Citronella Oil—		
Java 85/90% ..	.. 5s. 10½d. „	
Ceylon ..	.. 3s. 8d. per lb.	
Clove Oil	.. 8s. 3d. per lb.	Dearer.
Eucalyptus Oil 70/75% ..	2s. 3d. per lb.	
Lavender Oil—		
French 38/40% Esters	35s. per lb.	Dearer.
Lemon Oil ..	.. 3s. 2d. per lb.	
Lemongrass Oil ..	.. 5s. per lb.	
Orange Oil, Sweet	.. 11s. per lb.	
Otto of Rose Oil—		
Bulgarian ..	.. 40s per oz	
Anatolian ..	.. 18s. per oz.	
Palma Rosa Oil ..	.. 16s. 6d. per lb.	
Peppermint Oil—		
Wayne County	.. 35s. per lb. nominal.	
Japanese ..	.. 22s. 6d. per lb. nominal.	
Petitgrain Oil ..	.. 9s. 9d. per lb.	Dearer.
Sandal Wood Oil—		
Mysore	.. 26s. 7d. per lb.	
Australian ..	.. 18s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than January 12th, they are on sale at 1s. each at the Patent Office Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on November 27th.

I.—Applications

Bohme Akt.-Ges. Treatment of materials with liquid. 26,521. Nov. 6. (Ger., 13.11.23.)

Bullen. Drying-cylinders. 26,587. Nov. 7.

Imray (Soc. of Chemical Industry in Basle). Process of making disperse systems. 26,215. Nov. 3.

Ironside. Extraction and adsorber plant. 26,714. Nov. 8.

Pinn. Furnaces. 26,337. Nov. 5.

Testrup, and Techno-Chemical Laboratories, Ltd. Interchange of heat. 26,314. Nov. 4.

Testrup and Thomson. Treatment of liquids. 26,524. Nov. 6.

I.—Complete Specifications Accepted

14,676 (1923). Woosnam. Furnaces. (223,918.)

19,870 (1923). New Eccles Rubber Works, Ltd., and Cox. Containers for storing acids, corrosive liquids, and the like. (223,997.)

26,171 (1923). Heimsoth und Vollmer Ges. Reverberatory furnaces. (206,144.)

27,679 (1923). Dorman, Long and Co., Ltd., Roelofsen, and Lowe. Production of fractional distillation. (224,085.)

32,195 (1923). Serive. Rotary drying and torrefying apparatus. (224,111.)

12,541 (1924). Brown and Son (Huddersfield), Ltd., and Child. Tube mills, rotary kilns, rotary screens, and the like. (224,173.)

II.—Applications

Asphalt Cold Mix, Ltd., and Levy. 26,171. See IX.

Chaney and Neath. Distillation of coal. 26,718. Nov. 8.

Chemical Engineering Co. (Manchester), Ltd., Battersby, and Spensley. Refining or clarifying oils. 26,143. Nov. 3.

Dvorkovitz. Manufacture of hard coke. 26,176. Nov. 3.

Glasgow, Stelfox, and Humphreys and Glasgow. Manufacture of water-gas. 26,196. Nov. 3.

Hartung. 26,320. *See* XXIII.

Harvey and Holford. Dehydrators for treating oils. 26,719. Nov. 8.

Ingman, and Midland Coal Products, Ltd. Manufacture of briquetted fuel. 26,578. Nov. 7.

Rice. Solid fuel. 26,140. Nov. 3.

II.—Complete Specifications Accepted

30,289 (1923). White (General Motors Research Corp.). Fuels for internal-combustion engines. (224,102.)

2694 (1924). Syndikat für Gastorschung. Dry distillation of bituminous fuel. (210,797.)

2760 (1924). Gros. Pyrogenic transformation of acetylene or gaseous mixtures containing acetylene. (211,461.)

13,135 (1924). Spencer-Bonecourt, Ltd., and Gregson. Installations for carbonising coal or other fuel. (224,179.)

IV.—Applications

Bloxam (Akt.-Ges. für Anilin-Fabrikation). Manufacture of quinonoid derivatives of 2:1-naphthophenothiazine. 26,629. Nov. 7.

Carpmael (Farbenfabr. vorm F. Bayer und Co.). Manufacture of dyestuffs. 26,715. Nov. 8.

Johnson (Badische Anilin- u. Soda-Fabrik). Manufacture of vat colouring-matters. 26,530. Nov. 6.

IV.—Complete Specifications Accepted

2379 (1924). Soc. of Chemical Industry in Basle. Manufacture of a thionaphthisatin and its intermediate products. (240,465.)

3548 (1924). Soc. of Chemical Industry in Basle. Manufacture of a thionaphthisatin and its intermediate products. (219,276.)

V.—Applications

Akt.-Ges. für Anilin Fabrikation. Manufacture of lustrous threads. 26,627. Nov. 7. (Ger., 14.11.23.)

Cellon Werke Dr. A. Eichengrün. Production of thin films of cellulose derivatives. 26,329. Nov. 4.

V.—Complete Specifications Accepted

17,125 (1923). Lilienfeld. Manufacture of cellulose solutions. (216,475.)

16,512 (1924). Akt.-Ges. für Anilin-Fabrikation. Manufacture of viscose silk. (220,282.)

VI.—Application

Leontieff. Steaming and ageing textile fabrics etc. 26,183. Nov. 3.

VI.—Complete Specification Accepted

26,158 (1923). British Dyestuffs Corp., Baddiley, Shepherdson, Swann, Hill, and Lawrie. Dyeing acetyl cellulose or fabrics containing the same. (224,077.)

VII.—Applications

Calder, and Chance and Hunt, Ltd. Manufacture of sulphuric acid. 26,435. Nov. 5.

Naamlooze Vennootschap Handelmaatschappij Grikro. Manufacture of zinc oxide. 26,660. Nov. 7. (Ger., 3.12.23.)

Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Manufacture and purification of hydrogen. 26,286, 26,399. Nov. 4-5. (Fr., 3.6.24 and 5.8.24.)

VII.—Complete Specifications Accepted

20,385 (1923). Gaillard. Manufacture of sulphuric acid. (202,629.)

7484 (1924). Kassner. Catalytic oxidation of ammonia. (213,571.)

11,039 and 11,040 (1924). Quartz et Silice. Manufacture of articles in silica glass. (224,163 and 224,164.)

IX.—Applications

Asphalt Cold Mix, Ltd., and Levy. Bituminous emulsions. 26,171. Nov. 3.

Giromard. Manufacture of Portland cement. 26,271. Nov. 4.

Rigby. Manufacture of cement. 26,675. Nov. 8.

Twynam. Manufacture of bricks and tiles. 26,112. Nov. 3.

IX.—Complete Specification Accepted

23,111 (1923). Brown. Prevention of dry rot and wet rot in timber and wood. (224,043.)

X.—Applications

Borchers and Stimson. Manufacture of alloys. 26,465. 26,550. Nov. 6.

British Thomson-Houston Co., Ltd. Methods of treating metals. 26,418. Nov. 5. (U.S., 6.11.23.)

Greenawalt. Method of treating ores etc. 26,424. Nov. 5.

Stimson. Manufacture of alloys. 26,551. Nov. 6.

X.—Complete Specifications Accepted

18,944 (1923). Chemical Treatment Co. Desulphurising iron, steel, ferro-alloys, and other metals. (201,555.)

19,208 (1923). Schmidt. Separating particles of metal from a mixture of metallic oxide and metal. (223,969.)

19,838 (1923). Bengough and Stuart. Protecting surfaces of aluminium or aluminium alloys. (223,994.)

19,839 (1923). Bengough and Stuart. Producing a coloured surface on aluminium or aluminium alloys. (223,995.)

25,584 (1923). Coignard. Obtaining a deposition of chromium by electrolysis. (224,065.)

26,171 (1923). Heimsoth und Vollmer Ges. See I.

26,960 (1923). Metallisation, Ltd. (Meurer'sche Akt.-Ges. für Spritzmetall-Veredelung). Welding aluminium. (206,162.)

XI.—Application

Richards, Wythers, and Siluminite Insulator Co. Electric insulating-materials. 26,224. Nov. 3.

XI.—Complete Specification Accepted

25,584 (1923). Coignard. See X.

XII.—Applications

Chemical Engineering Co. (Manchester), Ltd., Battersby and Spensley. 26,143. See II.

Duclaux. Purification and decoloration of oils and fats. 26,205. Nov. 3. (Fr., 2.11.23.)

Harvey and Holford. 26,719. See II.

XIII.—Applications

Evans. Separation of foreign matter from gum etc. 26,324. Nov. 4.

Phillip. Production of paints, varnishes, etc. 26,639. Nov. 7.

XIII.—Complete Specifications Accepted

19,333 (1923). Risler. Process for obtaining phosphorescence in luminous paints. (207,786.)

19,591 (1923). Consort. f. Elektro-Chem. Industrie. Process of improving resins. (201,916.)

2787 (1924). Evans. Separation of kauri gum from foreign matter. (224,131.)

XIV.—Applications

Falls. Rubber etc. substitutes. 26,382. Nov. 5.

Warren. Production of metallised surfaces on rubber etc. 26,517. Nov. 6.

XVI.—Application

Soc. Chimique de la Grande Paroisse, Azote et Produits Chimiques. Manufacture of fertilisers. 26,401. Nov. 5. (Fr., 13.3.24.)

XVII.—Application

20,048 (1923). Dextrin Automat Ges. Liquefaction and saccharification of starch. (215,705.)

XIX.—Application

Milkal, Ltd., and Sierra. Apparatus for manufacturing milk etc. powder. 26,913. Nov. 3.

XIX.—Complete Specifications Accepted

21,478 (1923). Muller. Desiccation of vegetable material. (224,025.)

22,631 (1923). Stevenson. Preserving milk and other liquids. (224,037.)

XX.—Applications

Fernando. Medicinal compound. 26,295. Nov. 4.

Imray (Farbwerke vorm. Meister, Lucius, und Bruning). Manufacture of water-soluble condensation products. 26,730. Nov. 8.

Imray (Soc. of Chemical Industry in Basle). Manufacture of esters of unsaturated acids. 26,628. Nov. 7.

XX.—Complete Specification Accepted

16,634 (1924). Akt.-Ges. für Anilin-Fabrikation. Manufacture of vanillin. (219,676.)

XXIII.—Application

Hartung. Gravimetric analyses of gas. 26,320. Nov. 4.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*Australia:* Glassware, chinaware, (503); *British West Indies:* Soap, china and earthenware, (505); *Canada:* Iron and lead pipe, rubber, (508); Oils, (Canadian Government Trade Commissioner's Office, Portland House, 73, Basinghall Street, London, E.C. 2); *France:* Leather, oils, (513); *Germany:* Hardware, (516); Heavy chemicals (517); Pig iron, tinplate, (518); *Netherlands:* Iron and steel, (525).

Notes on Plant and Products.

Messrs. Fullerton, Hodgart and Barclay, Ltd., of Paisley, have received an order from a large firm of soap manufacturers in Germany for a patent double effect evaporator plant for the production of glycerine from spent lyes. Prior to 1914 a similar plant was delivered and erected for the same firm in Dusseldorf; the present order is thus a repeat, but for a larger installation. The present order will make the sixth to be supplied to Germany.

Protection of Industrial Property

In consequence of the accession of Greece to the International Convention for the Protection of Industrial Property, an Order in Council was made on October 9, 1924, applying the provisions of Section 91 of the Patents and Designs Act, 1907, as amended by the Patents and Designs Act, 1914, and the Patents and Designs Act, 1919, to Greece, from October 2, 1924. A copy of the Order may be seen in the Patent Office Library, 25, Southampton Buildings, Chancery Lane, London, W.C. 2.

Similar orders have been made in respect of Syria and Lebanon, owing to the accession of these countries to the International Convention for the Protection of Industrial Property.

PUBLICATIONS RECEIVED

Production of Explosives in the United States during the calendar year 1923, with notes on Mine Accidents due to Explosives. By W. W. Adams. Pp. 32. Technical Paper 358. Price 5 cents.

Die Fermente und ihre Wirkungen. By Prof. C. Oppenheimer, with a section on Physical Chemistry and Kinetics. By Dr. Richard Kuhn. Fifth edition revised. Part III. Pp. 321-48. Leipzig: G. Thieme, 1924. Price $1·90.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

VOL. 43 NEW SERIES — LONDON, NOVEMBER 28, 1924 — NO. 48

EDITORIAL

NOTABLE feature of modern life is the production of great numbers of books devoted to technical and scientific subjects and ngst these chemistry holds a very large place. o of these books are excellent, some are good, and some are merely indifferent. Milton believed that a good book is the precious life-blood of a master, and in Milton's day, when the audience was sm-ll and very critical, many books doubtless mei ed this description. To-day the audience is so vast and the subjects and the writers about them have become so numerous, that the leisurely transfusion of life-blood into a masterpiece has become impossible. Publishing has become a business, and writing has, too, in a way. Most modern books, even novels, attempt to expound a theory or elucidate a technical problem, and on every side authors are to be found addressing their audience from a special point of view. Few can afford the time or expense to read every book which appears and so most are willing to delegate the work of appraisement to the reviewer. Our reviewers have, in many ways, a difficult task. Usually busy men, they willingly give up a considerable portion of their all-too-scanty leisure to read carefully the works we send them and write down their impressions fairly and conscientiously. We know the trouble they take, how eager they are to discern merit or to reprove error. They have our warmest thanks and, knowing the interest taken in our reviews of books, we are sure that our readers appreciate their service, too. have abundant evidence of the closeness with ch our reviews are read and this has induced us levote considerable space in this issue to review a number of interesting books. For further information we have published some notes on the more important publishing firms, and. as we so often receive requests for particulars of books on chemical subjects, we have printed a list of all the books which have been reviewed in our columns—and this means practically all the books published during the past twelve months. The literature of chemistry is growing so rapidly that some kind of guide is necessary and we believe that this list will be a useful feature of the *Journal*.

* * *

The notes on the various firms which publish chemical books remind us that the public attitude to publishers has changed very much since Longmans were founded two centuries ago. In those days publishers were booksellers and it was customary, when any large work was to be published, for two or three publishers to issue a joint edition. This admixtu of the two sides led people to talk contemptuously of publishers as "booksellers." History relates that Moore was furious because Byron wrote "familiar letters to Murray, a bookseller," and the only defence put forward was that Murray kept his own carriage. It is even recorded that, at a literary dinner held during the Napoleonic wars, a toast to Napoleon was allowed on the grounds that he shot a bookseller. Saner views prevail to-day; and there will be no one to contradict the assertion that chemistry owes much to the publishers of works such as Thorpe's Dictionary, and treatises such as those of Mellor, Cohen, Friend and many others familiar to all chemists. The astonishing variety of subject dealt with in modern books on chemistry is well illustrated by the reviews printed in this number. An encouraging feature, too, is the more philosophic treatment of the problems of our science. There is a growing interest in the history of chemistry, there are valuable treatises on all branches of the science, and there are hopes that co-ordination will be soon within the comprehension of all. Much of this we owe to the enterprise of publishers, who are willing to print highly expensive works that are unintelligible, unfortunately, to the mass of the general public. It is for our readers to see that they are rewarded.

All the scientific societies are now well into the work of the winter session; sections are joining with sections to discuss all kinds of subjects, and there is a stimulating atmosphere of co-operation. The art of the joint meeting is being practised vigorously this winter, and the enthusiast with a taste for meetings, and no dislike for a little travelling, can easily occupy most of his evenings in London, Glasgow or Bristol. Manchester has, of course, long been familiar with the joint meeting and the interesting address delivered there recently by Sir William Willcox shows how valuable such meetings can be. The address, of which we print the major portion, is full of information and very suggestive. It is significant that so distinguished a lecturer should think it worth while to review the historical relations of chemistry and medicine, two sciences which have been closely linked together in the past, and will be still more intimately connected in the future. There is a certain tendency to assume that chemistry is concerned solely with the collection of facts, and that the study of its history serves merely to prevent errors such as the inclusion of a Bunsen burner, dating from 1866, in illustrations of apparatus used by Dumas in 1841 to determine the composition of water. History is useful in this respect, but its true utility is not so readily apparent. It may seem paradoxical to claim utility for non-utilitarian studies such as the dead languages, history or similar subjects. But the fact remains that such studies are of the utmost value in directing the mental outlook. It was at one time customary to advocate the study of history, Latin, or mathematics as a mental training. This does not state all the case; the mental outlook is more important than mere mental agility. Dr. Armstrong, in his presidential address, said that a man acquired a post by his competence, but succeeded afterwards by his ability as a man. Mr. Woolcock, our present president, is, it seems to us, actively pointing a similar moral in his insistence that chemists in industry should consider the manufacturer's problems more closely. It is a question of mental outlook, and the attitude of mind towards a problem will more often determine the success with which it is solved than extensive knowledge, necessary as this is. The investigator who possesses the history of his subject will, with the lessons of the past familiar to him, be unconsciously more prepared to advance than he who possesses the facts of the immediate present and nothing more. The complete chemist will always be more than a chemist, and to show that the question is of more than academic importance, it may be pointed out that the technical staff of more than one large and successful business organisation is recruited solely from those who combine competence with the right mental outlook.

THE INFLUENCE OF CHEMICAL RESEARCH ON MEDICINE AND FORENSIC MEDICINE*

By SIR WILLIAM WILLCOX, K.C.I.E., M.B., F.I.C.

Chemistry at the present day may rightly be described as an exact science. It is only during the last 150 years that it has become so, and it is well to remember what a debt chemistry owes to physics for its present prominent position among the exact sciences. Medicine has been closely linked with chemistry from the earliest times, and each, during their earlier development, has owed much to the other. Medicine, at the present time, may be described as an applied science. Many of its problems have been too difficult for solution beyond possibility of doubt, and theories and speculations still occupy a prominent position in the medicine of to-day. By researches in chemistry and the ancillary sciences many of the problems in medicine are being elucidated, so that as time advances theories and speculations are being gradually displaced by deductions based on exact scientific observations. It is doubtful, however, if medicine can ever possibly become a science characterised by such exactitude as obtains in chemistry. Too many complicated factors play a part in the processes of physiology and disease to render this attainable. It is certain, however, that the application of exact chemical methods to problems of medicine and physiology has done more than anything else to clear away error and to lead to the proper understanding of the difficulties with which they are confronted.

The development of chemistry has been divided into the following periods:—Firstly, the prehistoric period, dating from prehistoric times to 1500 B.C. The next period was the alchemic period of 1500 B.C. to 1560 A.D. It was during this period that scientific workers attempted to transmute metals and that the ancient Indian and Greek natural philosophers conceived their idea of atoms, a conception which was later elaborated and formed the basis of Dalton's atomic theory. During this alchemical period, chemistry appears to have had little relationship with therapeutic medicine, but its association with toxicology was very close. Poisoning and antidotes for poisoning appear to have exerted a great fascination on the human race from earliest times, and they are frequently mentioned in the earliest writings. Xenophon, 410 B.C., relates that the use of poisons was so frequent among the Medes that it was an ancient custom for the cup bearers to taste the wine before presenting it to the King. Criminal poisoning is referred to in Roman history in 331 B.C., when twenty matrons were surprised in the act of preparing a poison which they were compelled by the magistrates to drink and from which they perished. Roman law, 82 B.C., contains an enactment dealing with the crime of poisoning, and a later enactment dealt with the use of poisons for procuring abortion. In the first century B.C. Mithri-

* Address delivered at a joint meeting of the Manchester Sections of the Society of Chemical Industry, the Society of Dyers and Colourists, the Institute of Chemistry and the Manchester Literary and Philosophical Society.

dates was so interested in poisons that he personally conducted toxicological experiments on condemned criminals and others. He wrote a book on the subject, and he invented a universal antidote for poisons which Celsus describes as containing 36 ingredients. It is recorded that when Mithridates, tired of life, wished to commit suicide, his constitution had been so long inured to antidotes that poison had no effect on him. He was, therefore, compelled to ask a Gallic mercenary to despatch him with his sword.

With the renaissance in Italy, poisoning became a fine art, and political murder by poison was *in those days* considered to be quite legitimate, as is evidenced by the secret archives of the Council of Ten at Venice, 1400 A.D. to 1500 A.D. It was in this period that Pope Alexander VI and his son Cæsar Borgia committed numerous murders by poison, and Pope Alexander VI himself fell a victim to poison in 1503, his butler giving him the poisoned wine intended for one of his victims. Poisoning in England was not unknown at this period, and in 1531 A.D. a statute of Henry VIII ordered poisoners to be boiled to death. Up to the nineteenth century criminal poisoning was very common, and probably preparations of arsenic and corrosive sublimate were most commonly used. The methods of diagnosis of poisoning depended mainly upon the supposed circumstances attending the administration. The post-mortem appearances in cases of poisoning appeared to have been very little understood, and importance was attached to signs such as lividity, discoloration of viscera, etc., which we now know to be merely the ordinary post-mortem changes and not in any way characteristic of death by poison. In those days anyone suspected of poisoning stood very little chance of escape.

Toxicology did not really make any great advance until the development of modern chemistry and the application of accurate analytical methods. The only certain signs of poisoning are the identification and estimation by analysis of the poison in the body.

In the third period, the Iatro-Chemical period 1500—1700 A.D., chemical investigations were mainly directed towards the cure of all ills, the *elixir vitæ*. During this period, phosphorus was discovered, and improvements were effected in many processes, such as the making and staining of glass and of earthenware. This period is of value to medicine in the discovery of sodium sulphate by Glauber.

The Phlogiston, or fourth period, from 1660–1775 A.D., marked the efforts to explain the changes occurring in combustion and chemical combination. The work, though much of it was unfertile, paved the way for, and was the precursor of, the next period, which is the Quantitative Period, in which the foundation of modern chemistry was laid.

The fifth and last period, the Quantitative Period, from 1775 A.D. to the present time, marks the development and growth of modern chemistry. Oxygen was discovered by Priestley in 1774, and also independently by Scheele in 1777. Hydrogen was discovered by Cavendish in 1766, and, in his experiments on air, he found that 120th part of air resisted change, thus foreshadowing the discovery of argon by Lord Rayleigh and Sir William Ramsay in 1894. Scheele discovered chlorine in 1774, but thought it was a compound. Gay Lussac, in 1809, and Davy, in 1810, demonstrated the elementary nature of chlorine. Scheele discovered arseniuretted hydrogen in 1775, and hydrocyanic acid in 1783. It is unnecessary to pursue further the numerous discoveries made in the early part of this period by men whose honoured names are household words in the history of chemistry. It is interesting to note that these early workers made use of physiological experiments on animals in their researches.

The foundations of toxicological analysis were laid by the early work of this period. Thus, the Marsh test for arsenic was discovered in 1836, and further perfected by Berzelius. In 1839, it was shown that in certain cases of arsenical poisoning arsenic could be detected in the liver, spleen, heart and muscles, indicating that analysis should be made not only of the stomach and intestines but of the other organs of the body. The importance of the absorption of poisons, and the realisation that it is the absorbed poison which causes death in most instances, was thereby appreciated.

In 1844 Fresenius and Van Walberg devised a method for the systematic research of all poisons and for the destruction of organic matter—viscera—as a preliminary to analysis. This method of analysis is in common use to-day. In 1850, Strauss discovered a process by which alkaloidal poisons could be extracted from viscera, and this process, in a modified form, is one in common use to-day in the toxicological analysis of viscera in cases of poisoning by alkaloids.

We come to modern developments of chemistry. Liebig (1803 to 1873) may be regarded as the founder of organic chemistry. He elaborated the methods of ultimate organic analysis by combustion, and he applied his knowledge to the development of physiological and agricultural chemistry. Liebig's work was the foundation of the chemistry of the proteins and metabolism.

Pasteur was a chemist who had, perhaps, the greatest outlook on science of anyone in history. He is, indeed, claimed as the founder of modern medicine, though he had no official medical qualification. Pasteur's investigations of fermentation led him to the study of bacteriology. He demonstrated conclusively the Germ Theory, and showed, in a famous lecture at the Sorbonne in 1864, that the theory of abiogenesis, or spontaneous generation, advanced by Dr. Bastian in this country, was untenable. He demonstrated that the growth of organisms in sterile culture-media only occurred after these media had been inoculated with living organisms. The truth of *omnia vivum ex vivo* was demonstrated conclusively by his experiment, and this work was fully confirmed by Professor Tyndall in this country. This work of Pasteur led to the study of wound-infection by Lord Lister, and the birth of antiseptic, and, later, aseptic, surgery resulted. The human race owes an ineffable debt of gratitude to Pasteur and Lord Lister for their researches, whereby wounds and surgical operations have been delivered of the dread of infection and countless lives saved.

Pasteur's work on fermentation was followed by masterly studies in silkworm disease, anthrax, vibrio-sepsis and chicken cholera. Pasteur went on from the determination of the cause of disease to discover methods of immunity, and in 1881 he gave a brilliantly successful public demonstration in France of the practical value of his immunising methods against anthrax. He also discovered the means of immunising animals already infected with rabies by the injection of emulsions of the attenuated spinal cords of infected animals. This method is still in use in all parts of the world at the present day, and the discovery is all the more remarkable in that the organism causing rabies has not even yet been isolated.

Passing on from Pasteur, we come to Emil Fischer. He was a chemist to whom modern medicine and physiology owe an enormous debt of gratitude. His work on the proteins led to an understanding of the constitution of the protein molecule, and the methods by which the metabolic processes in the body bring about its synthesis. His discovery of phenylhydrazine led to the foundation of a more precise knowledge of carbohydrate metabolism and diabetes. He discovered veronal, and a host of other new drugs whereby toxicology was greatly advanced.

Paul Ehrlich, another great chemist, by his chemical studies, and their application to medicine, has been one of the greatest benefactors of modern times. His experiments on dyes and tissue-staining led to the discovery of the tri-acid stain whereby the study of histology was greatly advanced. He discovered the Fuchsin stain for tubercle bacilli in 1882 and enunciated a theory of immunity which has been, and still is, the guide-post to numerous discoveries, such as that by Wassermann, of the famous common fixation test for syphilis and other diseases. Ehrlich's name will always be associated with the discovery of Salvarsan and the allied arseno-benzol derivatives, which have been of incalculable value in the treatment of syphilis, relapsing fever, etc. Ehrlich, by his study of the blood corpuscles, consequent on his perfection of staining methods, became the founder of hæmatology.

Modern medicine has become an applied science, and its advance is mainly due to the application of accurate scientific investigation. The chemistry of digestion, the processes whereby renal and skin excretions are effected, the processes of metabolism, all these owe their elucidation to modern chemistry. The fascinating phenomena of internal secretion are essentially chemical processes, and offer a very wide field for further research.

One of the most interesting discoveries of recent times is the isolation of adrenalin, the active principle of the internal secretion of the suprarenal glands. Its chemical and physical properties have been accurately determined, and its physiological action is quantitatively known. It is of interest to note that adrenalin has been artificially synthetised, the synthetic product being known as suprarenin.

What a wide field of research is still open chemistry and biochemistry! The vitamins a most important part in nutrition. Their resist to heat and the methods of extracting them known, but none of them has yet been iso and their chemical constitution is unknown.

As instances of the recent developments in cine, developments which owe their discovery to chemical research, mention may be m micro-chemical processes which enable t protein nitrogen, and the creatinin and ur blood to be determined.

The application of chemical methods wher free and organically combined hydrochlo in the stomach could be determined, and organic acid could be estimated, have be utmost value in medical diagnosis.

Most valuable research on liver disease a Alice has been carried out during the last five or ears. This has been based entirely upon the ch work of Van den Bergh, who discovered a met esti- mating the bilirubin in the serum fr small quantity of blood, the method being d on Irving's discovery of the test for bilirum

Medicine requires all these new tests ve y, very much. As soon as they are all published hey are adopted in all the hospitals in the country. The great debt which modern medicine owes to chemistry, could not be better illustrated than by the isolation, due to Banting, Best, an MacLeod, and their co-workers, of insulin and its use in treating diabetes. The discovery of insulin really depended upon the preliminary chemical work in perfecting the methods of estimating sugar, acetone and diacetic acid in the blood, the carbon dioxide combining power of the blood, and so on. Just as a great victory in war is usually the culmination of steady and painstaking preparation with an object in view, so a great discovery in scientific research is not to be looked for by fortuitous investigations, but rather as the crowning-point of steady and painstaking investigations along carefully thought-out and definite lines.

The perfection of methods of toxicological analysis with which the name of Sir Thomas Stephenson will ever be associated has added greatly to the advancement of toxicology. The application of newly-discovered tests for the alkaloidal and other poisons has been of great importance. For instance, in the Palmer case at Rugeley, in Staffordshire, there is little doubt that it was a case of strychnine poisoning, but at that time (1855) the test for strychnine was not known. The expert for the Crown was unable to say that strychnine was present. From the clinical evidence it seems pretty clear that the death was from strychnine, and Palmer was convicted of murder by poison by strychnine. If that evidence were presented to-day to the Court, Palmer ought to have got off. There is only one proof for poisoning, and that is finding the poison in the body.

The Crippen case was interesting because hyoscin was a very decomposable alkaloid, and that no one could possibly find it in the body after a few days or weeks. Dr. Crippen buried the viscera in quicklime, which helped to preserve those viscera; otherwise I

doubt if the hyoscin would ever have been discovered. It took a month to get out the hyoscin. One dare not go above blood heat; above blood heat the hyoscin would have been hydrolysed. So one had to work, in the extractions and evaporations, at about the temperature of the body, and then one succeeded in getting an alkaloid which gave all the chemical tests for hyoscin.

A great advance in the toxicological detection of arsenic followed the introduction of the electrolytic Marsh-Berzelius test. Before that test was introduced it was rather a nightmare doing toxicological analyses in suspected cases of poisoning by arsenic sometimes, because at one period, just after the War, it was very difficult to get hold of pure zinc. The electrolytic Marsh-Berzelius test has done away with all that anxiety. You may get rather lower results with it, but you get reliable ones, and there is no danger of finding some poison which was not in the viscera. This test was first applied by me for forensic purposes in the "Sutton" case in 1911. I took the precaution of not relying entirely on the Marsh-Berzelius test, and estimated the arsenic in the viscera as sulphide, obtaining enough evidence to say it was a fatal case of poisoning.

Veronal is another substance of very great importance in toxicology which I should like to see abolished from pharmacology. There are an enormous number of deaths from veronal, and many are not diagnosed, because it is thought the death may be due to natural causes. The method of determining veronal is straightforward and simple. It is one that I published in 1913, and I think it has been of use in the analysis of cases of veronal poisoning.

In connexion with the analysis of blood stains, the precipitin test has enabled the medical-legal expert to say not only that the stain of the blood, but the animal species of the blood can, in most cases, be accurately determined. This method has been used by the scientific workers for the Home Office, certainly for the last fifteen years. Toxicological analysis is usually complicated by the presence of organic decomposable matter, and requires experience and care in order that errors may be avoided. It is really a branch of applied chemistry, and requires a great deal of practical experience. It is not a subject that can be lightly undertaken, because the organic matter may lead one astray if one is not alive to this possibility.

A very important function of the medical man and chemist is the giving of evidence in Courts of Law, or before Government Commissions, Departmental Committees, and other public bodies, who are conducting enquiries into subjects of a chemical or medical nature. The enquiries may be of a criminal or a civil nature; whichever it is the function of the scientific witness is the same. The giving of evidence by the scientific witness is one of the greatest privileges and honours which fall to his lot.

It is important to realise that the true function of the expert witness is to assist the Court of Enquiry by his expert knowledge and experience. He is not there to win the case for any particular side. He should not be an *ex parte* witness, and he should be absolutely free from bias. This is supremely essential in criminal cases, but it should be none the less important that in a civil case the expert witness should be absolutely impartial. The giving of scientific expert evidence is a responsibility which should not be lightly undertaken. Statements of fact, on which the enquiry is based, should be carefully considered and examined in a critical spirit. The scientific witness should refresh himself by the most careful study of the literature and scientific knowledge relating to the subject in question. If necessary, he should conduct scientific experiments and investigations to elucidate any difficulties which may arise. An exceedingly interesting example of that is a celebrated "Shampoo" case. Tetrachloride of carbon was at that time popular as a shampoo among ladies, but its use is now forbidden. The vapour was found to be very heavy, and a few breaths of it would prove fatal.

Sometimes before you can form an opinion you may have to do some experiments. The expert witness should turn and turn about in his mind the subject on which he is asked to advise. He should unsparingly cross-examine himself on every aspect of the question. It is of great advantage that an expert witness should imagine himself to be in the position of judge or cross-examining counsel, and to try and view the subject of enquiry from their point of view as well as from the aspect of the counsel on whose side he is engaged. The success of an expert as a witness is much assisted by an appreciation of the psychological attitude of those who question him. This view of things will enable the scientific witness to anticipate the questions which are going to be put to him and it will make him tolerant and charitable to the searching questions of the cross-examining counsel. Before being called upon to give evidence, the expert witness should express his opinion on the facts before him, in a written report, and it is well that the reasons for the opinion should be concisely stated in the report. The opinions expressed in the report should be unalterable views on which the expert has no doubt whatever. In giving evidence, the witness should remember that it is his duty to help the Court by answering questions put to him in a clear, concise, fearless, and audible manner. Many witnesses do not speak up in giving evidence. It is rather bad for the reporters who are present.

In giving evidence-in-chief, the answers should be brief and to the point. In cross-examination, the answers should, where possible, be as concise and clear as in evidence-in-chief. Lengthy explanations and evasions of a direct answer are likely to create a bad impression. A direct negative or affirmative should be given where possible. If this is not possible, the reasons for the inability to give a direct answer should be clearly and curtly stated. Lengthy explanations and attempts to give lectures in the witness box are apt to weaken the evidence, and to raise points of which the cross-examining counsel will not fail to take advantage.

The duty of a witness, whether he is an expert witness or an ordinary witness, is to answer questions put to him by those intended to do so. He should avoid making any statements which are not answers to questions put to him. The expert witness should

avoid giving any answers which are not absolutely free from ambiguity. Thus, for instance, if a question is a double or triple one the witness should ask for the question to be suitably divided so that separate answers may be given to each.

If quotations from books or reports are put to him, the expert witness will be wise to ask to see the works in question, and to give his explanation of the bearing which any written statement has on the inquiry. Generally, when one is confronted with a book some passage is picked out which happens, perhaps, to tell against the evidence one may have given, whereas the whole book is supporting the evidence. Similarly, with statistics and reports.

From a very lengthy experience as a forensic witness, I should like to express my very great appreciation of the courtesy and consideration which are invariably extended by the members of the legal profession to those of our profession. It is the duty and privilege of the expert witness to assist justice by his experience and advice. It is also his duty to ensure that his views are clearly put before the Court, and not one jot or one tittle should be withheld or left in doubt.

To conclude, the relationship between chemical research and medicine is so close that advances in each occur *pari passu*. With the development of bacteriology fifty years ago, and the impetus derived from its application to medicine, chemistry became somewhat overshadowed. There have been clear signs of a great revival in the study of biochemistry during the last ten years, and at present medicine is looking towards chemistry for great and immediate advances. Physical chemistry opens the gates to advances in an untrodden field of medicine and therapeutics. Already, colloidal chemistry is supplying a host of new remedies possessing special attributes owing to their physical state. In the solution by chemical methods of problems relating to disease or poisoning in the body, observations and analyses are often perforce conducted with very small quantities of material. It is for this reason that micro-chemical and colorimetric methods are frequently employed. In doing analysis on a poisoning case you have to work with very small quantities of material, tiny little test tubes, or perhaps even capillary tubes, and to do the tests on small watch glasses.

In chemistry, as in medicine, specialisation of work has become necessary, since the fields of each are so vast. The interest taken by the various chemical societies in this country in biochemical problems, the rapid growth and influence of the Biochemical Society, and the attention given to biochemical problems by the various physiological and pathological societies, are all evidence of the intimate co-operation existing between chemistry and medicine. Pure chemistry has, as its religion, absolute accuracy of work. It is necessary that this spirit of accuracy should be the foundation of all those branches of chemistry applied to medicine. The close co-operation between pure chemistry and those branches applied to medical research is the best safeguard against any dangers from over-specialisation. Biochemistry will be best advanced by the application of the principles of pure chemistry in its work. It is to be hoped that biochemistry will more and more attract to its ranks men who, like Pasteur, have engrained in them the principles and methods of pure chemical science, and who will approach biological problems in that spirit of critical judgment and of experimental investigation which are so essential for great work.

FURTHER DEVELOPMENTS IN PULVERISED FUELS

(From a Correspondent)

Remarkable improvements in the technique of pulverised-fuel firing continue to be made in the United States, one of the latest principles being that of complete automatic control of the working of boiler plant. This is being tried with success on a number of large boilers, notably at the Cahokia power station on the Mississippi at St. Louis and at the Cleveland electricity station. The principle consists essentially in controlling electrically, according to the variation in the actual steam flow, the rate of the feeders which supply pulverised fuel to the burners, together with the height of the damper; that is, a variation in the delivery to the combustion chamber of both the coal and air supplies. At the same time, the ratio between the two is kept constant so as to ensure maximum carbon dioxide and combustion efficiency, irrespective of the amount of coal being burnt.

At the Ford plants, the second installation of four huge boilers of 26,400 sq. ft. heating surface each is now ready to start up at River Rouge, Detroit, and Mr. Cotterell, of the Underfeed Stoker Co., Ltd., states that the plant at Walkerville, Canada, has three boilers of 13,500 sq. ft. heating surface, and is to work in conjunction with the new "Caracristi" process of low-temperature carbonisation, in which a ½ in. layer of roughly pulverised coal travels on a cast-iron plate conveyor swimming on a bath of molten lead at about 1200° F., the carbonisation being said to be complete in five minutes. The residual low-temperature fuel, containing about 10 per cent. volatile matter, is then to be used in the pulverised condition in place of raw coal.

The pioneer plant at Lakeside, Milwaukee, with "Lopulco" pulverised fuel, has now started up the second section of the station comprising eight boilers of 17,500 sq. ft. heating surface, and at the Cleveland Electric Illumination Company, there are four double boilers, each having a total heating surface of 30,600 sq. ft., and ranking therefore amongst the largest in the world, fired with "Lopulco" pulverised fuel from both sides.

With regard to the Allegheny Steam Heating Company of Pittsburgh, with the largest single boiler in the world, 32,750 sq. ft. heating surface, the furnace is designed for a rating of no less than 40,000 lb. to 450,000 lb. of water per hour, that is a ratio of 11 : 1, and the whole operation is extremely satisfactory, giving continuously 15·5 per cent. carbon dioxide.

PUBLISHERS OF CHEMICAL BOOKS

Notes on some of the more important organisations and firms

An account of the more important publishers of chemical books in the English language is no mean matter. Publishers of chemical books do not confine their attention to chemical books; they include in their wide purview other subjects such as gas manufacture, politics, poetry, history, mathematics, fortification, the use of the globes, Persian carpets, ants, beetles, grubs obscure, and wriggling worms. A few of them, but only very few, deal with the law in addition to science; the legal publishers as a rule stick to the law and to what the law produces. Although there are a few firms which make their main business the publication of technical books, for instance, Messrs. Crosby Lockwood and Son and ers. C. Griffin and Co., these are exceptions. quently, a statement about publishers of l books must be nearly as comprehensive as t books and to deal with the books pub- firms in existence to-day does not narrow t very much, for some of the veterans in s go back to the early days of publishers, e days when there was no marked dis- ween a printer and a publisher.

. of our publishing houses are sufficiently e, middle-aged, one might call them without being offensive, for the Oxford University Press was founded in 1468 and the Cambridge University Press in 1521. Those dates were once *fin de siècle*, but surely now belong to the middle ages. Then there are a few firms whose history goes back to the eighteenth century, one of these (Messrs. Longman) to the early part of the eighteenth century, and, of course, there are the new-comers of whom Messrs. Blackie and Son and Messrs. C. Griffin and Co. have now attained years of discretion, having been upwards of a hundred years in bu ness. One of the new upstarts, the firm of Macmillan, has by strict attention to appearances almost attained to respectability, but if the truth were known, and we scorn anything short of the truth, they have merely a beggarly eighty odd years of existence to their credit. We will, however, do them the justice of stating that they have never claimed to be veterans. They have never been ashamed of their youth and inexperience or of anything else, and to the best of our belief we do not know why they should be. As for some of the infants—one firm had the audacity to come into existence in this very century, which is now running —we can hardly consider them as deserving any mention, but they, too, will in time grow up and we will insert a few particulars about all, even those whose birth belongs to this era of short hair, short clothes, short hours of work, and short hours of sleep, shortness of money and of a good deal else.

The Oxford University Press

The first book printed on behalf of the University of Oxford was dated MCCCCLXVIII. Many good authorities consider that 1468 is too early a date, and that an "x" has been accidentally omitted. On the other hand, we may remind our readers that at the time in question the use of Roman figures for dates and in book-keeping was almost universal, except in Italy, and that the omission of an "x" in the date of a publication would have been more easily detected then than now. We do not know the evidence on either side. The University authorities appear in one place to think their Press began in 1478, in another place they appear to think it began in 1468. Whichever date is the correct one, there is no doubt that the Oxford University Press only slowly emerged from obscurity. Early in the eighteenth century the University acquired the copyright of "Clarendon's History of the Rebellion," and out of the profits of this work built the home of the Clarendon Press. They have retained the copyright—so we suppose—to this day; for there are always a few exceptions to every broad principle; and the wind is tempered to the shorn lamb. We think of keeping such an animal as a domestic pet during the ensuing winter, until, say, the end of March. If the experiment is not a success we suppose we must buy a new overcoat, but we are of a sanguine humour. With the encouragement of a Royal Charter or two the Oxford University Press has flourished exceedingly during four centuries; it has published Latin and Greek books in profusion and of these we have a few on our own shelves, including the edition of the "Epistles of Phalaris," of date 1718, and made by Charles Boyle, a relative of the more famous Boyle, who was the father of modern chemistry, and brother of the Earl of Cork. A famous book in its way, too! In accurate and comprehensive dictionaries the Oxford University Press delights: the "Oxford English Dictionary" would do our writing a great deal of good if we had time to go through the bulky volumes with care: and think of Liddell and Scott and the "Lexicon": Schelleri and the "Dictionary of National Biography"! But ever since the day of Boyle's "Phalaris" the University has adopted a high standard before conferring its hall-mark on a work, not only a high standard of printing and paper, but of writing and scholarship. There are certain books of which you could say at once that they would be suitable for the Clarendon Press. We recognised Pollock and Maitland's "History of English Law" as belonging to this class, and Pollo 's "Leading Cases done into Verse" as being altogether too frivolous. But memory being uncertain we turned up the title page of Pollock and Maitland and found it was published by the Cambridge University Press. Well, well; and Pollock was an Oxford professor. The book was good enough to have been published by the Clarendon Press, and that is a compliment to both the book and the Press. The Press has branches in New York, Toronto, Melbourne, Bombay, Edinburgh and Glasgow, and agents in half-a-dozen other cities in different parts

of the world. Among its chemical publications are such well-known works as Monier Williams' "Power-Alcohol," and Morrell's "Varnishes."

The Cambridge University Press

The Cambridge University Press dates from the year 1521. Since then it has steadily grown in importance: John Field who was put in charge of it in the year 1655, showed his zeal by building a new printing-house which remained in use until 1827; his printing room was "sixty feet by twenty, held six presses, had paper windows and a pleasant garden."

The Cambridge University Press was one of the earliest firms to make use of Earl Stanhope's invention of stereotype plates, and bought two presses of his invention in the year 1804.

Oxford has its Clarendon Press; Cambridge, its Pitt Press housed in a building which was erected and paid for out of the surplus cash provided for a statue for William Pitt, a former member of Pembroke College. Oxford was much helped by Archbishop Laud; one of the distinguished men who helped to put the Cambridge Press in order was Richard Bentley. Bentley knew more about Boyle's edition of the "Epistles of Phalaris" than did Boyle or any once since his date. His controversial methods were superb: he was a Yorkshireman: there are no scientific men now alive who could deal with a controversial subject as Bentley did, but if any wish to make the attempt it should be one of

"the sons of Margaret and Clare-hall,
Where Bentley late tempestuous wont to sport,
In troubled waters, but now sleeps in port."

Well, in 1742 we suppose the college port was as soothing as it is now.

The Cambridge University Press has published Bibles, Histories, both Ancient and Modern, many mathematical and physical books including the works of Cayley, Kelvin, Tait and other well-known authorities. We fancy it has not published the works of Newton, a mathematician and physicist of equal repute. Of books more directly interesting to the chemist should be mentioned, Bohr, on "The Theory of Spectra and Atomic Constitution," Rutherford, on "Radio-active Substances," and Whetham on the "Theory of Solution," Liveing and Dewar, "Collected Papers on Spectroscopy," and Muir's "Principles of Chemistry."

The House of Longman

University Presses have many advantages, but they have no pedigree. No-one could write a "Forsyte Saga" about one of them. When we come as we do now to the private firms who publish we are struck by the fact that the businesses are good enough to keep. The writer of these notes has a better knowledge of the lead business than of the publishing business and he notices this common characteristic: each of these industries is sufficiently remunerative to enable a modest man engaged in it to rear a modest family; each is sufficiently respectable to justify the sons and grandsons in continuing to engage in it. Some of the publishing firms have continued in the same family for four, five, or even six generations, some lead smelters and red-lead makers have kept the business in the family for at least a hundred and fifty years. Brewers have amassed money too easily; they tend to become peers and bankers; their sons join the Diplomatic Service. We cannot recall any publisher or any lead manufacturer who became a Viscount; Peers, idle Peers, we know not any who came from these origins.

The house of Longman goes back to the year 1724, when Thomas Longman bought the business which had been Taylor's in Paternoster Row, London. There they are to this day in the very place where "Robinson Crusoe" was published in 1719 by their predecessor, Taylor. Upwards of two hundred years of steady publishing, always improving a little, better type, better paper, better remuneration for the authors, income tax and no doubt finally super-tax for the publishers. Two hundred years the Longmans have been there, two hundred more will bide, very likely. They joined with four other firms in publishing "Johnson's Dictionary," they published all kinds of other books, the "Voyage of the Sunbeam," Macaulay's "History" and Disraeli's novels; so far as we know they are the oldest private publishing firm in the country since, in 1890, they bought up a yet older firm, Messrs. Rivington, founded in the reign of Queen Anne. A casual inspection of a few hundred chemical books leads us to estimate that Longmans have published more chemical books that we should care to have on our shelves than any other firm; "Monographs on Physics," including Lymans' "Spectroscopy of the Ultra Violet," and J. J. Thomson's "Rays of Positive Electricity"; a series of Text-Books of Physical Chemistry, including Findlay's "Phase Rule," Baly's "Spectroscopy" and Desch's "Metallography"; then a series of monographs on Industrial Chemistry, including Morgan's "Organic Compounds of Arsenic and Antimony," Bone's "Coal," Hale's "Electrolysis," Perkin's "Natural Colouring Matters," and several other books fit to be in every gentleman's library; a series of books by Stewart and another series of books by Plimmer, on Biochemistry. Do not allow us to omit Thorpe's "Dictionary of Applied Chemistry," or Mellor's "Inorganic Chemistry." Thorpe and Mellor are the chemist's Bible and Bradshaw, his Routh and Garnett, his Codlin and his Short. If you know your way about Thorpe and Mellor—and Mellor's path is not everybody's path—you can for a long while fare as if you were a chemist. When the Society of Chemical Industry asks us the next time what improvements we can suggest, we shall propose two pages similar to, or identical with, those who now adorn the Duenna, to bring us continually Mellor and Thorpe, which no doubt in their spare time they will read aloud to each other, probably simultaneously; blame them not, they are young.

Messrs. John Murray

John Murray, or Mac Murray, as he was known for a time, bought in the year 1768 a bookselling business at the sign of the "Ship," No. 32, Fleet Street, London. He was a descendant of the old family of Murray of Athol, and had valuable connexions with many interesting and important people in Scotland.

He soon established a reputation as a capable and upright publisher, and was jointly interested in several enterprises with Messrs. Constable and Messrs. Ballantyne. These caused him a good deal of anxiety, and he wisely severed his participation in their affairs before the financial difficulties of these two firms became too acute. When the crash finally came both Constables and Ballantynes were heavily in debt, and Sir Walter Scott, who was also involved, had to devote many years of his life to clearing off his share of the loss by writing some of his most successful novels. Many of these were published by Murray, sometimes in conjunction with Messrs. Blackwood and Constable. Murray also published Byron's poems, Jane Austen's novels, and other standard books. His descendants carried on the business without departing from the high standard set by the original John Murray; they published Lyell's Geology, Darwin's books, the works of Sir Henry Maine, and indeed high-class books in every department of knowledge.

In Science the firm publishes "Science Progress," and the various Bulletins of the Imperial Institute; it also publishes Hall's "Soil," Hall's "Rothamsted Experiments," and many well-known books on agriculture and horticulture. There is usually something stately about Murray's publications, nothing common or mean. Murray's house in Albemarle Street was for many years the resort of the most distinguished writers, travellers and men of note in London.

Blackie and Son

The firm of Blackie and Son, Ltd., is among the grave and reverend seniors of the publishing fraternity, dating from 1809 when John Blackie, senr., took over the previously existing Glasgow publishing house of A. and J. Brownlie. If the Brownlies be reckoned in the Blackie ancestry then the firm may count its birth as having taken place in the last quarter of the eighteenth century.

Glasgow, through its ancient university, has been a centre of culture and learning from mediæval times onwards. The beautifully printed productions of Robert and Andrew Foulis (1750—70)—famous among great printers of all time—bear witness to the quality of the cultural life of eighteenth-century Glasgow. Have we not ourselves a Foulis Homer, a noble folio, a constant source of pride and an occasional source of recreation? The Foulis tradition was continued in Glasgow by Andrew and John M. Duncan, who succeeded Foulis as printers to the university, and, like that great printer, specialised in the production of well executed editions of the classical authors. The Duncans' premises, machinery and type, were purchased by Mr. Blackie in 1819, so that, in a measure, Messrs. Blackie and Son may consider themselves to be in the line of succession from the great Foulis. Certainly they have always sought to maintain the high standard of production in books set by these fathers of the noble art of printing.

The Blackie firm from its earliest days specialised in works of some enduring value as works of reference. Bell's "Glasgow Geography," published in 1812, a complete geographical, statistical and political account of the world in six well-packed volumes, well illustrated and well mapped, is an example. In quite early times there were handsome, richly illustrated editions of works such as Rollin's "Ancient History," "Travels in Italy," by Dr. Moore, father of Sir John Moore who fell at Corunna, "Burns's Poems," "John Bunyan," with text specially prepared by George Offor, still the standard text. Technical and educational publications were also produced by the firm from an early date. Later, when the steam engine had arrived, the changing time is reflected in the firm's catalogue in works such as "Machinery and Mill Work," "The Engineer and Machinist's Assistant," "Railway Machinery," by D. K. Clark, and "The Engineer's and Machinist's Drawing Book" by the same author. Classics are represented by the "Roman Antiquities" of Dr. Adam, Rector of the Edinburgh High School in Sir Walter Scott's day, and by Potter's "Antiquities of Greece." At a rather later period (1836) the works of James Hogg, the Ettrick shepherd, were issued by the firm in a sumptuous edition.

Of purely scientific books the earliest publication of the firm was Comstock's "Natural Philosophy" (1846). Eighteen hundred and seventy saw the issue of Deschanel's "Natural Philosophy" translated and edited by Prof. J. D. Everett. About this time the firm put in hand the preparation of an English edition of the great French dictionary of chemistry, "Wurtz, Dictionnaire de Chimie," Prof. John Ferguson undertaking the editorial control. William Ramsay (afterwards Sir William Ramsay of Argon fame) and James Dobbie (afterwards Sir James Dobbie) were both at that time assistants in the chemistry department of Glasgow University, and were two of the contributors from whom came much good "copy." But, unfortunately, when the work was well under way and the publishers wished to have the first and second volumes got ready for issue it was discovered that many of the articles for the early volumes could not be available until the last French volume was ready. As a result the whole project was relinquished and the work done scrapped, Ramsay's with the rest. Bernthsen's "Organic Chemistry," edited by Prof. Sudborough, formerly of the University College of Wales, Aberystwyth, now of the Indian Institute of Science, Bangalore, is another of the older, though still entirely fresh, chemistry books published by the firm.

In recent years the firm has developed its scientific catalogue very greatly. Dr. R. M. Caven's series, "Manuals of Pure and Applied Chemistry," gives evidence of the firm's activity in the production of works on chemistry, while several volumes of the new series on "Applied Physics" have appeared, and include books and contributions from some of the most eminent men of science.

Gurney and Jackson

This firm was founded early in the nineteenth century. It has specialised in the publication of chemical and other technical books. Messrs. Gurney and Jackson are and have been for many years the publishers to the Chemical Society.

W. H. SMITH AND SON

Two Scotch brothers founded Macmillans in 1843; two English brothers founded Smiths about thirty years earlier. The former became publishers, the latter booksellers and newsagents. From the point of view of success, reputation and honours, it is hard to say which side of the Border has the better record. There are two courses, one for these typical representatives to continue a friendly rivalry: the other course would be to amalgamate the two concerns. We have had to think a great deal about amalgamations during the last few days and may attach undue importance to it as a means of the nation's evolution.

CHARLES GRIFFIN AND CO., LTD.

This century-old publishing house has earned for itself the title of "Makers of Modern Technology." Founded in Glasgow when George III was King, bookselling was combined with the sale of fine chemicals and scientific apparatus. Griffin's Chemical Museum and Griffin's Public Library were well-known establishments and this helped to give the publishing venture in 1820 its scientific and technical bent. "The Glasgow Looking Glass" of 1825 has a quaint advertisement in which a griffin of mythical and heraldic fame is figured serving books in the library.

The publishing branch flourished so abundantly that in 1848 it was transferred to London and became a separate concern under the care of Charles Griffin, grandson of the founder, Joseph Griffin. Members of the family have continued the business ever since and two are now serving as directors, Mr. Charles R. Griffin being a fifth generation. The present chairman and managing director is Mr. Francis J. Blight, F.R.S.E., whose enterprise and efficiency for over a quarter of a century has secured for the house the unobtrusive but solid popularity which has attended the publication of works of world-wide usefulness. Mr. Horace V. Blight, M.C., A.C.A., a director and secretary of the house, was killed in action in France in 1918, and Mr. Arthur Downer, F.I.S.A. (son-in-law of the chairman) has since joined the board of directors.

In 1820 Griffin's published "A Dictionary of Chemistry" by Prof. Andrew Ure, and "An Encyclopædia of Chemistry" with its applications to "Mineralogy, Physiology and the Arts" by Prof. R. Dundas Thomson, F.R.S., and later "The Encyclopædia Metropolitana," "The Circle of Sciences," "Rose's "Manual of Analytical Chemistry," Humphry Davy's "Electro-Chemistry," Faraday's "Lectures on the Chemical History of a Candle," and many other classics. They were the first publishers of "The Chemical News" and they founded "The Year Book of Scientific and Learned Societies," now in its forty-first year of issue and have been responsible for innumerable handbooks and technical treatises, their "Textbook of Inorganic Chemistry," edited by Dr. J. Newton Friend being known to all our readers.

BAILLIERE TINDALL AND CO.

Messrs. Bailliere, Tindall and Co., 8, Henrietta Street, Covent Garden, W.C. 2, who have been established in this country since 1827, are therefore one of the oldest publishing and retailing houses of medical, chemical and scientific books. They issue several catalogues and carry a considerable stock of recent books on chemistry, besides which, it should be noted, they have a Library Supply Department, a Periodical Department and a Foreign Order Department, and can therefore obtain any British or Foreign periodicals and books which may not be stocked. These are useful and time-saving services.

Among their publications are the well-known "Industrial Chemistry Series," edited by Dr. Samuel Rideal, Kingzett's "Chemical Encyclopædia," Barnett's "Anthracene and Anthraquinione." Cross and Cole's "Modern Microscopy," Baker's "Spectroscope," and other standard works.

This firm, also, is agent for Messrs. Williams and Wilkins of Baltimore, who are publishers of some of the most scientific books issued in any part of the world. Among the periodicals they print is *Chemical Reviews*, a new journal appearing under the editorial auspices of the American Chemical Society.

W. AND R. CHAMBERS, LTD.

This business was established in 1832 by William and Robert Chambers in Edinburgh. The founding of "Chambers's Journal" and the launching of that great work, "Chambers's Encyclopædia," are perhaps the most notable features in the firm's history, and these are to this day their most important and popular publications. Among other of their outstanding works are "Chambers's Cyclopædia of English Literature," "Biographical Dictionary," "Concise Gazetteer of the World," "English Dictionary," "Twentieth Century Dictionary," "Organic Chemistry," "Inorganic Chemistry," by Prof. Perkin and Kipping, and other important educational text-books.

CHAPMAN AND HALL, LTD.

The firm of Chapman and Hall, Ltd. have long been noted for their scientific and technical publications, many of which have become standards of reference. It is perhaps of interest to remark that this House, established so long ago as 1837, acted as the original publishers of the immortal works of Charles Dickens. Anthony Trollope was also at one time on the Board of Directors, and George Meredith was for some time reader to the firm.

The literary associations have therefore always been of considerable interest, and the scientific side of the business, established many years ago, is now in process of rapid development.

Chapman and Hall are also well-known as the European and British Empire agents of the old-established firm of John Wiley and Sons, Inc., of New York. Founded in about the year 1807 their catalogue now contains the extraordinary number of over 1000 books, including such household names as Treadwell and Hall, Patterson, and Holleman. Of the famous names which appeared on the general side of the early Wiley list was that of James Fenimore Cooper.

MACMILLANS.

Messrs. Macmillans have published a higher percentage of the books we have in our own small study

than any other publisher and a still higher percentage of our special favourites, such books as "Ball's History of Mathematics," "Lang's Theocritus," "Palgrave's Arabia," "Hajji Baba," "The Gay-Dombeys." It is always a marvel to us that so few people know "Hajji Baba"; if we ever commence business as a publisher the first two books we shall publish will be "Crotchet Castle" and "Hajji Baba"; we scoured London some eighteen months ago for a copy of "Crotchet Castle," but in vain. But we wander from the point. Macmillan's was started by two brothers, sons of a small farmer in the island of Arran, in the year 1843. With assets, which consisted almost exclusively of Highland ancestry and a determination to get on, they bought a small bookseller's shop in Aldersgate Street in the City of London. A few months later they bought a bookseller's shop in Trinity Street, Cambridge, and sold their London shop. The young men made friends with such celebrities as F. D. Maurice, R. C. Trench, E. White Benson, Sir William Thomson, Bishop Colenso and Charles Kingsley and published books on their behalf. If their business methods were similar to those practised by the firm in more recent years it is no matter for surprise that authors of every variety desired their help. In 1858 they bought a business in London, transferred the management of the Cambridge business to one of the Macmillans and a nephew of the name of Bowes, and made London their headquarters. They published the best-known works of such men as Huxley, Stephen, Pater, Trevelyan, Tennyson, Avebury, Geikie, Bryce and Kipling. School books and text books they published for children of all ages and dealing with every subject; these concern us not.

Macmillan's publish "Nature"; we envy the reputation and prestige of "Nature" and yet envy is not a common state of mind with us. They publish "Cohen's Organic Chemistry," "Lewkowitsch's Oils and Fats," "Lowry's Historical Introduction," Nernst, Ostwald, Partington's "Inorganic" and Thorpes' "Historical Chemistry." They also publish Roscoe and Schorlemmer; why say anything about Roscoe and Schorlemmer? One might as well describe the Pyramids or St. Paul's Cathedral. Even editors have a Roscoe and Schorlemmer, perhaps not the latest edition.

Bowes and Bowes

The business which the brothers Macmillan bought in 1843 in Trinity Street, Cambridge, had been founded by one John Nicholson, usually called "Maps," in 1752. After the Macmillans moved to London in 1858 the Cambridge bookselling business remained distinct and was managed by nephews of the Macmillans of the name of Bowes. The present style of the firm is Bowes and Bowes and the chemists who visited Cambridge in 1923 will remember Messrs. Bowes and Bowes' admirable "Guide to Cambridge" and their commodious premises. Books both new and second-hand are there in great numbers and the staff is always glad to search for out-of-the-way books.

H. K. Lewis and Co., Ltd.

The publishing and bookselling business carried on under the name of H. K. Lewis and Co., Ltd. was founded by H. K. Lewis in 1844, in premises at 136, Gower Street, London. Originally devoted mainly to medical and scientific books, the range of subjects gradually extended and the general science and technical sections steadily increased. As the volume of business increased additional space was required, and 24, Gower Place was added. Later the Publishing Department was moved to 28, Gower Place, and this gave much needed room in the main building for the accommodation of the Circulating Library Department, a Reading Room for Subscribers being provided. This change gave room for the opening of a special Department for Scientific Stationery—Card Indexes, Engineering Paper and Drawing Requisites, etc. Arrangements have also been made for keeping customers advised of any publications on subjects in which they are specially interested.

W. Heffer and Sons, Ltd.

Established fifty years ago through the energy and enterprise of Mr. William Heffer, still the head of the firm, the business has undergone constant expansion. In 1897 the Bookshop in Petty Cury, Cambridge, was taken, and the first step in the development of the business was made.

The publishing side at Petty Cury has developed into a vigorous branch of the business, concerning itself mainly, though not exclusively, with books of a technical character, notably science textbooks, and books on the teaching of modern languages. These books are practically all printed and bound at the Printing Works in Hills Road. Of recent years the Printing Works has done a large amount of general printing, including a number of technical and other journals, e.g., *The Analyst*, *The Journal of the Institute of Chemistry*, and *The Secretary*.

B. H. Blackwell

We regret to state that this famous Oxford bookseller and publisher died on October 26 this year. His personality was well known in Oxford, his shop there was, and still is, the resort of many literary men. The firm publishes a number of chemical and other books, including poetry. We notice they publish an edition of the "Poetry of the Anti-Jacobin"; every chemist ought to read this book.

Crosby Lockwood and Son

Messrs. Crosby Lockwood and Son have a very strong selection of Chemical Works, being the publishers of "Industrial and Manufacturing Chemistry" (Organic and Inorganic), in three volumes by Geoffrey Martin, D.Sc., Ph.D., F.C.S., etc. The author's series of Manuals of Chemical Technology are also well-known, numbering eight volumes, amongst which are "Oils, Fats and Waxes," "Perfumes, Essential Oils and Fruit Essences," and "Dyestuffs and Coal Tar Products." Dr. Geoffrey Martin is now engaged in writing "The Modern Soap and Detergent Industry." This work is being published in three volumes. Vol. I, "The Theory and Practice of Soap-Making" being now on the market. Mr.

Scott's "Standard Methods of Chemical Analysis" is, of course, a classic of the industry, but his new "Technical Methods of Metallurgical Analysis" is not so well known. "Chemical Synonyms and Trade Names," by Wm. Gardner, is an important and valuable book which has recently been published, being the first and only compilation of its kind. Messrs. Crosby Lockwood have been appointed agents for the series of Chemical Monographs of The American Catalog Company, of New York, and these valuable works can now be obtained from stock.

Edward Arnold and Co.

The well-known firm of Edward Arnold and Co. was founded over thirty years ago, and has specialised in books of all kinds, especially those of an educational, medical and scientific nature.

German Chemistry Books

Mr. Edward Goldston, of 25, Museum Street, London, W.C. 1, carries a stock of all the latest German Books on Chemistry, and will be pleased to send catalogues and lists regularly to all interested. He claims to have the largest stock of German chemistry books in this country.

J. and A. Churchill

Messrs. Churchill are well known as publishers of books on Natural Science, Hygiene and Medical Science. Their series of text-books of Chemical Research and Engineering includes modern books on emulsions, catalysis, molecular physics and colloids by writers of importance. They publish "Molinari's Chemistry" and "Bloxam's Chemistry." The latter has reached its eleventh edition. "Sutton's Volumetric Analysis" is a standard work, and "Allen's Commercial Organic Analysis" is the last word in such matters. Many of us have had occasion to visit their handsome quarters in Great Marborough Street. None of us has ever regretted a visit.

Methuen

The publishing house of Methuen and Co. was founded in 1889, taking its title from one of the christian names of its originator, Algernon Methuen Marshal Stedman, the son of a Godalming surgeon, who ten years later assumed the name of Methuen. This firm publishes all sorts of scientific books, including Einstein's original book on "Relativity." Indeed, their various books on "Relativity" generally have been recognised as the best of their kind. They also publish books on "Atoms" and the advanced sciences.

Ernest Benn, Ltd.

The publishing business of Messrs. Benn Brothers has grown so much in recent years that their book publishing side has been transferred to a separate company, Ernest Benn, Ltd.

All chemists know Benn's; they publish *The Chemical Age*, "Chemistry in the XXth Century," and pamphlets and books on chemical subjects which have been reviewed in our columns. There is nothing old fashioned or dilatory about the Benns; they are keen, businesslike and enterprising. They are new comers in the chemical world, but they are pushful people who have already become of importance chemically and will become of greater importance. You must keep your eye on Benn; he will keep his eye on you, and if there is any book he thinks you want he will publish it while you are considering how the book should be written. Benn's intend, when they have felt their feet, to make their chemical books as good as their Art books, and that is saying a good deal. They have a knack of doing what they intend.

McGraw-Hill Publishing Co., Ltd.

The publications of the McGraw-Hill Book Co., Inc., of New York, U.S.A., are handled in Europe by the McGraw-Hill Publishing Co., Ltd., of 6, Bouverie Street, London, E.C. 4.

The Book Co. is an amalgamation of the book departments of the Hill Publishing Co. and the McGraw Publishing, both of New York. Both these companies issued technical journals and both had book departments. When the companies were amalgamated in 1907 it was decided to create a separate company for the publishing of technical and scientific books. Every effort was therefore concentrated on the publishing of high-grade books. Readers of *Chemistry and Industry* are no doubt already well acquainted with such leading chemical engineers as Liddell, Clennell, Bogue, Loeb, and Bancroft, also the fine series of uniform volumes under the title of the "International Chemical Series." The metallurgical profession is well catered for by the fine books by Hofman, Peters, Richards and Ingalls, all of which were actually the foundation stones of the big publishing business of McGraw-Hill. *Chemical and Metallurgical Engineering* and *The Engineering and Mining Journal Press* are the two important journals published by this company for the chemical and metallurgical professions.

W. and G. Foyle, Ltd.

This firm started in the year 1904 with no capital except a box full of second-hand books and a few pieces of newspaper. It now has large premises in the Charing Cross Road, London, containing over a million volumes. If a chemist wants a new or a second-hand book of any description Messrs. Foyle will procure it for him.

Wm. Bryce

Mr. Bryce, of 54 Lothian Street, Edinburgh, has one of the largest stocks of books on chemistry and other branches of science in the British Isles. He has shelves full of Technical Journals from *Chemistry and Industry* downwards. He procures you the Alembic Club reprints, which are very good, and many other books which delight the chemist. We know from our own experience how speedily he procures for you what you want.

REVIEWS

A Comprehensive Treatise on Inorganic and Theoretical Chemistry. By J. W. Mellor, D.Sc. Vol. V. Pp. x+1004. London: Longmans, Green and Co., 1924. Price 63s.

The volumes of Dr. Mellor's treatise continue to be published in rapid sequence, and the appearance of the fifth volume is a welcome guarantee that the series will be complete before the early volumes have lost their freshness. The present number is concerned mainly with boron, aluminium, the rare earths and carbon (part I), whereas smaller chapters are devoted to gallium, indium, thallium and scandium. The work is constructed on lines similar to those of the preceding volumes. The subject matter is treated with detail unusual even in large treatises so that the term "comprehensive" is veritably justified. Skilful arrangement, judicious use of type and frequent employment of clear, if small, diagrams combine to render the book not merely an invaluable work of reference, but also a pleasant companion. The bibliography is exhaustive and the ability of the author to include in ordered sequence references to work published during the current year is a striking tribute to the success of his system of working. Most chemists will be grateful also that Dr. Mellor has not been content merely to co-ordinate and arrange a great array of facts but has impressed his personality on the work, even if they regret that he has not included those little touches of philosophy which formed such charming and unique features of his smaller books.

Where all is excellent it is difficult to single out a section for special praise, but the chapter dealing with the rare earths appears to the reviewer to be an outstanding example of the successful treatment of a subject of almost unique complexity.

The book is well printed, and is singularly free from misprints and clerical errors. The only slight drawback to the pleasure of its perusal is the continued use of somewhat inelegant abbreviations and the prolific use of authors' names whereby at times the stage appears so crowded with Hamlets that the interest in the play becomes obscured.

H. Wren

Modern Chemistry, Pure and Applied. By Prof. A. J. Hale. Vol. I, pp. xi+272; Vol. II, pp. vii+276; Vol. III, pp. vii+280; Vol. IV, pp. vii+280; Vol. V, pp. vii+280; Vol. VI, pp. vii+280. London: Virtue and Co., Ltd., 1923. Price, 16s. per volume.

In preparing this compendious work, the object of the author has been to provide for the chemical and general reader a concise account of modern chemistry as it appears, viewed as a whole. With this object in view, examples are culled freely from the academic as well as the industrial sides of the science, and sufficient explanation is given to aid the non-technical inquirer in search of information. Any large general treatise must constantly face the danger of being insufficiently detailed for the technician and too technical for the uninitiated. Although Prof. Hale's treatise is not blameless in this respect, one cannot but admire his perseverance in selecting from such a vast amount of material as that provided by the whole field of chemistry.

Volume I begins with the composition of air and water, opportunity being taken as occasion arises to introduce theoretical matter, passes on to the laws of chemical change, and then on to the non-metallic elements. Volume II reviews the alkali and alkaline earth metals and discusses the properties of dissolved substances, chemical change, the aluminium group, the rare earth elements and the inert gases. Organic chemistry occupies the whole of Volumes III to V, and overruns into seventeen pages of Vol. VI, of which the remainder is devoted to the industrial metals and their alloys, concluding with a chapter on analysis, and a name and subject index occupying 45 pages.

The work is very well printed, but its bulk has been made unnecessarily large by the use of very thick paper, and in view of the arrangement of the contents, the lack of a separate index for each volume, and of some indication of the contents on each back makes handling awkward. Prof. Hale's treatise constitutes a most interesting attempt to review the whole of chemistry, untrammelled by artificial divisions into pure and applied branches, and can be recommended to those who do desire, not an exhaustive treatise, but a much wider range of information than is available in a general text-book.

The Corrosion of Metals. By Ulick R. Evans, M.A. Pp. xii+212. London: Arnold and Co., 1924. Price 14s.

This little book has been written more particularly for three classes of readers, namely, the practical engineer or works chemist, the research worker, and for students of engineering, metallurgy and inorganic chemistry. One feels that to be of real value to the first two of these the book might well have been several times its present size. The problems of corrosion are so vast and intricate that it is impossible to deal adequately with them within the confines of some 200 pages. Many of the sections suffer in consequence from undue compression. To such as have access to a good library this may not be a serious disadvantage, for the book is replete with references which are thoroughly up to date. Mr. Evans has evidently read widely and is to be congratulated upon the large amount of useful material that he has been able to collect together.

After a brief account of the more important theories of corrosion, a chapter is devoted to the direct combination of metals with non-metals, the researches of Pilling and Bedworth, and of Tammann receiving particular attention. After explaining briefly in the third chapter the essential principles of electro-chemistry, the author proceeds to discuss anodic corrosion, corrosion involving the production of hydrogen gas, and, subsequently, the presence of

dissolved oxygen. A section is devoted to the corrosion of copper alloys and condenser tubes, and it is useful thus to have, in tabloid form, a review of the comprehensive researches of Dr. Bengough and his collaborators, as seen from Mr. Evans's standpoint.

In dealing with the prevention of corrosion reference is made to the method of softening water by filtration through permutite, whereby dissolved calcium and magnesium salts are replaced by the corresponding sodium salts. As these have no scale-forming properties and are not subject to hydrolysis, Mr. Evans concludes that they are probably less dangerous from the corrosion point of view (p. 169). This, however, is contrary to the present writer's experience both in the laboratory and in practice, in so far as mild steel is concerned.

The author illustrates in a graphic manner the complexity of the problems of corrosion. "If, for instance, two factors alone had to be considered," he writes, "and ten values of each factor were thought to be sufficient for the tests, clearly 10^2 or 100 experiments would suffice to give the required information. If, however, there are ten factors involved, we should require 10^{10} or ten thousand million experiments. In actual fact the number of important factors is very large."

Mr. Evans is evidently a whole-hearted believer in electrochemical explanations for corrosion phenomena, and the book is written from that point of view. Yet surely in so vast a field there must be many widely different causes for corrosion. One gains the impression that the author, by seeking to tie everything—except perhaps the dry corrosion of metals, with regard to which he appears to have altered his earlier views—down to an electrochemical explanation, to the exclusion of all others, is taking too narrow a view of the subject, and does not quite realise the magnitude of the problem he is so courageously attacking.

The book is attractively written and has been well printed. The grammar is a little weak in places, and the occasional use of such archaic terms as *oxidization* is somewhat cumbersome. But these are minor points, which the author will no doubt remedy in later issues. J. Newton Friend

Outlines of Organic Chemistry. By E. J. Holmyard, M.A. Pp. xii+466. London: Edward Arnold & Co., 1924. Price 7s. 6d.

To one whose chemical training in a University College in this country did not include the preparation of a single organic compound, it is amazing to find how far the teaching of the subject has spread, for the volume before me is written for senior schoolboys and medical students.

It may be, as the author says, a matter of surprise that so little organic chemistry is taught to elementary students. On the other hand, will such a beginner be encouraged with any hope of success "to refer to Beilstein or Richter or the original literature . . . . a detail of training to which great importance is attached." All one can say is that Clifton boys must be well in advance of the ordinary degree student of our Universities, few of whom would—or, in many cases could, even with encouragement—tackle the original German references.

After the first 160 pages these elementary students —beginners, we may suppose—are required to answer such questions as: In what way is the chemical behaviour of phenylnitromethane peculiar? give a brief description of the electronic theory of valency; what explanation of the mechanism of the Friedel and Crafts' Reaction has been advanced? write an essay on the relation between physical properties and chemical constitution of organic compounds and so forth.

These and similar questions are associated in one's mind with an examination paper in the Honours school of chemistry. But this may be mere prejudice, and one naturally turns therefore to the earlier part of the volume to see if the foundations have been well and truly laid, a matter of greater importance than the reading of original references.

There is, to begin with, a full and clear account of the usual methods of analysis and molecular weight determinations. This is followed by what is termed "determination of molecular architecture," and three examples are given, namely, ethyl alcohol, acetic and formic acids. The quadrivalency of carbon is of course insisted on, though the author does not explain why "a free-valency waggling about in space like a tentacle of an octopus is enough to send a cold shiver down the back of an organic chemist"—a didactic form of statement which in the case of beginners would, I imagine, convey little meaning. How are the three examples treated? The usual chemical changes and equations are given, the action of sodium, of phosphorus chloride, etc., but there are no practical details to help the student to visualise these changes or to realise how we know that the products in question are formed. This section is completed in 15 pages. Then follows a short chapter on radicals, when we come to Part II on stereoisomerism, tautomerism, the valency of carbon and catalytic reactions, after which the systematic treatment of aliphatic and aromatic compounds is begun.

The book is written in a clear and lively style, which will appeal to boys, with occasional bits of history, and is embellished with the portraits of distinguished chemists. For a University student with some experience of practical work it can be warmly recommended. J. B. Cohen

Gelatin in Photography. Vol. I. By S. E. Sheppard, D.Sc. Monographs on the Theory of Photography from the Research Laboratory of the Eastman Kodak Company. New York: D. Van Nostrand Company, 1923. Price $2.50.

The importance of as complete a knowledge as possible of the properties of gelatin is well recognised in the photographic industry and any work which promises to increase knowledge in this direction is eagerly looked for and scrutinised. The present volume, the third of the Monographs on the Theory of Photography issued by the Kodak Company, belongs to the category of books that promise much but

equally leave much to be desired. It would appear that the author has attempted too much in too small a space. The historical résumé with which the book opens is but little more than a catalogue of names, dates, and processes, and the fourteen pages it occupies could have been better employed in the amplification of some of the later, more purely scientific matter.

The chapter on manufacturing processes is too long and ill-balanced for a mere sketch, and is far too short to permit of a useful discussion of those factors which are of the greatest practical importance to the photographic manufacturer. The references to original papers are very comprehensive and cover practically the whole field dealt with, and this is true not merely of this section, but of the whole book. On the other hand, the space of seventy odd pages devoted to the review of gelatin manufacture is obviously inadequate, if the many problems involved are to be usefully discussed, and one is left with a feeling of dissatisfaction.

Quite the best chapter in the book is that on the analytical and constitutional chemistry of gelatin, though it is by no means free from matter calling for comment. Exception may surely be taken to the method of determining sulphurous acid by direct titration with $N/10$ iodine. It is now well recognised that gelatin has an iodine absorption value, which varies with different gelatins and is independent of any sulphurous acid content. This is hinted at vaguely on p. 115, where the author says, "Some gelatins, however, evidently contain something beside sulphurous acid which combines with iodine, not always formaldehyde." Again on p. 116 it is stated, "The direct iodine number has a certain value but is not simply a measure of sulphurous acid in gelatins." One would think that two such statements occurring so close together at least called for discussion, if not reconciliation. This example is typical of a number of others, which are open at least to the criticism of loose writing.

No analyst would use the statement made at the bottom of p. 120 as an adequate description of a phosphorus determination. Nor can one agree with the remark (given as a footnote on p. 118) that exact conditions for the ammoniacal silver nitrate test cannot be given because the specifications will vary according to the particular photographic use of the gelatin. The importance of the test may not be doubted, but the conditions of the test must be specified very exactly, and some discussion of the nature of the materials in gelatin which render the test possible, and which make it of value would have been welcomed.

Under the physical testing of gelatins, the more important points are mentioned, but insufficient emphasis is laid on those details which are of most importance in evaluating gelatins for photographic purposes, *e.g.*, p. 207, Fig. 41 shows what the author calls a viscosity—jelly strength curve, but which one would prefer to look upon as a viscosity cooling curve, since viscosity is plotted against temperature. Such curves are of the highest value to the photographic manufacturer, because with practice they indicate what a gelatin is likely to do under actual working conditions. This point appears to have been entirely overlooked in the volume under review. No mention is made of the necessity of allowing the gelatin solution or dispersion to attain equilibrium before proceeding to determine its viscosity, though neglect of such a precaution is a fruitful source of anomalous results.

The volume is disappointing, though much may be due to the inadequate space available: it is at times even irritating, when for example one finds the name Procter spelt in two different ways on the same page. There are fortunately few substances so difficult to investigate or so protean in form and character as gelatin. Equally, there are few substances that have been more strenuously investigated during the past decade. One cannot but expect that a monograph devoted to these aspects of the material should convey this newer knowledge concisely and clearly. Such a monograph is urgently needed, and few are better equipped for such a task than the author of this work on gelatin. It is to be hoped that changes will be made in any subsequent edition so that the work shall more truly represent the standard of the Kodak Research Laboratory at Rochester, and the real knowledge of the writer of the book.

H. W. Greenwood

I. Michael Faraday. By W. L. Randell. Pp. 187. The Roadmaker Series. London: Leonard Parsons, 1924. Price 4s. 6d.

II. The Life of Sir William Crookes. By Dr. E. E. Fournier d'Albe. With a Foreword by Sir Oliver Lodge, D.Sc., F.R.S. Pp. xix+413. London: T. Fisher Unwin, Ltd., 1924. Price 25s.

III. The Life of John William Strutt, Third Baron Rayleigh. By his son, R. J. Strutt, Fourth Baron Rayleigh. Pp. xi+403. London: E. Arnold & Co. 1924. Price 25s.

Biography is a fascinating art, and in proportion to its fascination so the rules mount up for the guidance or confusion of biographers. Dr. Johnson held that a man's life was best written by himself, and when this condition cannot be fulfilled one must ask, at least, that the subject of the biography be made to live in the brief space of the book. The three biographies under review exhibit three different ways of approaching the problem.

I.—The author of this life of Faraday, realising that previous biographies had been mainly concerned with the scientist, has desired to make a clearer picture of the man himself. In this he has well succeeded, and the qualities of Faraday are well brought out, sufficient mention being made of his researches to show their importance. We see Faraday, the errand-boy, promoted to book-binding, his tireless efforts at self-education, and the romantic conditions under which he became assistant to Humphry Davy at the Royal Institution. An interesting account is given of the period of travel on the Continent as valet-assistant to Davy, and a chapter on the state of science in 1791 provides an

introduction to Faraday's researches, which culminated in the production of the first electromotor and his pioneer work on electrolysis. The manifold activities that filled the remaining years of his life are well described, and the book concludes with an appreciation of his qualities, his modesty and lovable character, and his dislike of hypothesis and love of experimental research—a quality which explains the almost unvarying accuracy of his deductions. The author is rightly fascinated with his theme, and has produced a most readable little book, which, as it is also well presented, will make a pleasant companion during a winter evening.

II.—The life of Sir William Crookes is of unusual interest, not only as a record of scientific achievement, but also for the enigma presented by the man. Sir Oliver Lodge, in his foreword, says that "in his (Crookes') presence one did not feel the worshipful enthusiasm which some of the great men of science have aroused," and further implies that "the brilliance of Crookes' discoveries," rather than his personal qualities, "forced him into the highest official position a scientific man can attain"—the presidency of the Royal Society. In addition, his activities in the world of finance and in the much less substantial world of spiritualism are unusual elements in the life of a great chemist.

As far as possible Dr. Fournier d'Albe has allowed Crookes to tell his own story, utilising correspondence freely as well as extracts from his writings. A clear picture is given of Crookes' student days under Hofmann, and of the peregrinations that led to the establishment of the *Chemical News*, which Crookes edited whilst carrying out researches and acting as a consultant. His work in spectroscopy that led to the discovery of thallium is interestingly described, and a fair account is given of the controversy with Lamy over priority in the discovery. After gaining his F.R.S. in 1863, Crookes passed through a troubled period, and his time was occupied with the use of carbolic acid as a disinfectant, the recovery of gold by the amalgamation process, and many lawsuits. These lawsuits and numerous appearances in the courts as an expert witness gained for Crookes a reputation for pugnacity, an aspersion which he indignantly repudiated. His work on the atomic weight of thallium bears witness to his unwearied patience, his accuracy, and his ingenuity in dealing with difficulties. Perhaps the culminating point of his career came with the British Association address on "radiant matter," but a chemist who could claim credit for the discovery of thallium, the radiometer and cathode-ray phenomena, as well as for speculations on the origin of the elements that were far in advance of his time, had no reason for dissatisfaction.

The book gives a vivid picture of the career of a most unusual personality, and yet leaves one—despite its undoubted interest—with a vague dissatisfaction. It is difficult to say whether the cause lies in Crookes' personality and his dealings in *haute finance*, or in the somewhat detached attitude of the biographer. It is certain, however, that the book should be on the shelves of every chemist, because it faithfully describes the work of a great pioneer in chemistry.

III.—It was laid down by Dr. Johnson that only those that live with a man can write his life with exactness and discrimination. This condition is fulfilled by the admirable life of the late Lord Rayleigh which has been prepared by his son, himself a distinguished physicist.

Lord Rayleigh was born with great advantages, and almost from the first he was successful, his reputation being made by his first book, a treatise on sound, published at the age of thirty-three. Despite the claims due to his social position, his one end was the pursuit of knowledge, an aim which he followed with entire devotion. Honours poured upon him, but he remained always a simple, modest gentleman, whose strongest affirmation was "I think you may take it . . . . " when asked for an opinion. Of the romantic his life held little; he was not imaginative or artistic, but he had a remarkable mind, and his son has, with tact and sympathy, enabled us to watch its workings.

Chemists will at once turn to the account of the discovery of argon, and they will find it remarkably clear and interesting. The author is particularly successful in showing how Sir William Ramsay became a co-partner in the discovery, both scientists emerging with credit from a delicate position. The logical beauty of the steps which led Lord Rayleigh from his inquiry into the reason for the apparent departure of the atomic weights from whole numbers to the discovery of argon is well brought out, and the consequences of the work—the arc process of fixing atmospheric nitrogen, the discovery of the inert gases and Aston's work on isotopes—are lucidly explained. For Rayleigh's work on sound, the diffraction grating, the spectroscope, and electrical standards, his collected scientific papers must be consulted, but sufficient account of them is given to make the biography a true picture of the man. Rayleigh was a physicist, but his life is full of interest for chemists. Did he not say, "If you want a thoroughly troublesome job, take up some chemical problem," and did he not relate with relish that Pepper, lecturing before Queen Victoria, said, "The oxygen and hydrogen will now have the honour of combining before your Majesty?" The life of Lord Rayleigh is a fascinating book that should be widely read.

NOTES FROM CANADA

The total revenue of the Hydro-Electric system of Ontario in 1913 was $2,017,439, whereas in 1923 it was $17,219,044, an increase of 557·9 per cent.

The Chemistry department of Laval University, Quebec, has moved into the new building. The late Sir William Price gave $25,000, the income from which is to be used to provide bursaries for students. He also gave $25,000 to the department funds.

At the Royalite No. 4 well, near Black Diamond, in Turner Valley, about fifty miles south-west of Calgary, Alberta, the Imperial Oil Co. has struck a very heavy flow of rich gas at 3740 feet. The flow is 20,000,000 cub. ft. a day, and the gas has a high oil content.

Books Reviewed, November, 1923 to November, 1924

The date on which the review appeared is given in brackets at the end of each entry

CHEMISTRY

ABDERHALDEN, E. Pflanzenuntersuchungen, Handbuch der Biologischen Arbeitsmethoden. Abt. XI. Part 2. No. 4. Pp. 656—764. Berlin: Urban and Schwarzenberg, 1924. Price 5·25 Swiss fr. (May 16, 1924.)

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BITHELL, J. Chemische Grundbegriffe. By Prof. A. Benrath. Bilingual Series. Edited by J. E. Mansion. Pp. 80+80. London: George G. Harrap and Co., Ltd., 1924. Price 2s. (Feb. 8, 1924.)

BLANCHARD, A. A., and J. W. PHELAN. Synthetic Organic Chemistry: A Course of Laboratory and Classroom Study for 1st Year College Students. Third edition entirely rewritten and enlarged. Pp. xiv+321. New York: J. Wiley and Sons, Inc. London: Chapman and Hall, Ltd., 1922. Price 15s. (Dec. 7, 1923.)

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CUMMING, W. M. Systematic Organic Chemistry. I. V. Hopper and T. S. Wheeler. Pp. xxii+535. London: Constable and Co., Ltd., 1923. Price 25s. (Jan. 25, 1924.)

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HITCHCOCK, F. L., and C. S. ROBINSON. Differential Equations in Applied Chemistry. Pp. vi+110. New York: John Wiley and Sons; London: Chapman and Hall, 1924. Price 7s. 7d. (Feb. 22, 1924.)

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MECKLENBURG, W. Kurzes Lehrbuch der Chemie. Second edition. Pp. xvi+793. Brunswick: F. Vieweg and Sons, 1924. Price, paper 20m., bound, 23m. (Aug. 22, 1924.)

MELLOR, J. W. A Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. IV. Pp. x+1074. London: Longmans, Green and Co., 1923. Price 63s. (Jan. 4, 1924.)

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PHYSICS

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Houston, R. A. Light and Colour. Pp. xi+179. London: Longmans, Green and Co., 1923. Price 7s. 6d. (June 6, 1924.)

Houston, R. A. A Treatise on Light. Pp. xi+486. New edition, revised and enlarged. London: Longmans, Green and Co., 1924. Price 12s. 6d. (June 6, 1924.)

Rice, J. Relativity, a Systematic Treatment of Einstein's Theory. Pp. xiv+389. London: Longmans, Green and Co., 1923. Price 18s. (Jan. 18, 1924.)

GENERAL

Rickard, T. A. Technical Writing. Second edition, rewritten and enlarged. Pp. ix+337. New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1923. Price 10s. (Dec. 21, 1923.)

Comptes Rendus du Troisième Congrès de Chimie Industrielle (Paris, October 21–27, 1923). Pp. 1000. Paris: Société de Chimie Industrielle, 49, Rue des Mathurins. Subscription price, 50 fr. (May 16, 1924.)

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CHEMICAL INDUSTRY

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Bearn, J. G. The Chemistry of Paints, Pigments and Varnishes. Pp. x+277. London: E. Benn, Ltd., 1923. Price 30s. (Dec. 28, 1924.)

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DURVELLE, J. P. The Preparation of Perfumes and Cosmetics. Translated from the fourth French edition by E. J. Parry, B.Sc. Pp. viii+420. London: Scott, Greenwood and Son, 1923. Price 21s. (Feb. 8, 1924.)

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HECHT, H. Lehrbuch der Keramik. Pp. 336. Berlin and Vienna: Urban and Schwarzenberg, 1923. (Dec. 28, 1923.)

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LANGE, OTTO. Chemisch-Technische Vorschriften. Vol. IV. Dungemittel (Sprengstoffe), Futtermittel, Lebensmittel. Third edition completely revised and enlarged. Pp. 21-750. Leipzig: O. Spamer, 1924. Price, paper, 45 g.m. bound 50 g.m. (Sept. 12, 1924.)

LEDERLIN, P. Blanchiment. Teinture, Impression, Apprets. Edited by Prof. C. Matignon. Pp. 543. Paris: J. B. Bailliere, 1923. Price, paper, 45 frs.; bound, 55 frs. (Nov. 23, 1923.)

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MITCHELL, H. V. Fuel Oils and Their Applications. Pp. xii+171. London: Sir I. Pitman and Sons, Ltd., 1924. Price 5s. (April 25, 1924.)

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Nickel Ores. Monograph issued by the Imperial Institute. Pp. 80. London: John Murray. Price 5s. (March 14, 1924.)

NICOL, E. W. L. Coke and Its Uses, in Relation to smoke Prevention and Fuel Economy. Pp. xii+132. London: E. Benn Bros., Ltd., 1923. Price 10s. 6d. (Dec. 21, 1923.)

PARKES, J. W. Concentration of Sulphuric Acid (Lunge-Cumming Series). Pp. xii+394. London: Gurney and Jackson, 1924. 31s. 6d. net. (July 4, 1924.)

PARRISH, P. The Design and Working of Ammonia Stills. Pp. xvii+283. London: E. Benn Bros., Ltd., 1924. Price 40s. (Sept. 19, 1924.)

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PORTER, H. C. Coal Carbonisation. American Chemical Society Monograph Series. Pp. 442. New York: The Chemical Catalog Co., Inc., 1924. Price $6. (Oct. 17, 1924.)

POUCHER, W. A. Perfumes and Synthetics with Special Reference to Synthetics. Pp. xi+462. London: Chapman and Hall, Ltd., 1923 Price 21s. (Feb. 8, 1924.)

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SEARLE, A. B. The Chemistry and Physics of Clays and Other Ceramic Materials. Pp. xiii+695. London: Ernest Benn, Ltd., 1924. Price 55s. net. (March 14, 1924.)

SEELIGMANN, F., and EMIL ZIEKE. With the collaboration of W. Schlick and Dr. F. Zimmer. Handbuch der Lack- und Firnisindustrie. Third edition. Pp. 827. Edited by E. Zieke and Dr. H. Wolff, Berlin, 1923. (Nov. 16, 1923.)

SIMONS, T. Ore Dressing. Principles and Practice. First edition. Pp. xvii+292. London: McGraw-Hill Publishing Co., Ltd., 1924. Price 17s. 6d. (July 4, 1924.)

SINGER, FELIX. Die Keramik im Dienste von Industrie und Volkswirtschaft. Brunswick: Fr. Vieweg and Sohn, A.-G., 1924. Price 50s. (May 16, 1924.)

SMITH, S. The Action of the Beater. Translated by Major R. Marx, Pp. xi+212. London: The Technical Section of the Papermakers' Association of Great Britain and Ireland, 1923. Price 15s. (Sept. 19, 1924.)

SMYTHE, J. A. Lead. Its Occurrence in Nature, The Modes of Its Extraction, Its Properties and Uses, with some Account of Its Principal Compounds. Monographs on Industrial Chemistry. Edited by Sir Edward Thorpe, C.B., F.R.S. Pp. vi+343. London. Longmans, Green and Co., 1923. Price 16s. net. (Jan. 18, 1924.)

SPIELMANN, P. E. The Constituents of Coal Tar. Pp. xii+219. London: Longmans, Green and Co., 1924. Price 12s. 6d. (Nov. 14, 1924.)

STILLMAN, A. L. Briquetting. Pp. x+466. Easton, Pa. Chemical Publishing Co., 1923. Price $6.0. (July 11, 1924.)

STRACHE, H., and R. LANT. Kohlenchemie. Pp. xvi+599. Leipzig: Akademische Verlag G. m.b.H., 1924. Price, paper, 24 goldmarks bound, 26 g.m. (June 27. 1924.)

VEZES, M., and G. DUPONT Résines et Térébenthines; les Industries Dérivées. Encyclopedie de Chimie Industrielle. Pp. 656. Paris: J. B. Bailliere et Fils., 1924. Price, paper, 60 fr.; bound, 70 fr. (July 11, 1924.)

VOGEL, J. H., and ING. ARMIN SCHULZE. Carbid und Acetylen, als Ausgangsmaterial für Produkte der Chemischen Industrie. Pp. 130. Leipzig: Otto Spamer 1924. Price, paper, 5 g.m. bound, 6 g.m (Oct. 10, 1924.)

WARNES, A. R. Coal Tar Distillation and Working-Up of Tar Products. Third edition, rewritten and enlarged Pp. xv+511. London: Ernest Benn, Ltd., 1923. Price 45s. (Feb. 1, 1924.)

WYLD, W. Manufacture of Sulphuric Acid (Chamber Process). (Lunge-Cumming Series.) Pp. xi+424. London: Gurney and Jackson, 1924. 31s. 6d. (July 4, 1924.)

FORTHCOMING EVENTS

Dec. 1. OIL AND COLOUR CHEMISTS' ASSOCIATION, Joint Discussion with the SOCIETY OF CHEMICAL INDUSTRY, *London Section*, Chemical Society's Rooms, Burlington House, Piccadilly, London W. 1, "Protective Paints."

Dec. 1. INSTITUTION OF ELECTRICAL ENGINEERS, *Western Centre*, South Wales Institute of Engineers, Cardiff, at 6 p.m. "Modern Illumination," Demonstration by W. E. Bush.

Dec. 1. ROYAL SOCIETY OF ARTS, John Street, Adelphi, London, W.C. 2, at 8 p.m. Cantor Lecture, "Modern Colour Problems," by L. C. Martin. Also on December 8.

Dec. 1. UNIVERSITY OF BIRMINGHAM CHEMICAL SOCIETY. Chemical Lecture Theatre, Edgbaston, Birmingham, at 5.30 p.m. "The Bohr Theory of Atomic Structure," by R. E. Kellett.

Dec. 1. INSTITUTION OF THE RUBBER INDUSTRY, *London and District Section*, Engineers' Club, Coventry Street, London, W., at 8 p.m. "Research Work on the Plantation," by Major B. J. Eaton.

Dec. 2. INSTITUTE OF METALS, *Birmingham Section*, Chamber of Commerce, New Street. 7 p.m "Metal Spraying," by W. E. Ballard.

Dec. 2. INSTITUTE OF METALS, *North-East Coast Section*. Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. "Aluminium, its Production and Uses," by G. B. Brook.

Dec. 2. WEST YORKSHIRE METALLURGICAL SOCIETY, George Hotel, Huddersfield, at 7.30 p.m. Discussion on "The Corrosion of Engineering Materials."

Dec. 2. IMPERIAL COLLEGE CHEMICAL SOCIETY. Main Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W. 7, at 5 p.m. "The Specific Heats of Gases," by Prof. J. R. Partington.

Dec. 2. INSTITUTION OF PETROLEUM TECHNOLOGISTS, at the House of the Royal Society of Arts, John Street, Adelphi, London, W.C. 2, at 5.30 p.m. "Fuel Oil Resources of the Future," by A. W. Nash and H. G. Shatwell. "The Somerset Oil Shales," by H. G. Shatwell, A. W. Nash, and J. Ivor Graham.

Dec. 3. INSTITUTE OF CHEMISTRY, *Leeds Area Section.* Annual Meeting will be held in the Great Northern Hotel, Leeds, at 7 p.m., instead of on November 26

Dec. 3. LITERARY AND PHILOSOPHICAL SOCIETY, *Chemical Section*, the Museum, New Walk, Leicester, at 8 p.m. "The Action of Light on the Photographic Plate," by Dr. T. Slater Price.

Dec. 3. ROYAL SOCIETY OF ARTS, John Street, Adelphi, London, W.C. 2, at 8 p.m. "The Teaching of Science in Secondary Schools," by Prof. C. A. Carus Wilson.

Dec. 3. SOCIETY OF CHEMICAL INDUSTRY, *Nottingham Section*, University College, Nottingham, at 7.30 p.m. A paper on Glass will be given by Prof. W. E. S. Turner.

Dec. 4. CHEMICAL SOCIETY, Burlington House, Piccadilly, W. 1, at 8 p.m. Ordinary Scientific Meeting. (1) "New Halogen Derivatives of Camphor. Part VI. β-Bromocamphor-α-sulphonic acid," by H. Burgess and T. M. Lowry. (2) "New Halogen Derivatives of Camphor. Part VII. The Constitution of the Reychler Series of Camphorsulphonic acids. Experiments on Chlorosulphoxides," by H. Burgess and T. M. Lowry.

Dec. 4. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section*, Chemical Department, The University, Woodland Road, Bristol, at 7.30 p.m. "Some International Aspects of the Dye Industry," by W. E. Fearnsides.

Dec. 4. SOCIETY OF DYERS AND COLOURISTS, *Bradford Junior Branch.* "Cotton Finishing," by E. Pearson.

Dec. 4. SOCIETY OF DYERS AND COLOURISTS, *West Riding Section.* "The Moth Proofing of Textiles and other Wearing Apparel," by C. O. Clark.

Dec. 4. INSTITUTE OF METALS, *Sheffield Section*, The University, St. George's Square, Sheffield, at 7.30 p.m. "Electro-Plating." Discussion to be opened by A. Jefferson. (Conjoint Meeting with the Silver Trades Society.)

Dec. 4. INSTITUTE OF CHEMISTRY, *Huddersfield Section.* "The Pioneers of Chemical Industry in Huddersfield," by Dr. L. Gordon Paul.

Dec. 5. SOCIETY OF CHEMICAL INDUSTRY, *Manchester Section*, Textile Institute, 16, St. Mary's Parsonage, Manchester, at 7 p.m. "Peptisation," by A. V. Slater.

Dec. 5. SOCIETY OF CHEMICAL INDUSTRY, *Liverpool Section*, Muspratt Lecture Theatre, The University, Liverpool, at 6 p.m. "Liquid Hydrocarbons obtained in the Compression of Oil Gas," by P. Lewis-Dale.

Dec. 5. INSTITUTION OF MECHANICAL ENGINEERS, Storey's Gate, London, S.W. 1, at 6 p.m. (1) "The Effect of Low and High Temperatures on Materials," by Prof. F. C. Lea, and (2) "The Elastic Limit in Tension, its Influence on the Breakdown by Fatigue," by J. M. Lessells.

Dec. 5. UNIVERSITY OF LONDON, King's College, *Faculty of Science*, Strand, London, W.C. 2, at 5.30 p.m. "The Historical Development of the Measurement of Stress in Materials Subjected to Load," by Prof. E. G. Coker.

Alteration.—The January meeting of the Manchester Section of the Society of Chemical Industry which had been arranged for January 2 is now arranged for January 9. In this meeting it is hoped that in addition to the paper by Messrs. Simpkin and Sinnatt, the Section will have the honour of welcoming and hearing a paper by Prof. Hugh S. Taylor of Princeton University, U.S.A., the title of his address to be "The Properties of a Catalytic Surface."

SOCIETY OF CHEMICAL INDUSTRY

MEETING OF COUNCIL

The monthly meeting of Council was held on November 14, the President (Mr. W. J. U. Woolcock, C.B.E.) in the Chair.

It was agreed to send an Address of Congratulation to the University of Leeds on the occasion of the celebration of its Coming of Age in December.

An invitation was received from the Committee of the London Section to hold the Annual General Meeting of the Society in London in 1926, and it was unanimously resolved to recommend to the Annual General Meeting in 1925 that this invitation be accepted.

The Society's representatives on Outside Bodies were re-elected for the year 1924–25 as follows :—

Federal Council for Pure and Applied Chemistry :—Mr. F. H. Carr, Dr. S. Miall, and Mr. W. J. U. Woolcock.

National Physical Laboratory (*General Board*) :—Sir Wm. J. Pope and Prof. J. W. Hinchley.

British Engineering Standards Association :—Aircraft Sub-Committee on Chemicals : Prof. W. A. Bone. Sub-Committee on Textiles : Mr. C. F. Cross. Sub-Committee on Dopes : Dr. J. N. Goldsmith. Sectional Committee of Chemical Engineering : Mr. C. S. Garland, Capt. C. J. Goodwin, Dr. W. R. Ormandy, and Mr. J. A. Reavell.

Imperial Mineral Resources Bureau :—Lead, Silver, Zinc, and Cadmium Sub-Committee : Mr. H. M. Ridge. Aluminium, Magnesium, Potassium, and Sodium Sub-Committee : Dr. R. Seligman. Minor Metals Sub-Committee : Mr. W. G. Wagner. Publication and Libraries Sub-Committee : Mr. W. J. A. Butterfield. Abstracts Sub-Committee : Prof. H. Louis and Mr. T. F. Burton. Chemical Industries Sub-Committee : Mr. C. S. Garland.

British Empire Sugar Research Association :—Prof. A. R. Ling and Mr. J. W. Macdonald.

Joint Committee for the Standardisation of Scientific Glassware :—Mr. F. H. Carr, Dr. R. T. Colgate, and Dr. Bernard Dyer.

Governing Board of Imperial College of Science and Technology :—Sir William Pearce.

Reference was made to the recent death of Mr. J. T. Wood, of Nottingham, an old member of the Society, a past Chairman of the Nottingham Section, and a contributor of valuable papers to the *Journal*. It was unanimously resolved to send a letter of sympathy to Mrs. Wood.

Reports of various Committees were submitted, and 28 new members were elected :—Home, 23 ; Overseas, 5.

The next meeting of Council will be held on Friday, December 12, 1924, at 2.30 p.m.

SUSPENSION OF ENTRANCE FEE

As an inducement to Chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Society in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 4, June 13 and 27, July 4 and 25, September 19, or October 3 and 17, 1924, that they are willing to dispose of to the Society.

DEATHS

Fergusson, Donald M. (elected 1902), of 285, Fifty-first Avenue East, Vancouver, B.C., Canada, Analytical Chemist. In April, 1924.

Hellon, Dr. Robert (elected 1885), of 40, New Lowther Street, Whitehaven, Analytical Chemist. On Nov. 9, 1924.

Wood, Joseph T. (elected 1887), of 62, Park Road, Nottingham, Tanner. On Nov. 9, 1924.

LIVERPOOL SECTION

The second meeting was held on November 21, Mr. Edwin Thompson in the chair. In opening the proceedings, the chairman congratulated Dr. G. C. Clayton on his re-election to Parliament and also welcomed Prof. E. C. C. Baly on his return from his lecture tour in America.

Mr. J. L. F. Vogel, who read a paper entitled, "Notes on Alloy Metals used in Alloy Steels," said he wished to draw the attention of chemists to the wide field covered by the metallurgy of alloy steels and to the part played by chemistry in their production. He emphasised the very large extent to which alloy steels were now employed and showed how the intense concentration on the production of munitions during the war revealed the important part played by these steels and by the rarer metals employed in their manufacture. The first point to be remembered was that manufacturers and consumers were interested solely in the physical properties of steel; for them chemical analysis was merely a means of ensuring uniformity in production and freedom from deleterious impurities.

Accepted views on the structure of alloy steels were explained and the physical characteristics of the different alloy metals and deleterious impurities were tabulated for comparison. The extent to which useful information could be deduced from this table was discussed and each metal was briefly considered with reference to its effect on steel, its production from the ores and the sources of supply. The problem facing makers of ferro-alloys and alloy metals for steel was that the products they supplied must contain the desired metals within comparatively narrow limits and that they must be very free from any deleterious or even doubtful impurities, and they had to realise that their products would be judged more by their physical properties than by their composition. Broadly speaking, ferro-alloys such as ferro-tungsten, ferro-chrome and ferro-molybdenum, which were reduced directly from the ores by electric furnace or by thermit processes, called for the purest raw materials, since the possibility of eliminating impurities in the course of manufacture was very limited. The pure metals such as nickel, cobalt, tungsten, or chromium, could be produced from considerably less pure raw materials since the impurities could be eliminated in processes of manufacture. Alloy steels complying with a specification as to physical properties could sometimes be obtained by several different mixtures and the cost of raw materials was, therefore, an important consideration. Finally, attention was drawn to the need for improved quick methods of assay for mixtures and alloys of the various metals, and for improved processes for commercial production of the metals and ferro-alloys.

CHEMICAL SOCIETY

An ordinary scientific meeting was held on Thursday, November 20, the President, Prof. W. P. Wynne, occupying the Chair. Fellows were invited to attend, on December 9, at 4.30 p.m., a meeting of the Faraday Society: a group of papers on "Base Exchange in Soils" would be read. It was also announced that an award of the Harrison Memorial Prize would shortly be considered, and that applications, nominations or information should reach the President of the Chemical Society not later than December 1. Applications for the Annual Reports for 1924 (Fellows' price, 5s. 6d.) should also be received as soon as possible.

The first two papers were read by Dr. F. Challenger:—

The sulphur compounds of Kimmeridge shale oil. Part I. [With J. R. A. Jinks and J. Haslam.]

The authors find that on removal of bases, phenols, and traces of ketones from that portion of the oil which is volatile in steam, and subsequent distillation under reduced pressure, a fraction b.p. 80–100° is obtained. From this fraction 2-methylthiophen identified as mercury 2-methylthienyl chloride and bromide was obtained. Also tribromo-2-methylthiophen, b.p. 86–87° was obtained from the regenerated oil. The same fraction also contains toluene. The highest fractions of the oil are semi-solid, and on treatment with alcohol and ether, yield a sulphur-free wax-like solid, b.p. 62–63°.

The interaction of thiocyanogen and of hydrogen sulphide with unsaturated compounds. Part II. [With T. H. Bott.]

The product obtained from thiocyanogen and styryl methyl ketone (*T.*, 1923, **123**, 1055) has a composition PhCH:C(SCN)·COMe. It is probable that thiocyanogen forms an unstable dithiocyano-additive product with styryl methyl ketone, which loses a molecule of thiocyanic acid. Distyryl ketone gives a compound of analogous composition containing 2 thiocyano groups. Carvone also forms a mono-thiocyano-derivative. When styryl methyl ketone reacts with hydrogen sulphide, duplobenzylidene-acetone sulphide is obtained, for which Fromm has suggested the structure

$$\begin{array}{l} CH_3C(OH)\text{——}CH{:}CHPh \\ \quad\quad\;\; \rangle S \\ CH_3C(OH)\text{——}CH{:}CHPh \end{array}$$

the corresponding disulphide and the additive products from hydrogen sulphide and styryl phenyl

ketone being formulated similarly. On general considerations, and from analogy with carvone and carvotanacetone hydrosulphides, the structure

$$\begin{array}{c} CH_3.COCH_2.CHPh \\ | \\ S \\ | \\ CH_3.CO.CH_2.CHPh \end{array}$$

would appear more probable. The authors find that duplobenzylideneacetone sulphide is stable towards bromine in chloroform. With the disulphide the reaction is complicated, but indicates a saturated structure.

Prof. C. S. Gibson communicated :—

A new method for the preparation of 9-alkylcarbazoles. [With H. Burton.]

N-Methyl- (or ethyl) anthranilic acid condensed with *o*-bromonitrobenzene in the presence of potassium carbonate and copper powder yields 2′-nitro-*N*-methyl-(or ethyl)-diphenylamine-6-carboxylic acids. These acids on reduction with ferrous sulphate and ammonia are converted into the corresponding amino-acids which are easily characterised by well-defined acetyl-derivatives. The amino-acids, on being heated above their melting points lose a molecule of water, and give lactams (compare Clemo, Perkin, and Robinson, *J.*, 1924, **125**, 1779). The corresponding acetyl-derivative, under similar conditions, gives rise to the same lactam. 2′-Nitro-N-methyldiphenylamine-6-carboxylic acid gives a small yield of 9-nitro-N-methylacridone when it is heated with 95% sulphuric acid. The amino-acids, on diazotisation and treatment with sodium hydroxide solution form the corresponding 9-alkylcarbazole.

Prof. R. Robinson said it was significant that the carboxyl group should in the reaction described be so very easily displaced under the influence of a positively charged diazonium complex. It had long been realised that in aromatic substitution the entering group is positive and that displacement of a carboxyl group is analogous to substitution. The case under discussion was an excellent example of the combination of these hypotheses.

Dr. N. V. Sidgwick discussed :—

The behaviour of the simple halides with water.

The four results of treating the simple halides with water can be explained if we assume (A) that that water can form co-ordinate linkings either through its hydrogen or its oxygen, (B) that the maximum covalency of an element is 4 from Li to F, 6 from Na to Br, and 8 for the heavier elements.

(1) Ionisation will be promoted by hydration of the ion, through the negative effect of the co-ordinate linking; thus with a covalency of 4 we get Li^+ and Be^{++}: with 6, Na^+, Mg^{++}, and Al^{+++}: quadrivalent cations only appear when a covalency of 8 is reached (Sn^{++++}).

(2) If the element can take up two more electrons, it will join to the O of the water; the H will react with the Cl, giving hydrolysis to the hydroxide and HCl (BCl_3, $SiCl_4$, PCl_3, PF_6, IF_5, MoF_6, TeF_6, WF_6, WCl_6, UF_6).

(3) If it is exerting its full covalency already, it cannot combine with water at all, and will not react: CCl_4, SF_6, SeF_6.

(4) In NCl_3 and OCl_2 the covalency is below the maximum, but the octet is full and cannot expand; hence it will share a pair of its own electrons with the hydrogen of the water, giving $HOH \rightarrow NCl_3$. This will then lose HOCl, forming NH_3.

Prof. R. Robinson briefly referred to the anomaly of carbon tetraiodide, as also did the author, with whose fruitful ideas he was in general agreement.

Prof. H. Bassett pointed out that whether addition of water caused ionisation or hydrolysis seemed to depend on the number of added water molecules being large in comparison with that of the halogen atoms, or vice versa; actually, both ionisation and hydrolysis occurred together.

Prof. T. M. Lowry referred to a statement made, he believed, by Ciamician in 1891, that " water adds on in two different ways: to metallic atoms with oxygen inside, and otherwise with hydrogen inside."

Prof. R. Robinson then briefly described the syntheses dealt with in the following three papers :—

Experiments on the synthesis of certain higher aliphatic compounds. Part I. A synthesis of lactarinic acid and of oleic acid. [With (Mrs.) G. M. Robinson.]

A method of preparation of long-chain keto-acids has been devised. An ethyl alkylacetoacetate is converted into its sodium derivative and condensed with the ester chloride of a dibasic acid. The product is submitted to hydrolysis in stages. Starting with *n*-undecyl iodide and adipic acid, lactarinic acid, $CH_3{\cdot}[CH_2]_{11}{\cdot}CO{\cdot}[CH_2]_4{\cdot}CO_2H$, was obtained whilst *v*-ketostearic acid was prepared from *n*-heptyl iodide and sebacic acid. The conversion of *v*-ketostearic acid into oleic acid has already been carried out. The communication also contains an account of the reduction of stearolic acid to pure oleic acid and of the synthesis of γ-ketopalmitic acid, $CH_3{\cdot}[CH_2]_{11}{\cdot}CO{\cdot}[CH_2]_2{\cdot}CO_2H$.

A synthesis of pyrylium salts of anthocyanidin type. Part V. The synthesis of cyanidin chloride and of delphinidin chloride. [With D. D. Pratt.]

The methods whereby the authors synthesised pelargonidin (Part III) have been applied to the cases of cyanidin and delphinidin which are mono- and dihydroxy derivatives of pelargonidin respectively. ω-Methoxyacetoveratrone and ω-3:4:5-tetramethoxyacetophenone were required for these syntheses and obtained by a method exemplified in the case of the former. Veratroyl chloride and ethyl sodio-α-γ-dimethoxyacetoacetate react in ethereal solution to a product which yields pure ω-methoxyacetoveratrone on careful hydrolysis with dilute aqueous potassium hydroxide. It condenses with 2-hydroxy-4:6-dimethoxybenzaldehyde in presence of hydrogen chloride in ethereal solution with formation of the pentamethyl ether of cyanidin chloride and this is changed by boiling hydriodic acid and phenol into

cyanidin iodide. By double decomposition with silver chloride the chloride was produced and proved to be identical with the substance of natural origin. The synthesis of delphinidin was carried out in a similar manner.

A synthesis of myricetin and of a galangin monomethyl ether occurring in galanga root. [With J. Kalff.]

THE action of benzoic anhydride and sodium benzoate on ω-methoxychloracetophenone at 180° leads to a product which yields Testoni's *galangin monomethyl ether* on hydrolysis. Substituting trimethylgallic acid derivatives for those of benzoic acid, myricetin tetramethyl ether is obtained and this yields myricetin on demethylation.

CORRESPONDENCE

THE CHEMICAL SOCIETY

Sir,—Among the suggestions made by Prof. T. S. Patterson, in your issue of November 21, 1924, by way of overcoming some of the difficulties which now beset the Chemical Society, there is one to which I, in common with many others, would take strong exception—namely, that of abolishing the summaries and conclusions which I think it is most desirable to cultivate at the end of communications relative to chemical work.

Chemical literature is so profuse nowadays that it is impossible, no matter to what extent one may specialise, to study all papers in detail, and, on the other hand, it appears to me that much of the detail could be, with advantage, omitted or condensed, and more care be taken to draw and express conclusions.

There is, however, only one radical cure for the troubles which are encountered by the Chemical and allied societies—namely, the creation of one real Institute of Chemistry, as first suggested by the writer in the "Chemical Trade Journal" (of April 8, 1916), a subject which is now engaging, as I understand, considerable attention at other hands, under the term "Chemistry House."

One comprehensive journal of transactions (planned sectionally) and one set of abstracts of papers from sources outside Chemistry House, are the great desirabilities.—Yours faithfully, C. T. KINGZETT

November 24, 1924.

PERSONAL AND OTHER ITEMS

H.R.H. the Prince of Wales has consented to open the new Chemistry Department of the University of Edinburgh on December 3.

The Council of the University of Birmingham has made the following appointments for the session 1924–25: Mr. A. R. Bowen to be Research Worker in the Department of Oil Mining, Mr. S. H. Edgar to be teaching scholar in the Department of Chemistry, Mr. A. W. Paynton to be Student Demonstrator in the Department of Bio-chemistry of fermentation.

Mr. J. W. Saville, who has been employed on the commercial staff of Messrs. Brotherton and Co., Ltd., for more than forty years, has been appointed a Justice of the Peace for Wakefield.

The Scholarship of the Institution of Petroleum Technologists, granted to a student member of the Institution who is completing the petroleum technology course at Birmingham University, has been awarded to Mr. Geoffrey Cotton.

Captain Oliver Lyttelton, D.S.O., has been elected to a seat on the board of the British Metal Corporation, Ltd., and has been appointed a joint managing director.

MM. Painlevé, Gaston Menier, E. Borel, Dal Piaz, Dervillé, Albin Haller, Picard, Rateau Koenigs and others have been appointed for four years' membership of the Council of the Administration of the National Conservatoire of Arts et Métiers at Paris.

Mr. H. T. Cranfield, senior lecturer in agricultural chemistry and head of the chemical department of the Midland Agricultural and Dairy College, has been appointed adviser in agricultural chemistry for the Midland counties served by the College.

Isotopes of Cadmium; Tellurium and Bismuth

In a letter to *Nature*, dated November 4, Dr. F. W. Aston writes that he has now succeeded in obtaining and analysing the mass-rays of cadmium, tellurium and bismuth. By the use of an anode containing cadmium fluoride, rays were obtained which, though feeble, gave satisfactory results with long exposures and the most highly sensitised schumannised plates. Cadmium is a very complex element, having six isotopes: 110 (c), 111 (e), 112 (b), 113 (d), 114 (a), 116 (f.). The last is isobaric with the lightest isotope of tin. The intensities of the lines are in the order of the letters and agree reasonably with the chemical atomic weight 112·41. The most striking characteristic of the group is its remarkable similarity to that of tin. If we except the heaviest isotope of tin (124), which does not seem to have its counterpart in cadmium, the intensity relations between the isotopes of the two elements appear almost identical. This is a most suggestive fact and may have a deep significance in connexion with the relative stability of the nuclei of isotopes. The plates are not very favourable for accurate determinations of masses, but these seem integral with that of iodine.

The line of the latter element was extremely faint in these experiments, so it was considered a favourable opportunity to make another attempt on tellurium, which had defied all attacks during the earlier discharge tube work. A little pure metallic tellurium was ground into the anode mixture and success was at once obtained. Tellurium gives three lines of mass numbers—126, 128, 130. The intensities of the two latter appear about equal and double that of the first. This result was repeated with an anode containing tellurium and lithium fluoride, and there is no reason to doubt that these are all genuine isotopes. Comparison with other lines on the plates suggests that their masses may be less than whole numbers by one or two parts in a thousand, but it seems probable that the mean atomic weight is actually greater than 128, whereas all the later chemical determinations are less than that figure, the accepted value being 127·5. The element tellurium is unique among those so far

analysed, as it seems probable that all its mass-numbers form members of isobaric pairs. These are shared by xenon, the element of next higher even atomic number.

The boiling-point of tellurium is not very different from that of bismuth, so that it seemed possible that the latter might yield to the same treatment. This hope was realised with an anode containing metallic bismuth, and a single line appeared in the expected position—209. This line is very faint, and owing to the great mass lies in an unfavourable part of the plate, but there seems no reason to doubt that bismuth is a simple element of mass number 209, as recent determinations of its atomic weight suggest.

The Van't Hoff Celebration

This year half a century has passed since van 't Hoff (in September, 1874) and Le Bel (in November, 1874) published their celebrated memoirs which form the foundation of "Chemistry in Space," or Stereo-chemistry. In honour of this event, which is of such outstanding importance for the development of chemistry, a commemorative celebration has been held in the Aula of the University of Amsterdam, under the auspices of the Dutch Chemical Society and of the Dutch Society of Chemical Industry, at which Prof. Dr. Ernst Cohen, of Utrecht, and Prof. Dr. Paul Walden, of Rostock, spoke. At the request of the firm of J. A. A. Gerritsen, of Zeist (Holland), the well-known Dutch medallist, J. C. Wienecke, has prepared gratuitously a plaque (57 by 45 mm.) bearing the portrait of van 't Hoff at the age of 22, the age at which he published his theory. The plaque can be obtained from the above firm at the price of 2.50 Gulden, in bronze, or 12 Gulden in silver, or about 4s. 4d. and 2s., respectively.

British Standard Specifications for Fuel Oils

These Specifications for fuel for heavy-oil engines ("Petroleum and Shale Oils," No. 209, 1924) are some of the first fruits of the Sectional Committee on petroleum products of the British Engineering Standards Association. Specifications are given for four grades of fuel oil, one being a gas oil and the rest non-distillate oils; all classes of heavy-oil engines thus being catered for. Users of heavy-oil engines should satisfy themselves, by test or otherwise, which of the four grades of oil specified can most satisfactorily be utilised in any given engine, and the corresponding specification should then be adopted. It is of interest to note that no mention of specific gravity is made, as the conclusion has been reached that it is quite unnecessary to specify the specific gravity of a fuel oil provided the viscosity characteristics are clearly defined. Further, the sulphur content is not specified. Every effort was made to obtain evidence to prove that the harmful effects attributed to oils in certain cases were due to the sulphur in the oil. Pending the production of such evidence it has been decided that for fuel oils used in heavy-oil engines but not under boilers, a test for sulphur unnecessarily increases the cost of the oil. The specifications will be revised, if necessary, in twelve months' time. The methods of testing the oil given in these specifications are those adopted by the Institution of Petroleum Technologists, and are described in detail. Copies may be obtained from the B.E.S.A. Publications Department, 28, Victoria Street, London, S.W. 1, price 1s. 2d., post free.

Wood-charcoal Gas Producers

The French Commission de Carbonisation is obtaining satisfactory results in its work on the improvement of portable charcoal-gas producers. At present the French production of wood charcoal is only 150,000 metric tons, but this quantity could be increased, without harming the forests, to 1,000,000 t. The Commission proposes, whilst encouraging the development of the production of charcoal, to have recourse to carbonisation in the forests, and will therefore hold a competition in the following spring for transportable plant for carbonisation. Tests are under way at Sevran Livry, on different types of gas producers, the tests taking account of the analysis of the fuels, their resistance to shock, the analysis of the gas produced and the ash obtained, the measurement of the power produced, and other working characteristics.

COMPANY NEWS

BRIMSDOWN LEAD CO.

According to the *Investor's Chronicle* we understand that an important further step is about to be taken towards completely consolidating the white lead interests in this country. The Associated Lead Manufacturers' combine now embraces Cookson and Co., Ltd., the largest business of the kind in Great Britain; Locke, Lancaster and Johnsons, Ltd.; and Rowe Brothers. The capital is £740,000 in 6 per cent preference shares and £1,000,000 in ordinary shares. Arrangements are now being made to acquire the Brimsdown lead business, and thus strengthen the combine. The acquisition will be on a share basis, Brimsdown preference shareholders receiving 15s. per share (66 per cent. in preference and 33 per cent. in ordinary shares of the combine), and Brimsdown ordinary 3s. 6d., all in ordinary shares. It is expected that the directors of the Brimsdown Lead Co. will send details of the offer of the Associated Lead Manufacturers to the shareholders in the course of a few days and recommend its acceptance. The transfer books of the Brimsdown Co. are closed for a few days to facilitate payment of a dividend on the preference shares.

ILFORD, LTD.

The net profit for the year to October 31, 1924, amounted to £56,747, compared with £46,686 last year. The sum of £8802 was brought forward and there is a total of £65,549 for appropriation. £11,400 is for preference dividend, £5000 has been written off goodwill (against £10,000), and £10,000 has been transferred to reserve (against nil). The dividend, after being 8 per cent. for the last five years, has been raised to 10 per cent. on the ordinary shares, and the sum of £8149 is to be carried forward.

BRITISH SULPHATE OF AMMONIA FEDERATION, LTD.

The fourth annual general meeting was held on October 20, Mr. D. Milne Watson (President of the Gas, Light and Coke Co.) presiding. The outstanding features in the sulphate of ammonia market in the year under review was a large increase in consumption and a considerable fall in price. Organisations, similar to this federation, had been formed in France, Belgium, Holland, Germany, Italy, Japan and Australia, the chief objects being to establish and maintain a reasonable price for this product calculated to induce consumption on the largest scale, and also for the combination of propaganda effort. During the last eighteen months there had been an increase in consumption of nearly 200,000 t. of sulphate of ammonia on a total world production of, roughly, 2,500,000 t., and this increase was secured at a comparatively small sacrifice in price. An appeal was made to non-members, whose total production amounted to less than 10 per cent. of the output in this country, to join the federation and so enable it to increase its propaganda activities, and to carry through a reasonable and logical programme, beneficial both to consumer and producer.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 10s. per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate .. .. **Nickel Ammon. Sulphate**	£38 per ton d/d. Normal business.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid ..	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst. ..	£9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	6½d.—1s. 2d. per lb., according to quality.

Antimony sulphide—	
Crimson	1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes White and Dark	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P.	£50—£65 per ton, according to quantity.
Sulphur Chloride	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£11 10s. per ton, and upwards.
Grey	£14 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand quiet but price steady.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 9d. per gall. 60% O.P.
Solvent	5s. per gall. 40% O.P. Firmer.
Wood Tar	£4—£5 per ton. Very quiet.
Brown Sugar of Lead	£41 per ton. Steady market.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6¼d. per lb. Quiet.
Crude 60's	1s. 8d.—1s. 10d. per gall. Market better.
Acid Cresylic, 97/99	2s. per gall. Fair business.
Pale 95%	1s. 8d.—1s. 11d. per gall. Not much business.
Dark	1s. 7d.—1s. 9d. per gall. Market dull.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6½d.—7½d. per gall. Small demand
Unstrained	6d.—6½d. per gall.
Benzole—	
Crude 65's	7½d.—9d. per gall. ex works in tank wagons.
Standard Motor	1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Pure	1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d.—1s. 7d. per gall. More inquiry.
Toluole—Pure	1s. 7d.—1s. 9d. per gall. Small demand for home consumption.
Xylol—Coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	8d.—8½d. per gall. Little demand.
Middle Oil, Heavy Oil, Standard Specification	5½d.—6½d. per gall., according to quality and district. Market firmer. Steady demand.
Naphtha—	
Solvent 90/160	1s. 3d.—1s. 4d. per gall. Demand good. Higher prices probable.
Solvent 90/190	11½d.—1s. 1d. per gall. Demand maintained.
Naphthalene Crude—	
Cheaper in Yorkshire than Lancashire. Demand rather better.	
Drained Creosote Salts	£3—£5 per ton. Demand slightly better.
Whizzed or hot pressed	£6—£9 per ton. Demand very poor.
Naphthalene—	
Crystals and Flaked	£12—£15 per ton, according to district.
Pitch, medium soft	45s.—60s. per ton according to district. Plenty of inquiry. Prospects brighter.
Pyridine—90/160	18s. 6d.—19s. per gall. Market quiet.
Heavy	11s. 6d.—12s. per gall. Steady.

INTERMEDIATES AND DYES

Business in dyestuffs has been maintained but without further improvement.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb.
Acid H.	3s. 10d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1d. per lb. Improved demand.
Acid Sulphanilic	9d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	8d. per lb. naked at works.
Aniline Salts	8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	3s. 10d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chloraniline	3s. per lb. 100% basis.
p-Chlorphenol	4s. 3d. per lb. d/d.
o-Cresol 19/31° C.	4d.—4½d. per lb. Rather quiet.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 3d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 2½d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
G. Salt.	2s. 3d. per lb. 100% basis d/d.
Monochlorbenzol	£63 per ton.
a-Naphthol	2s. 4d. per lb. d/d.
β-Naphthol	1s. per lb. d/d.
a- Naphthylamine	1s. 3½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	4s. 2½d. per lb. d/d.
p-Nitraniline	2s. 2½d. per lb. d/d.

Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene	.. 10d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 4s. per lb. d/d.
p-Phenylene Diamine	.. 10s. per lb. 100% basis d/d.
R. Salt	.. 2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 2d. per lb. 100% basis d/d.
o-Toluidine ..	.. 10d. per lb. naked at works.
p-Toluidine ..	.. 2s. 10d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £45 per ton, ex wharf London, in glass containers.
Acid, Acetyl Salicylic	.. 3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P.	.. 2s. 6d. per lb.
Acid Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric ..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 4d. per lb., less 5% for ton lots. Market still weak.
Acid, Gallic ..	.. 2s. 11d. per lb. for pure crystal in cwt. lots.
Acid, Pyrogallic, Cryst.	.. 6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	.. 1s. 6d.—1s. 7d. per lb., according to quantity.
Acid, Tannic B.P.	.. 2s. 10d. per lb. Forward quotations higher spot value likely to increase.
Acid, Tartaric ..	.. 1s. per lb., less 5%.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 1s. 10d.—2s. per lb. More enquiry.
Amidopyrin ..	.. 15s. per lb.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone	.. 13s. 9d. per lb. Slightly lower. Quiet steady demand.
Benzonaphthol ..	.. 5s. 3d. per lb. spot.
Bismuth Carbonate	.. 8s. 6d.—10s. 6d. per lb.
„ Citrate ..	.. 8s. 6d.—10s. 6d. „
„ Salicylate	.. 8s. 0d.—10s. 0d. „
„ Subnitrate	.. 7s. 9d.—9s. 7d. „ According to quantity. Prices again reduced owing to fall in the metal.
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Very scarce and dear. Prices uncertain.
Ammonium ..	.. 2s. 1d. per lb.
Potassium ..	.. 1s. 11d. per lb.
Sodium	.. 2s. per lb.
Calcium Lactate ..	.. 1s. 7d.—2s. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate ..	.. 4s. per lb.
Chloroform ..	.. 2s. 6d. per lb. for cwt. lots.
Formaldehyde ..	.. £48—£49 per ton in barrels, ex wharf London. Supplies exceed demand.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Glycerophosphates—	
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. „
Guaiacol Carbonate	.. 9s. 6d. per lb.
Hexamine ..	.. 3s. per lb. for bold crystal. Powder slightly less.
Homatropine Hydrobromide	.. 25s.—30s. per oz.
Hydrastine hydrochlor	.. English make offered, 120s. per oz.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. „
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 3d. per lb. Price recently reduced.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Light, pure ..	.. £46 per ton.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £25 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 57s. per lb. for December delivery. No spot deliveries available.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials ..	.. Market very quiet.
Red oxide ..	.. 5s. 2d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 5d.—3s. 7d. „
White precip. ..	.. 4s. 6d.—4s. 8d. „
Calomel ..	.. 3s. 10d.—4s. „
Methyl Salicylate	.. 1s. 9d.—2s. per lb.
Methyl Sulphonal	.. 22s. 6d. per lb. Slightly weaker.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 2s. 8d. per lb. for B.P. quality.
Paraldehyde ..	.. 1s. 2d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin ..	.. 5s. 6d. per lb.
Phenazone ..	.. 6s. 10d. per lb.
Phenolphthalein ..	.. 5s. 6d. per lb. for cwt. lots. Supply exceeds demand.
Potass. Bitartrate— 99/100% (Cream of Tartar) ..	.. 84s. per cwt., less 2½% for ton lots.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Ferricyanide	.. 1s. 9d. per lb. Quiet.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	.. 7½d. per lb. spot. Forward prices higher.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 5s. 3d. per lb.
Saccharin ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. 9d. per lb. for cwt. lots.
Silver Proteinate ..	.. 9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite— Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb.

Sod. Potass. Tartrate (Rochelle Salt) ..	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Fair demand. Powder 2s. 1d.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 4d. per lb. Flake 2s. 6d. per lb. Good demand. Market firmer.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.
Sulphonal	14s. 6d. per lb. Little demand.
Thymol	18s. per lb. Firmer market.

PERFUMERY CHEMICALS

Acetophenone	11s. 3d.	per lb.	
Aubepine	15s.	,,	Cheaper.
Amyl Acetate	3s.	,,	Cheaper.
Amyl Butyrate	6s. 6d.	,,	
Amyl Salicylate	3s. 3d.	,,	
Anethol (M.P. 21/22° C.)	4s. 6d.	,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d.	,,	
Benzyl Alcohol free from Chlorine	2s. 9d.	,,	
Benzaldehyde free from Chlorine	3s. 6d.	,,	
Benzyl Benzoate	3s. 6d.	,,	
Cinnamic Aldehyde—			
Natural	18s. 6d.	,,	Cheaper.
Coumarin	18s. 9d.	,,	
Citronellol	17s.	,,	
Citral	8s.	,,	
Ethyl Cinnamate ..	12s. 6d.	,,	
Ethyl Phthalate	3s.	,,	Cheaper.
Eugenol	10s. 6d.	,,	Dearer.
Geraniol (Palmarosa) ..	33s. 6d.	,,	
Geraniol	12s. 6d.—20s.	per lb.	Dearer.
Heliotropine	6s. 9d.	,,	
Iso Eugenol	16s.	,,	
Linalol ex Bois de Rose ..	26s.	,,	
Linalyl Acetate	26s.	,,	
Methyl Anthranilate ..	10s.	,,	Dearer.
Methyl Benzoate	5s.	,,	
Musk Ambrette	50s.	,,	
Musk Xylol	14s.	,,	Dearer.
Nerolin	4s. 6d.	,,	Cheaper.
Phenyl Ethyl Acetate ..	15s. 6d.	,,	Dearer.
Phenyl Ethyl Alcohol ..	16s.	,,	
Rhodinol	55s.	,,	
Safrol	1s. 10d.	,,	
Terpineol	2s. 4d.	,,	
Vanillin	25s. 6d.	,,	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 10d. per lb.
Bergamot Oil	16s. per lb.
Bourbon Geranium Oil ..	35s. per lb.
Camphor Oil	65s. per cwt.
Cananga Oil Java ..	11s. per lb.
Cassia Oil, 80/85% ..	9s. 9d. per lb.
Cinnamon Oil, Leaf ..	6¼d. per oz.
Citronella Oil—	
Java 85/90%	5s. 10½d. per lb.
Ceylon	3s. 8d. per lb.
Clove Oil	8s. 3d. per lb.
Eucalyptus Oil 70/75% ..	2s. 3d. per lb.
Lavender Oil—	
French 38/40% Esters	35s. per lb.
Lemon Oil	3s. 2d. per lb.
Lemongrass Oil	5s. per lb.
Orange Oil, Sweet ..	11s. per lb.
Otto of Rose Oil—	
Bulgarian	40s. per oz
Anatolian	18s. per oz.
Palma Rosa Oil	16s. 6d. per lb.
Peppermint Oil—	
Wayne County ..	35s. per lb. nominal.
Japanese	22s. 6d. per lb. nominal.
Petitgrain Oil	9s. 9d. per lb.
Sandal Wood Oil—	
Mysore	26s. 7d. per lb.
Australian	18s. 6d. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Jan. 19th, they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Dec. 4th.

I.—Applications

Askania-Werke Akt.-Ges., and Wünsch. 26,805. *See* II.

Bendixen, McKechnie, and Reid. Extraction, solution, and mixture of soluble and insoluble substances. 26,909. Nov. 11.

British Drug Houses, Ltd. Apparatus for comparing colour of liquids. 27,006. Nov. 12.

Dunstan and Remfry. Purification of liquids. 27,132. Nov. 13.

Foster. Radiation pyrometers. 27,335. Nov. 15.

Granger and Mariller. Rectification of liquids. 27,055. Nov. 12. (Fr., 12.11.23.)

Johnson (Badische Anilin und Soda Fabrik). Carrying out reactions under pressure. 27,027. Nov. 12.

Randolph. Dryers for granular material. 26,780. Nov. 10. (U.S., 24.12.23.)

Salerni. Apparatus for removing dust from gases etc. 26,826. Nov. 10.

Salerni. Condensers. 26,836. Nov. 10.

I.—Complete Specifications Accepted

19,985 (1923). Eichengrun. Preventing the flammability of easily inflammable articles and extinguishing fire. (202,302.)

21,074 (1923). Schmidt. Drying or heating apparatus. (224,313.)

4281 (1924). Imray (Meister, Lucius, und Bruning). Process of expelling volatile substances by means of a stream of vapour. (224,431.)

4638 (1924). Soc. d'Exploit. des Procédés Hiloux. Dryer and pulveriser. (211,887.)

9980 (1924). British Thomson-Houston Co., Ltd. Apparatus for separating particles of foreign matter from liquid. (214,990.)

10,878 (1924). Portes. Mixing liquids of different temperatures and regulating the temperature of the mixed liquids. (216,849.)

II.—Applications

Aktiebolaget Separator-Nobel. Separating paraffins from liquid hydrocarbons. 27,242, 27,243. Nov. 14. (Sweden, 28.11.23.)

Askania-Werke Akt.-Ges., and Wünsch. Regulating withdrawal of gas from retorts or furnaces. 26,805. Nov. 10.

Brutzkus. Obtaining water-gas from liquid hydrocarbons. 26,786. Nov. 10.

Carlson and Gröndal. Production of oil etc. from shales etc. 27,130. Nov. 13. (Sweden, 17.11.23.)

Deutsche Glühfadenfabrik, and Schwarzkopf. Incandescent cathodes. 26,938. Nov. 11. (Ger., 21.5.24.)

Dunstan and Remfry. 27,132. *See* I.

Gérard. Gas-generators. 27,277. Nov. 14. (Fr., 12.12.23.)

Hertel. Distillation of carbonaceous material. 27,170. Nov. 13.

Johnson (Wood). Gas-producers. 27,238. Nov. 14.

O'Donnell. Fuel briquettes. 26,810. Nov. 10.

Potts (Algemeene Norit Maatschappij). Manufacture of decolorising carbon. 26,993. Nov. 12.

Potts (Algemeene Norit Maatschappij). Manufacture of active carbons. 26,992, 26,993. Nov. 12.

Rolland. Separation of combustible constituents from clinkers etc. 27,253. Nov. 14. (Ger., 12.4.24.)

Salerni. Distillation etc. of carbonaceous etc. materials. [illegible].284. Nov. 14.

Whitfield. Gasification of fuel in steam-boiler furnaces. [illegible].212. Nov. 14.

[illegible].—Complete Specification Accepted

1794 (1924). Stinnes-Riebeck Montan- und Oelwerke Akt.-Ges. Separating benzol or benzine from mixtures containing dilute alcohol. (210,094.)

III.—Complete Specifications Accepted

20,574 (1923). Chemical Engineering and Wilton's Patent Furnace Co., Ltd., and Shadbolt. Distillation of tar. (224,305.)

1794 (1924). Stinnes-Riebeck Montan- und Oelwerke Akt.-Ges. *See* II.

IV.—Applications

Barnard, Mercer, and Roth. Production of dyestuffs for cellulose esters. 27,317. Nov. 15.

Scottish Dyes, Ltd., Thomas, and Thomson. Manufacture of dyestuffs etc. 27,012. Nov. 12.

IV.—Complete Specification Accepted

26,725 (1923). British Dyestuffs Corporation, Ltd., Baddiley, and Tatum. Dyestuffs of the anthraquinone series. (224,363.)

V.—Applications

Arrizabalaga. Manufacture of waterproof fabrics. 27,247. Nov. 14.

Barnard, Mercer, and Roth. 27,317. *See* IV.

Barrett, Coward, and Tootall Broadhurst Lee Co., Ltd. Cellulosic material. 26,987. Nov. 12.

Holman and Leicester. Manufacture of paper. 27,163. Nov. 13.

Johnson (Badische Anilin- und Soda-Fabrik). Manufacture of coloured cellulose plastics etc. 27,028. Nov. 12.

Molinari. Treating flax fibres etc. 26,906. Nov. 11. (Fr., 9.4.24.)

Stevenson. Manufacture of acetyl cellulose 26,878. Nov. 11.

V.—Complete Specifications Accepted

25,382 (1923). Donagemma, Tofini, Valentini, and Micozzi. Machines for spinning artificial silk. (224,352.)

25,840 (1923). Smith. Process of treating silk. (212,517.)

365 (1924). Courtaulds, Ltd., Clement, and Riviere. Manufacture of threads, filaments, strips, or films from cellulose esters. (224,404.)

366 (1924). Courtaulds, Ltd., and Glover. Manufacture of threads, filaments, strips, or films from cellulose esters. (224,405.)

3112 (1924). Soc. de Stéarinerie et Savonnerie de Lyon. Manufacture of cellulose esters. (219,926.)

16,913 (1924). Bourcet and Regnault. Removing ink from printed paper. (219,311.)

VI.—Applications

Chemische Fabrik Pott und Co., and Pospiech. Wetting-out means for carbonisation, dyeing, etc. 27,047. Nov. 12.

Dean. Dyeing-machinery. 27,310. Nov. 15.

Della Zuana. Machines for mercerising cotton skeins. 27,169. Nov. 13. (Italy, 23.11.23.)

Raduner und Co., Akt.-Ges. Apparatus for use in processes wherein hypochlorites are used. 26,883. Nov. 11. (Switz. 21.9.24.)

VI.—Complete Specifications Accepted

20,068 (1923). Cruse. Impregnation of fibres by electrolysis. (224,285.)

26,029 (1923). British Dyestuffs Corporation, Ltd., Lawrie, and Blackshaw. Production of black shades on cellulose acetate materials. (224,359.)

26,355 (1923). Escaich and Worms. Processes for dyeing or printing fibres of all kinds. (224,361.)

9260 (1924). Joco Rubber and Waterproofing Co., Ltd. Metallised waterproof fabrics. (223,529.)

VII.—Applications

Anjow. 27,129. *See* X.

Compagnie de l'Azote et des Fertilisants Soc. Anon. Preparation of a solution of cyanamide. 27,048. Nov. 12. (Switz., 20.11.23.)

Consortium für Nassmetallurgie. Production of lead compounds from ores etc. 26,920. Nov. 11. (Ger., 23.9.24.)

Consortium für Nassmetallurgie. Production of sparingly soluble lead compounds. 27,257. Nov. 14. (Ger., 18.9.23.)

Raduner und Co., Akt.-Ges. 26,883. *See* VI.

VII.—Complete Specifications Accepted

27,052 (1923). Ramsay. Producing oxides of nitrogen. (206,498.)

32,517 (1923). Norsk Hydro-Elektrisk Kvaelstofaktieselskab. *See* XVI.

5315 (1924). Johnson (Badische Anilin und Soda Fabrik). Production of alkali cyanide. (224,438.)

11,615 (1924). Bernard. Enrichment or other treatment of phosphated chalk and other substances with a basis of carbonate of calcium or lime. (224,468.)

VIII.—Application

Brown. Drying clay products etc. 26,996. Nov. 12.

VIII.—Complete Specification Accepted

11,771 (1923). Beaumont (Kraus). Ceramic and other materials and bodies. (224,257.)

IX.—Applications

Shellard. Composition for building walls etc. 27,010. Nov. 12.

Tidy. Glazing cement, concrete, etc. 27,029. Nov. 12.

IX.—Complete Specification Accepted

20,584 (1923). Kobiolke. Artificially drying and seasoning timber. (224,306.)

X.—Applications

Anjow. Treating tungsten ore to obtain tungsten oxide. 27,129. Nov. 13.

Coley. Manufacture of zinc. 26,887. Nov. 11.

Consortium für Nassmetallurgie. 26,920. *See* VII.

James (Eisenwerk Ges. Maximilianshütte). Production of high tensile steel. 26,844. Nov. 11.

Jullien. Making electrolytic copper. 27,348. Nov. 15. (Fr., 16.11.23.)

Marks (Maschinenbau-Anstalt Humboldt). Preparation of low-grade iron ores. 26,936. Nov. 11.

Vandersteñ. Cupola furnaces. 26,903. Nov. 11.

X.—Complete Specifications Accepted

19,592 (1923). Constant and Bruzac. Reduction of metal oxides. (202,970.)

7374 (1924). Stig and Stig. Production of alloyed steel and iron with chromium, manganese, molybdenum, tungsten, vanadium, and the like. (213,568.)

13,599 (1924). Vincent. Soldering-composition. (224,472.)

XI.—Applications

Deutsche Glühfadenfabrik, and Schwarzkopf. 26,938. *See* II.

General Electric Co., Ltd. Coated filaments for thermionic discharge tubes. 26,925. Nov. 11.

Gjersoe. Electric furnaces. 26,921. Nov. 11. (Norway, 12.11.23.)

Jullien. 27,348. *See* X.

Pehrson. Electric furnaces. 26,918. Nov. 11.

Wills. Electric accumulators etc. 27,215. Nov. 14.

XI.—Complete Specifications Accepted

18,903 (1923). Wild, Barfield, and Coleman. Electric furnaces or the like. (224,272.)

20,068 (1923). Cruse. *See* VI.

21,910 (1923). Chile Exploration Co. Electrodes and their manufacture. (212,871.)

XII.—Complete Specification Accepted

25,200 (1924). Sizer. Extraction of oil from oil-bearing seeds etc. (224,485.)

XIII.—Complete Specification Accepted

19,511 (1923). Tsubata. Preparing a painting material in powder form for use with either water or oil. (224,273.)

XIV.—Application

British Dyestuffs Corporation, Ltd., Cronshaw, and Naunton. Vulcanisation of rubber etc. 27,036. Nov. 12.

XIV.—Complete Specification Accepted

18,802 (1924). Goldschmidt Akt.-Ges. Improving rubber. (220,318.)

XV.—Application

Harnden. Production of effects upon artificial leather etc. 26,851. Nov. 11.

XVI.—Complete Specification Accepted

32,517 (1923). Norsk Hydro-Elektrisk Kvaelstofaktieselskab. Converting fertilisers etc. into a non-caking condition. (210,409.)

XVII.—Complete Specification Accepted

17,934 (1923). Ling and Nanji. Process of treating starch, giving a product for use in brewing and in confectionery and allied manufactures. (224,269.)

XVIII.—Complete Specification Accepted

17,934 (1923). Ling and Nanji. *See* XVII.

XIX.—Applications

Dunstan and Renfry. 27,132. *See* I.

Fryer, and McDougall and Yalding, Ltd. Insecticides, sheep dips, etc. 27,041. Nov. 12.

Imhoff. Sewage treatment in aeration tanks. 26,876. Nov. 11.

Raduner and Co., Akt.-Ges. 26,883. *See* VI.

Simon, and Simon Bros. (Engineers), Ltd. Manufacture of insecticides etc. 26,781, Nov. 10.

Simon, and Simon Bros. (Engineers), Ltd. Treating vegetable matter. 26,782. Nov. 10.

XIX.—Complete Specification Accepted

19,951 (1923). Monti. Making naturally-flavoured non-alcoholic syrups, sparkling beverages, etc. (201,932.)

XX.—Application

Sharp and Dohme, Inc. Manufacture of alkyl resorcinols. 27,259. Nov. 14. (U.S., 31.7.23.)

XX.—Complete Specifications Accepted

27,462 (1923). British Dyestuffs Corporation, Ltd., Cronshaw, and Naunton. Manufacture of triarylguanidines. (224,376.)

5678 (1924). Sartig. Process of denicotinising tobacco. (224,439.)

XXI.—Applications

Halden and Co., Ltd., and Rumsey. Manufacture of sensitised photographic paper, fabric, etc. 26,849, 26,850. Nov. 11.

Hudson. Photography. 27,309. Nov. 15.

XXIII.—Application

Union Apparatebau Ges. Gas density recording device. 26,820. Nov. 10. (Ger., 11.10.23.)

PUBLICATIONS RECEIVED

THE CHEMISTRY OF ENZYME ACTIONS. Second and revised edition. By K. G. Falk. American Chemical Society Monograph Series. Pp. 242. New York: Chemical Catalog Co., Inc., 1924. Price $3·50.

TECHNICAL ORGANISATION. ITS DEVELOPMENT AND ADMINISTRATION. By J. M. Weiss and C. R. Downs. Pp. x+197. New York: The McGraw-Hill Book Co., Inc., 1924.

THE CHEMISTRY OF BREADMAKING. By James Grant. Fourth edition. Pp. vi+232. London: E. Arnold and Co., 1924. Price 6s. net.

INTRODUCTION TO THEORETICAL PHYSICS. By A. Haas, Ph.D. Translated from the 3rd and 4th editions by T. Verschoyle, M.C., B.Sc., with a foreword by Prof. F. G. Donnan, F.R.S. Vol. I. Pp. xiv+331. London: Constable and Co., Ltd., 1924. 21s.

THE SCIENCE OF METALS. By Z. Jeffries and R. S. Archer. First edition. Pp. xvii+460. London: McGraw-Hill Book Co., Inc., 1924. Price 25s.

ELEMENTARY QUALITATIVE ANALYSIS FOR COLLEGE STUDENTS. By J. H. Reedy. First edition. Pp. xiv+137. London: McGraw-Hill Book Co., Inc., 1924. Price 7s. 6d.

PRACTICAL BACTERIOLOGY, AN INTRODUCTORY COURSE FOR STUDENTS OF AGRICULTURE. By A. Cunningham, B.Sc. P. vi+188. London: Oliver and Boyd, 1924. Price 7s. 6d.

MICHAEL FARADAY. By W. L. Randell. Pp. 187. London: L. Parsons, Ltd., The Roadmaker Series, 1924. Price 4s. 6d.

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JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

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EDITORIAL

WE publish this week letters from two correspondents who treat, in different ways, of the use of the English language. There is loubt that Mr. Rickard correctly indicates the ocratic ideas which tend to prevent the existence ifferent strata in America so far as the language ncerned. There is much to be said for these so far as the ordinary spoken language is cond. A general standard of moderately good ish suffices for the shop, the office and the home. the other hand, where the language is to be used the permanent record of scientific and industrial coveries, for the discussion of abstract scientific s or for purely literary purposes, it is desirable that utmost precision should be attempted, and that ward or ugly phrases should be avoided. Mr. gives some shocking examples of wording which l very easily be improved. Scientific journals ld have a higher standard of accurate and inive writing than that which is required for deng a race meeting or the merits of a patent medi- The future of the English language is in the of those who write it; a large proportion of live in America, and the American writers will e a large measure of praise for examples of ost skilful and elegant use and a corresponding measure of responsibility if their literary s tolerate slovenly writing. The Americans e become exceptionally expert in the use of many ; if they wish to do so there is no reason why should not be as adept as anyone else in the f that superb tool, the English language. Mr. ard certainly has assisted them and us by ritical and scholarly observations on the art of ting.

* * *

Sir Robert Hadfield has called attention to the great loss of time and money occasioned during recent years by strikes and other industrial disputes. The effect of these is far-reaching; a stoppage in one trade usually affects deliveries, orders and payments in several other trades. Vexatious postponements cause irritation and loss shared by the employers, the employed and the public. The Rt. Hon. Mr. Tom Shaw, our Minister of Labour, has had to face this problem continuously ever since he undertook his difficult and almost thankless task. As a means of calling attention to a legitimate grievance the strike is but little more effective than the round-table conferences which he is proposing to arrange in all large disputes of an industrial character. As a means of creating high prices, unemployment and high taxation a succession of long strikes is singularly efficient. There was a time, even so recently as five and twenty years ago, when a strike was practically the only effective measure of protest open to the comparatively feeble trades unions then gradually struggling to obtain control over industry. Circumstances have changed since then; a powerful Ministry of Labour has been organised, every trade has its own confederations, councils and boards. In every trade are many trades union leaders skillful as negotiators and possessing that experience which enables them to realise the burdens which the trade can endure, the share of the gross profits which can be paid as wages without crippling it and having that broad outlook on affairs which enables them to face the huge problems of modern times. In every trade are to be found employers who sincerely desire fair and generous treatment of those who spend their lives in the industry. With all these influences a less expensive method of attaining industrial peace should be possible. There is, of course, a tendency, which we can all understand and deplore, for the rank and file to distrust their leaders more and more as these become abler, more experienced, more sagacious. The young are easily impressed by oratory, by the hope of prosperity to be organised by some league or committee. They resent the advice of those who, with the advantage of an extra thirty years of experience, nevertheless have the disadvantage of being out-of-date or out of sympathy with the fashionable party cries. During the last ten years there has been a significant dislike of law and order, a significant disrespect to contracts and agreements; we are not thinking only of trade agreements but all others. The Senchus Mor, an Irish law book a thousand years old, remarks that there are three occasions when civilisation retreats,

a war, a famine, and a time when agreements are not respected. The observance of agreements is almost as unfashionable as thrift. Both will come into their own again.

Fifty years ago van't Hoff and Le Bel independently originated and published a new conception of chemical structure and chemical combination which has been of fundamental importance to chemistry and particularly organic chemistry. Kekulé had in 1865 propounded the well-known hexagonal ring formation of benzene and Pasteur had vaguely and tentatively suggested the possibility of some tetrahedral spacing of the activities of a carbon atom, but before the work of van't Hoff and Le Bel the consideration of chemistry in connexion with the arrangement of the atoms in space was to all intents and purposes unknown. Van't Hoff, a distinguished Dutch chemist, had studied chemistry under Kekulé at Bonn, and afterwards under Wurtz at Paris, where Le Bel was also studying. Without communication with each other on this subject they independently and almost simultaneously published memoirs which showed that many of the facts of optical activity in organic compounds could be explained quite satisfactorily by assuming that the carbon atom could be treated as tetrahedral in space with its valencies equally separated from each other. This conception has been fruitful and is now universally accepted. It shows how, even in complicated compounds, the various atoms are placed in relation to each other, how in one compound two carbon atoms will lie close to each other and how in another nearly similar one the two carbon atoms may be far distant. The rotation of some substances to the left and others to the right has been satisfactorily explained. In the hands of Baeyer in Germany and Thorpe in this country the doctrine has been extended and elaborated. The asymmetrical carbon atom obscurely imagined by Pasteur and accurately investigated by van't Hoff and Le Bel has proved to be representative of a considerable class of other atoms. Sir William Pope has prepared many optically active compounds containing asymmetrical atoms of tin, nitrogen and other elements. The Dutch Chemical Society and the Dutch Society of Chemical Industry are holding a special meeting in Amsterdam on Saturday, October 25, to celebrate the fiftieth anniversary of the foundation of stereochemistry by the genius of van't Hoff and Le Bel. These Societies have invited the corresponding English Societies to send delegates to this meeting and it is certain that the English men of science will be glad to pay their tribute to the excellent work of their continental colleagues.

We have from time to time raised our voice on behalf of a broad scientific basis for the training of chemists. Dr. Ellis and Professor Drummond have written in our columns, the one showing the danger of expecting chemists to become bacteriologists, the other pleading for the inclusion of biological studies in the preliminary training of all scientific workers. A review of a new textbook on quantitative organic micro-analysis which we publish on another page makes a further contribution to the question. It was Réaumur, we think, who was the first to apply the microscope to the study of metals, but the real foundations of modern metallography were laid by Sorby in 1864, and later, by Heycock and Neville, whose classic work is well illustrated in the Government Pavilion at the British Empire Exhibition. The advances in metallurgy that are due to the use of the microscope are numerous and continually increasing. Yet the chemist has paid but little heed to the service offered by such a valuable aid. Biologists have perforce made use of the microscope and biochemists are well aware of its utility. In a book published not very many years ago, the value of the microscope to chemistry was delimited to the occasional examination of precipitates or fine powders to ascertain if they showed crystalline structure, and even to-day the use of the microscope is associated rather with the study of fermentation than with the analysis of organic compounds. Micro-analysis proffers a tool that the chemist should not hesitate to use and it is surprising that so elegant a tool should still await fuller appreciation. Improvements in technique need to be made, the field of application requires to be broadened, but enough instances of the time, trouble and even money saved by the use of micro-analytical methods could be quoted to show what a gap their lack leaves in the chemical equipment. It is not sufficient, however, to ascribe this deficiency to indifference; the cause lies much deeper, and is to be found in the training of the chemical student. An ideal training for any student of any branch of science cannot be suggested with any hope of gaining general approval, and chemistry is a branch of science that, owing to its complexity and range, provides particularly difficult problems both for teacher and student. This very complexity makes for specialisation, which inevitably means omission, and so micro-analysis is yet pleading for consideration. We at last have a text book which treats the subject thoroughly and in an up-to-date manner, but although we welcome it and anticipate that it will lead to a diffusion of microchemical methods, we cannot but regret that the stimulus should have come from without and not from within.

There is a number of interesting things in the Report of the Committee of the Privy Council for Scientific and Industrial Research, and the curious will find in it details of work on the use of a wavelength of light as a standard of length, of the experiences of the happy band that travelled to Australia and back to ascertain how apples behave on the high seas, and of research on forest products, the carbonisation of coal, problems of illumination, and many other subjects. A further account of Dr. Margaret Fishenden's valuable studies of problems of domestic heating is given and we learn that the work on the domestic coal fire carried out at Manchester is to be transferred to London. Further consideration of the Report must be deferred until a subsequent issue.

INDUSTRIAL FILTRATION.—PART III

By S. G. URE, M.A., B.Sc., M.I.Chem.E.

Among filters using paper as the filtering medium is the Stream-Line filter (Fig. 1), recently introduced by Dr. Hele Shaw. This filter consists of a pack of sheets of impervious paper, having a matte surface and perforated by a number of alternating rows of holes, of large and small diameters, the holes in the outer rows of each sheet being always of the smaller size. These holes are cut so that they coincide with the holes in the sheets immediately above or below, thus forming a pack of filter papers which

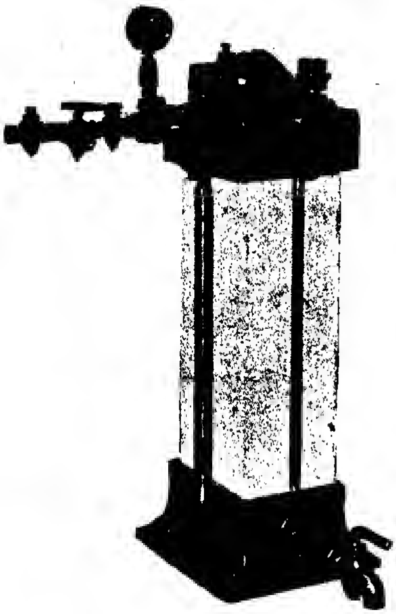

FIG. 1
Stream-line Filter—Vertical Type

is perforated by rows of holes of alternately large and small diameters extending continuously through the pack. The pack is compressed either by screw or hydraulic ram between two metal plates, through one of which the liquor is introduced, and through the other the filtrate and precipitate can be removed from the press. To permit of this, one plate has a series of holes or channels which coincide with the larger holes in the paper, whilst the other plate has two series of holes or channels, one series being in communication with the larger holes and connected with a sump for receiving the solid material, the other set coinciding with the smaller holes and communicating with the outlet pipe for the removal of the filtrate. The liquor, on entering the filter, flows into the larger holes, and as the pressure rises is forced between the sheets of paper which, on account of their rough surfaces, can never be squeezed into perfect contact with each other, and is collected in the smaller openings and passes to the outlet. The solid matter is retained on the inside of the inlet tubes, and in some filters can be removed to the pump, without stopping filtration, by an ingenious arrangement of pistons moving inside the tubes. Industrial filters of this type are built up of a number of units, each capable of filtering about 200 gallons of liquor per hour. The Stream-Line Filter Co. is also developing the continuous rotary filter illustrated in Fig. 2. In this machine eight packs of paper are fitted radially into a circular frame. Each pack consists of about four thousand strips, each strip being about 5½ in. long by 1 in. wide, and perforated with 9 holes about ½ in. in diameter. The alignment of the pack is controlled by two rods inserted in the end holes. A nut acting on a screwed rod attached to the lower block adjusts the pressure on the pack by moving the upper block, which is in contact with the top strip of paper. The lower block, of similar size to the upper, is in contact with the bottom strip. Each of these blocks has the same length and breadth as the paper strips, so that their outer surfaces lie in the planes formed by the edges of the paper. The lower block has a series of holes or a channel which coincide with the holes in the pack. These holes are connected with a central tube which fits into one of eight holes in the hub of the wheel. A bar with a slot attached to the under-side of the lower block also fits into another hole in the hub, and a tapered cotter driven through the corresponding slots in hub and pin fixes the pack rigidly to the hub.

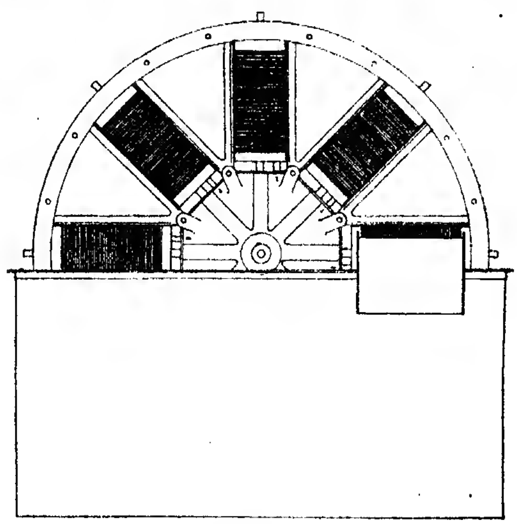

FIG. 2
The Stream-line Rotary Filter

The eight radial holes in the hub meet at the centre of the hollow shaft, which is plugged at one end and connected at the other through a receiver to a vacuum pump. The complete wheel is carried on two bearings, mounted on the top of a rectangular tank containing the liquid to be filtered, thus submerging a considerable portion of the lower half of the wheel. The level of the liquid in the tank is maintained constant by means of a suitably placed overflow pipe, and two knives carried by framing

mounted on the tank scrape the cake off the packs. As the wheel rotates suction is applied to the holes in the pack, the liquor thus drawn through the submerged packs being collected in the receiver. A machine of this type can be seen in action at the British Empire Exhibition. A pulp filter (Fig. 3) manufactured by the Kestner Evaporator and Engineering Co., Ltd., consists of a series of filter plates or frames varying from 20 to 24 in. in diameter, and provided with four ports or channels, two being placed at the top and two at the bottom of each plate or frame. Across the surface of the frame or plate is a number of bars designed to give the maximum area of filtration with the minimum area of unsupported pulp. The filtering medium consists of pure cotton pulp specially prepared for the purpose, pressed into cakes in a suitably designed pulp press. These cakes are held between the frames in such a manner that they form a series of chambers with

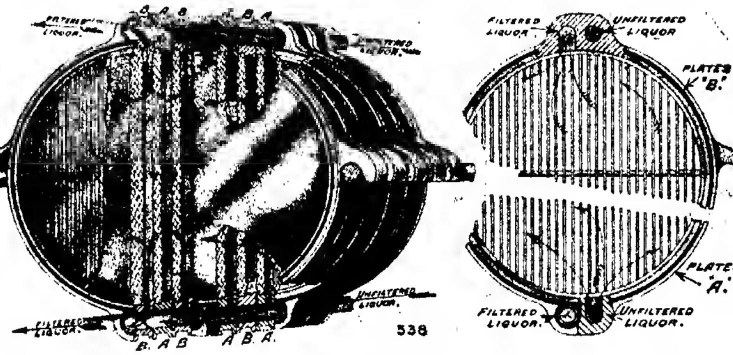

Fig. 3
Kestner Pulp Filter

the frames. Every alternate chamber is connected to the unfiltered liquor channels at the top and bottom of the frame. The other chambers are connected with the outlet channels also situated at the top and bottom of the frames. In this way the liquor enters one set of chambers through two ports in each chamber, and passing through the pulp walls of the chamber into the adjoining chambers, leaves through the filtered liquor outlet channels. The complete equipment for filters of this type comprises washer and steriliser for washing and sterilising the pulp before it is repressed into cakes in the pulp press. With this type of filter, gelatin can be filtered up to a 12 per cent. solution, the machine being suitable for treating such substances as glue, malt extract and fruit juices. Since it is essential that the pressure applied to the liquid in the press should be kept constant, the liquid to be filtered is supplied to the press from a constant level tank, placed from 15 to 20 ft. above the level of the filter.

Centrifugal Machines

As liquor is often separated by means of centrifugal machines from materials such as cotton, wool, or fibrous, granular, or coarsely crystalline products which do not form impenetrable layers on the basket, it is convenient to treat such plant under the title of industrial filtration. Machines utilising centrifugal force to effect the separation may be divided into two classes, the extractor, in which the solid is retained on a porous surface whilst the liquid is forced through by centrifugal force, and the separator, in which the centrifugal force causes the particles to separate into zones of different densities, the particles of the greatest density forming the outer zone. The separator type of centrifugal machine can, therefore, be used for the separation of two or more immiscible liquids.

Extractors

Amongst the well-known firms who manufacture centrifugal machines of the extractor type are T. Broadbent and Sons, Ltd., Huddersfield, Manlove Alliott and Co., Ltd., Nottingham, Pott, Cassels and Williamson, Motherwell, and Watson Laidlaw and Co., Ltd., Glasgow. The essential feature of an extractor machine is a perforated drum or basket which is mounted on a shaft and can be rotated at a high speed. The baskets for these machines consist of cylinders or drums formed of perforated copper, galvanised steel, or monel metal plates, and vary in size from 24 inches in diameter by 14 inches deep to 60 inches in diameter by 24 inches deep or 72 inches in diameter by 18 inches deep. Sometimes the basket is formed by weaving copper or iron wire on a suitable copper or steel frame, which can afterwards be galvanised or tinned. A basket of this type is illustrated in Fig. 4. The baskets are open at the top, and are attached to the driving shafts through the bottom plate, which is sometimes provided with openings through which the solid material can be discharged from the basket. In the underdriven type of machine this bottom discharge is effected through two or more flap-covered openings placed at equal distances from the centre of the basket, but in the overdriven type this discharge opening can be placed in the centre of the basket and covered by a conical shaped valve which can slide on the driving spindle. Baskets on the underdriven type of machine are fitted on the

outside with brake rings, whereas on the over-driven type a special pulley is usually mounted on

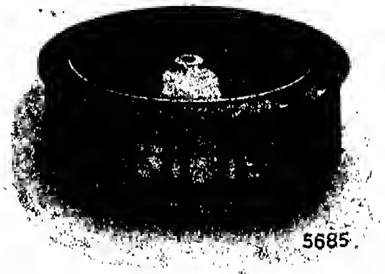

Fig. 4

Woven Centrifugal Basket by Manlove, Alliott & Co., Ltd.

the shaft. Frictional brake blocks, carried on a flexible band, surround the brake rings or pulleys, and can be tightened on to them by hand when stopping the machine. The speed of the basket varies from 1200 to 1500 revolutions per minute for a 24-inch basket to 650 revolutions per minute for a 72-inch diameter centrifugal. The choice of lining for the basket depends largely upon the chemical and physical properties of the material to be treated in the machine. Linings are, therefore made of metal sheets with parallel or conical, oblong or circular holes, of wires of different metals woven into a cloth by spiral or twill weaving, or of cotton and woollen cloths.

Usually three linings are supplied with the machine, the first, next to the shell, consisting of a plain woven lining having four meshes to the inch. This is covered by a plain-woven lining, having seven meshes to the inch and made of brass wire, this being in turn covered by a third lining having a much finer mesh. To retain the liquid thrown from the basket, it is surrounded by a cylindrical casing made of cast iron or other suitable material, and lead lined on the inner surface when the machines are used for centrifuging materials impregnated with acids. The top of the casing is open, whilst in the bottom are situated the holes required for the withdrawal of the discharged liquid and to allow the passage of the shaft and its bearings in the underdriven type. There is a central opening through which the solid material can be discharged in overdriven machines with a bottom discharge. Centrifugal machines may be driven either by belts, reciprocating steam engines, steam turbines, water turbines or electric motors, and the driving mechanism may be situated above the basket (the overdriven type) or below the basket (the underdriven type). When the reciprocating steam engine is used the basket shaft becomes the crank shaft of the engine and in the underdriven type the steam cylinder is bolted to the outer casing of the centrifugal, thus producing a machine which occupies little space and can be readily moved into a suitable position.

In electrically-driven centrifugals of the under-driven type the motor is usually bolted to the bottom of the casing; in the overhead type the motor is carried on a rigid steel framing which may form part of the platform supporting the casing or may be built into the walls of the building. The rotor of the motor drives the basket shaft through a centrifugal clutch or flexible coupling which protects the motor from damage and reduces the starting current required. The advantages in favour of the electrically driven machine are its efficiency, durability, cleanliness, and convenience, and the small space which it requires.

In the water-driven type of centrifugal machine the power is obtained from jets of water acting on a pelton wheel (Fig. 13). Here the water, entering through the pipes 8 and nozzles 7, impinges on the vanes 5 which are fixed to the wheel 2, then, falling into the chamber formed by the casings 3 and 4, passes to waste through the pipe 39. The lower end of the water wheel is bolted to the driver, forming a chamber in which the governor is placed. The

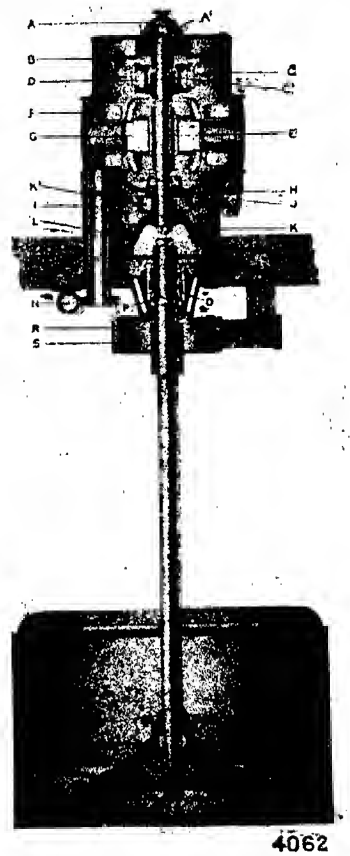

Fig. 5

Electrically-driven Centrifuge by Watson, Laidlaw & Co., Ltd.

governor actuates a tubular spindle 24, communicating with the top of the motor, where it operates

the lever mechanism 15, 16, 17, 18 controlling the water supply to the jets. The lower portion of the figure illustrates one method of supporting the weight of the spindle and basket in a machine of the overdriven type and shows a form of flexible coupling employed between the motor and centrifugal shafts. When this type of drive is adopted, it is advantageous to work the centrifugals in two sets, one of which cannot come into action until the first set has attained the maximum speed, as during acceleration the power required is greater than that for steady running. Pott, Cassels and

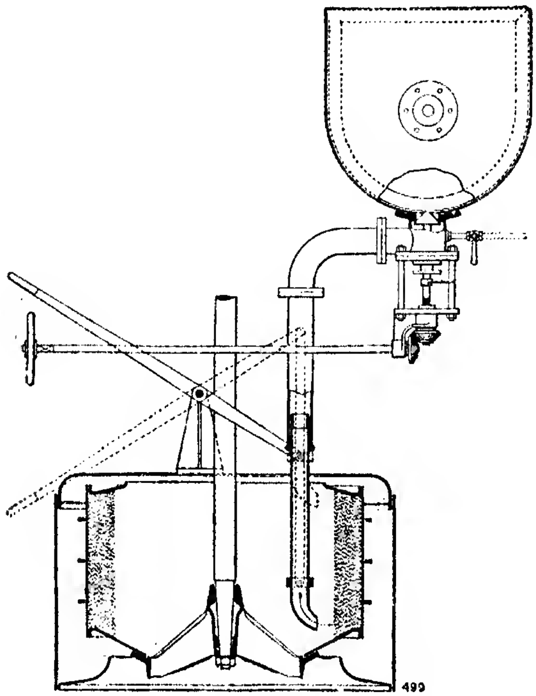

FIG. 6

Feeding device for mobile liquors by Pott, Cassels and Williamson, Ltd.

Williamson supply a patent interlocking gear so designed that only one-half of the machines in an installation can be accelerating at the same time, thus reducing the size of the pumping plant required without interfering with the output of the centrifugals.

When centrifugals are treating solid materials, such as in the extraction of water from cloths, the loading and unloading has to be done by hand with the machine at rest. If, however, the material under treatment contains small particles which can be carried by the liquor the machine can be fed whilst in motion. In order to get the crystals in a mobile mother liquor to rise up the wall of the basket it is necessary to feed the liquid into the basket at a definite velocity by means of a pipe capable of vertical movement which will discharge the liquid against the wall of the basket. Such an arrangement is illustrated in Fig. 6.

For the purification of the solid material retained in the basket steam and water sprays can be fitted inside the basket. Sometimes also steam sprays are fitted in the annulus formed by the casing and the basket, and are used for cleaning the perforations and the inner surface of the casing. The commonest method of discharging the basket is through an opening or openings in its base, the material being shovelled through these after the stoppage of the machine. To obviate this labour of removing the material from the sides of the baskets self-discharging baskets have been designed. In this case the bottom of the basket slopes downward at an angle greater than the angle of repose of the material. A conical disc attached to the spindle at about the mid-point of the depth of the basket acts as a spreader for the incoming material, causing it to be thrown against the middle portion of the basket wall. On stopping the machine the dried crystals slide down the inclined surface and are discharged through the central opening in the bottom of the basket. Another type of basket, suitable only for the underdriven machine, is provided with two projections to which lifting tackle can be fixed and the basket removed from the casing and emptied. Recently a patent has appeared aiming at the discharge of the solid matter from the basket whilst in motion, thus obviating the loss of energy required to start up the machine every run. The bottom of the basket in this machine is conical in shape, the apex of the cone, which points upwards, carrying a shaft provided with a sleeve which can be raised or lowered by a system of levers, whilst the machine is in motion. Attached to the lower end of this sleeve is a second hollow cone whose lower edge is fixed to a disc having a diameter a little less than the diameter of the basket. A piece of cloth the depth of the basket is sewn to form a tube having a diameter equal to the diameter of the basket. The upper end of this tube is attached to the rim of the basket and the lower end to the rim of the disc. The cone having been lowered to the bottom of the basket and the centrifugal started the liquor is admitted. When a sufficient amount of solid material has been deposited on the cloth the cone is raised until the disc of the cone is at the same height above the rim of basket as it was originally below, thus reversing the cloth, so that the solid material now on the outer surface is thrown by centrifugal force into a suitable receptacle on the top of the casing. After discharge the cone may be lowered and the cycle of operations repeated.

Centrifugals may be classified as fixed spindle or free spindle machines. In the former type two bearings rigidly attached to the casing and the sole plate are provided, the lower bearing being designed to act as a footstep and carry the weight of basket and spindle, whilst the upper bearing acts as a guide, and should be provided with an adjustment for controlling the play between spindle and bearing, thus preventing vibrations being set up when the basket is not properly loaded. In the older machines these bearings were of the plain gunmetal bush type, well lubricated, but in modern machines ball or roller bearings carried in dustproof housings are

largely used. A machine of the fixed spindle type requires very good foundations as any out of balance weight may produce unpleasant vibrations which are immediately communicated to the foundations. Therefore to render machines of this class capable of being placed on upper floors or in positions where good foundations are impossible the "suspended" type of machine has been introduced. Here a base ring having three short columns is used, the driving

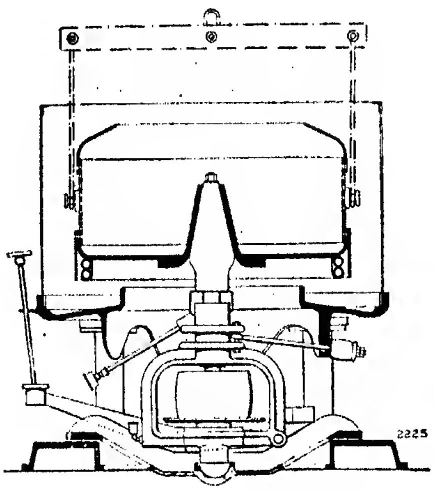

FIG. 7

Peg-top Centrifugal Machine by Manlove, Alliott & Co., Ltd.

gear of the casing basket being suspended from these columns by bolts which are free to take up any vibration produced by running the machine and prevent its transmission to the floors or foundation. In the free spindle type the spindle can move with any lateral movement of the basket and therefore with machines of this class greater care in loading is necessary. When loads are difficult to balance the balancing may be effected by hollow anchor rings containing mercury or other liquid fastened round the basket. Since the rotating basket and spindle of the underdriven type of machine of this class resembles a spinning top the machine is sometimes called a Peg Top centrifugal (Fig. 7). Machines of this class are also fitted with a buffer, which tends to restore the spindle to the upright position and at the same time should have sufficient frictional resistance to prevent the basket from wobbling. The Weston overdriven self-balancing centrifugal is another free spindle machine of the type usually adopted for free spindle machines requiring baskets of large diameters, since the top of the basket in a large underdriven machine would be at an inconvenient height above the floor. These Weston machines are also provided with buffers usually made of rubber, although the buffer effect is sometimes attained by the extension of the spindle, fitted with a shoe which slides in a spherical surface carried on the base of the machine.

SEPARATORS

The speed of these machines varies from 2000 revolutions per minute for machines of the Gee and Sturgeon types to 40,000 revolutions per minute in the small super centrifuges. The Sharples super-centrifuge made by Super-centrifugal Engineers, Ltd. of the commercial size illustrated in Fig. 8 consists of a plain cylindrical tube, termed a bowl, 36 in. long and 4¼ in. in diameter, which is rotated at 17,000 revolutions per minute. The upper end of the tube is closed by the bowl head, which carries the ports for the outflow of the separated liquids and by which the bowl is hung from a flexible vertical shaft. The lower end of the bowl is fitted with a removable cover so designed that it restricts any tendency of the bowl to oscillate. Removable wings in the bowl keep all parts of the liquid moving with the speed of the bowl. The machine can be driven by steam turbine, belt, or electric motor and when the bowl has reached its normal speed the

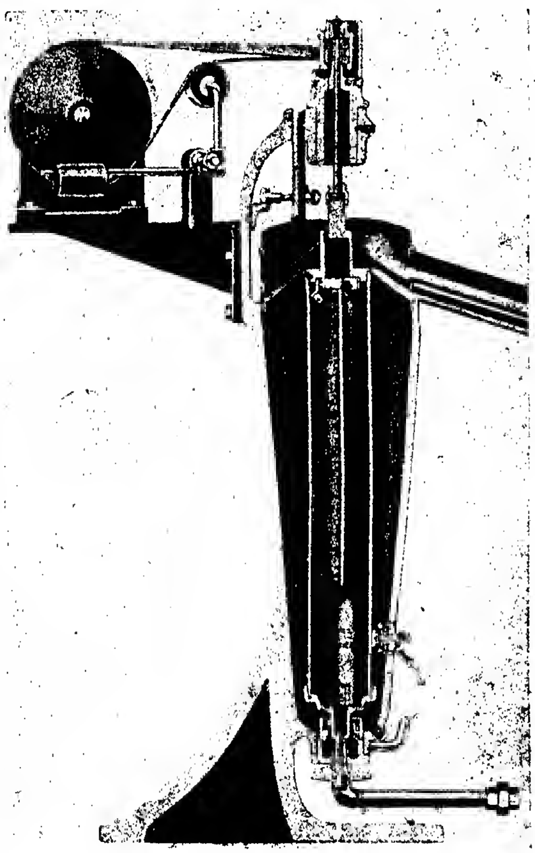

FIG. 8

Sharples Super-Centrifuge by Super-Centrifugal Engineers, Ltd.

liquor is admitted from an overhead tank through a central opening in the bottom cover. The rotation causes the liquid to separate into layers of different densities and as the bowl becomes full these layers ultimately reach the bowl head and flow out through

their respective outlets into collecting trays on the top of the machine. For efficient working with such a machine it is essential that the solid matter in the liquid under treatment should not exceed 1 or 2 per cent., as larger percentages require too much time in proportion to the length of run to be spent in removal, cleaning and replacement of the bowl. Machines, however, have been made for the continuous discharge of the solids, but this is only possible when a second liquid can be obtained which has a greater density than the original liquid and the solids which it contains, and which is immiscible with the original liquid. When a mixture consisting of the solid particles and the two immiscible liquids is fed into the bowl stratification in three layers takes place, the added liquid forming the outer, the solid particles the middle and the original liquid the inner layer, and the heavier outer liquid carries the solid particles with it through its discharge port. This machine can also be used for the separation of two or more liquids, but, as will be readily understood, successful working will be attained when the bowl head has been designed for dealing with the special mixture and it is fed into the machine at a suitable rate.

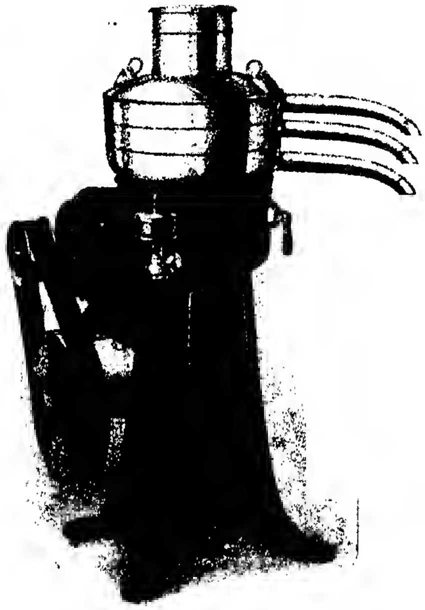

Fig. 9

Vickcen Centrifugal Separator by British Separators, Ltd.

Fig. 9 shows the general external arrangement of a belt-driven Vickeen Separator made by British Separators, Ltd. The liquid being treated passes down a central tube and enters the bowl through a conical distributing plate at the bottom of the bowl. Over this distributor is a number of conical plates having rows of holes round their outer and inner edges. Passages between the plates are formed by radial ribs. The top plate is formed of heavier material and terminates at its upper end in a tube which surrounds the feeding tube. A conical cover secured to the bowl by a cap nut fits over this top plate forming a passage between the upper surface of the plate and the under side of the cover. This passage leads to an annular opening formed by the outer wall of the tubular extension of the top plate and a variable ring held in position by a cap nut on the top of the cover. Several rings are supplied, and in this way the opening can be varied. The liquid on entering the bowl passes by means of the lower holes between the plates. Here separation takes place, the lighter liquid travelling up the cones and entering, through the top holes, the inner annulus, whilst the heavier liquid accumulating on the wall of the bowl is forced up the passage between the top plate and the cover and is discharged through the outer annulus into the lower collecting cover. Such a centrifugal separator running at 60 revolutions per minute is capable of purifying 180 gallons of transformer oil at 50° C. per hour. When the machine has to be used as a super-clarifier the top plate is replaced by one having a shorter tubular extension, and the outer annulus closed by a ring of suitable diameter, thus preventing the escape of the solids and heavier liquid whilst the lighter liquid is discharged into the lower collecting cover. Such an arrangement, whilst giving a clearer effluent, requires more frequent cleaning of the bowl.

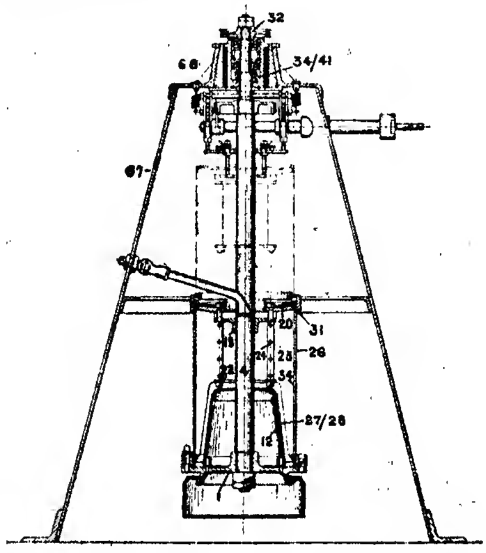

Fig. 10

Gee Centrifugal Separator by British Separators, Ltd.

In the Gee centrifugal (Fig. 10), a specially designed bearing is mounted on the top of a steel plate forming the cover of a hollow truncated cone. This bearing carries a vertical shaft, to the bottom of which is fixed a circular disc perforated at the centre. Below

this disc and free from it is the collecting-box attached to the outlet pipe, whilst on the upper side of the disc is a perforated filtering cone provided with a clamping device by which the filtering medium can be attached to its outer surface. A bayonet fitting allows the drum *l* to be easily attached to the rim of the disc. The top of this drum is covered by a plate having a large central hole through which the liquid is fed into the drum. When the machine removed and replaced by the second set supplied with the machine. It is found that the solid particles deposited on the plates are graded, coarse particles being deposited at the top and fine particles at the bottom. The machine can be easily adapted for centrifuging liquids which must be kept hot during the operation. There is practically no wear of the filtering medium and a constant rate of feed can be maintained during the charging period. Machines

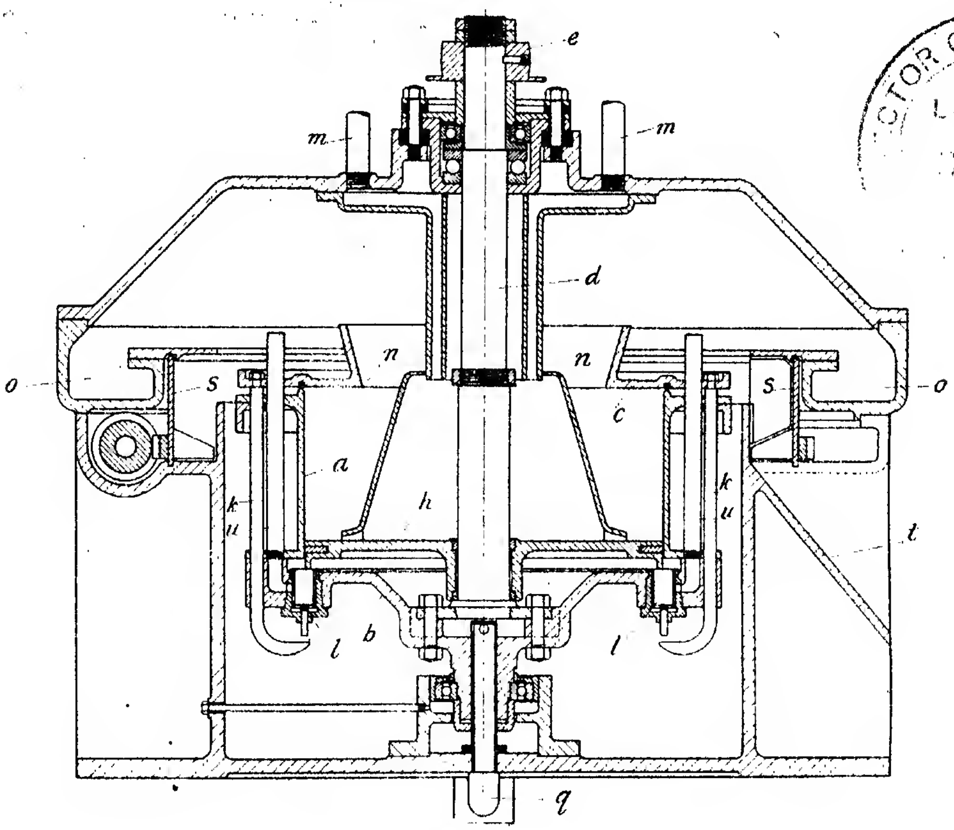

FIG. 11

Sturgeon Centrifugal Machine

is running this plate forms a watertight joint with the drum. Suspended from this plate, immediately below the central opening, is a spreading plate, the six rods attaching it to the upper plate passing downwards and terminating on the middle plate 24. To the top plate, the middle plate, the bottom plate, and these rods are fixed six radial plates which cause the liquid to rotate with the drum and divide the drum into six longitudinal compartments into each of which is fitted a thin plate having the same curvature as the drum and upon which the solid material is deposited. When the plates are charged the container is raised into the dotted position by means of a mechanically driven device carried on the outside of the pedestal. The plates can then be

have been made having drums of 12 and 36 inches in diameter.

One type of the Sturgeon centrifuge (Fig. 11) is a continuous running self-discharging machine. The machine illustrated consists of a vertical shaft, to which is attached the lower cylinder cover *b* and the cylinder *a*. The upper cover can slide on the shaft but is kept in position by the centrifugal force set up by a number of weights actuating bell-crank levers, pivoted on the outside of the cylinder and connected to the cylinder cover *c*. The cylinder is fitted with a piston *h* free to slide on the spindle. The liquid enters the machine at *m* and on reaching the cylinder is subjected to centrifugal force which causes the heavier particles to collect on the cylinder

wall whilst the purified liquid is discharged over the edge *n* into the outlet trough *o*. When sufficient solid has accumulated in the cylinder, the liquor supply is closed and pressure water is admitted through *q* below the piston *h*. As this rises it displaces the liquid still in the cylinder and compresses the solid material on the walls against the upper cylinder cover *c* until this is forced upwards and the solid matter is thrown on to the inner surface of the ring *s* from which it is scraped off into the outlet-chute *t*. The water supply having been closed, the movement of the cover *c* has operated the valves *l* through the rods *k* and the water escapes through the pipes *u*. Admission of liquid at *m* forces the piston *h* down to the bottom of the cylinder closing the valves *l*, thus making the centrifuge ready for dealing with the next change.

Electrical Precipitation

In some electrical experiments Count Schwerin observed that colloidal products collected on the poles, and when similar experiments were repeated on a peat suspension it was found that the dried peat showed a laminated structure, indicating that different materials under the influence of an electric field acquired different velocities. These investigations led to the development of the Osmose filter, which consists of an ordinary type of filter-press made of insulating material. The filter cloths are, however, supported by conducting materials such as wire gauze, which is insulated from the frames. If a difference of potential is maintained between two consecutive supports and the space between the cloths is filled with a clay suspension it is found that the water is discharged at the cathode and a firm cake is formed at the anode in a reasonable interval of time. A rotary machine has also been designed in which the anode consisting of a rotating drum is surrounded by copper strips forming the cathode; the lower portion of the drum being immersed in the liquid.

Recently an article appeared in *La Revue des Produits Chimiques* dealing with the work of MM. Marx and Rozier on the purification of liquids by the simultaneous action of centrifugal force and an electric field. When this principle is applied to a centrifugal of the peg-top type, longitudinal plates are fixed radially to the inner vertical wall. To these plates, but insulated therefrom, is fixed a concentric metal cylinder, thus forming an annulus with the bowl of the centrifugal. All the internal surfaces except the vertical wall of the bowl is covered by some insulating material. The bowl is then connected to one terminal of a dynamo and the inner cylindrical shell to the other terminal. In this way the liquid

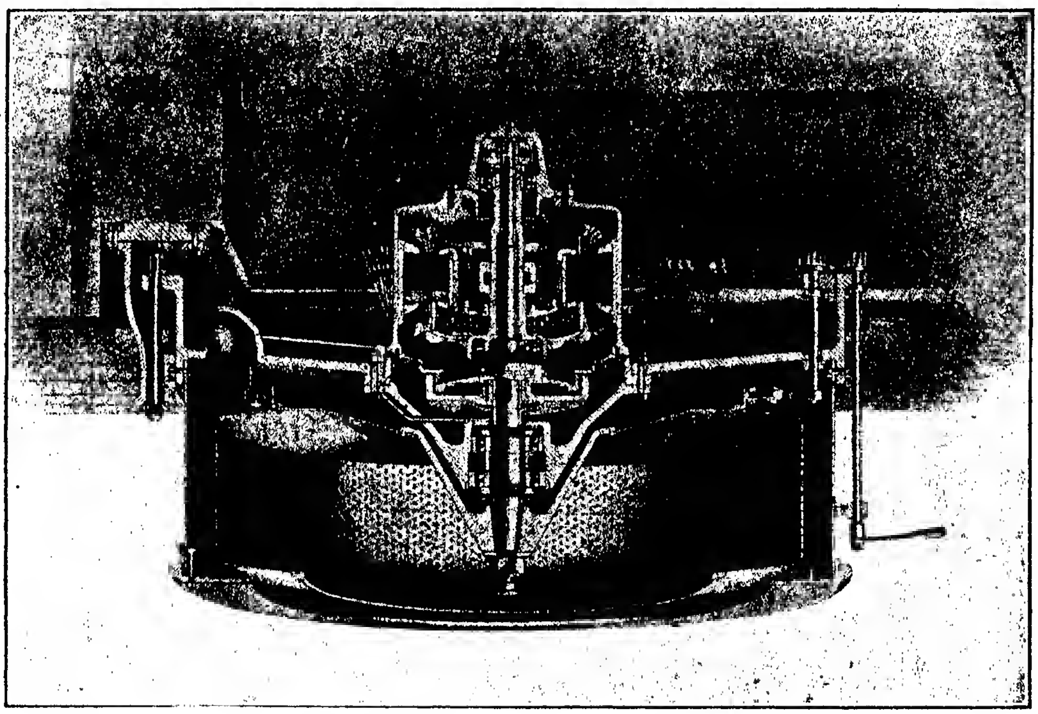

Fig. 12

Suspended, Electrically-Driven Hydro-extractor by Thomas Broadbent & Sons, Ltd.

fed to the bottom of the bowl and rising through the annulus is subjected to the simultaneous influence of an electric field as well as centrifugal force. When the machine is of the Sharples type the bowl itself is coupled to one of the terminals of the dynamo and a concentrically placed metal cylinder, insulated from the bowl, is connected to the other terminal. The authors show that transformer oil which had a rupture potential of 19,000 volts across a 10 mm. gap, had this rupture potential raised to 30,000 volts after 5 minutes' treatment in an electro-centrifuge, whereas the same oil subjected to the same treatment in an ordinary centrifuge of the same type, had the rupture potential raised to only 22,000 volts.

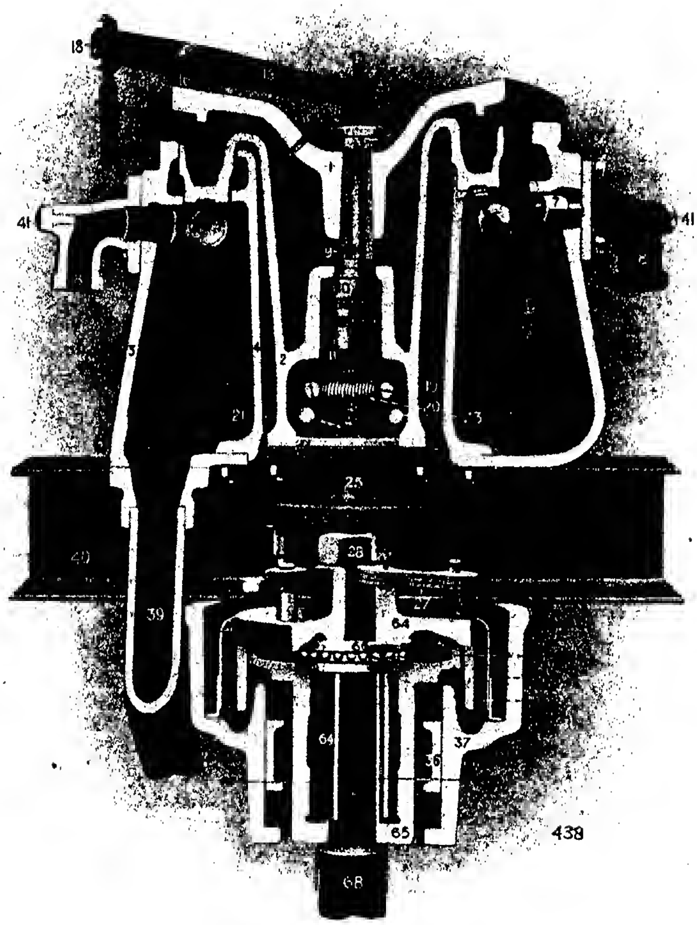

FIG. 13

Pelton Wheel and Top Bearing of Over-driven Centrifugal by Pott, Cassels and Williamson

principle can also be applied to machines of the Vickeen type, by forming each plate of two metal plates separated by an insulating material. The under sides of these plates are electrically connected to the base of the bowl which is in turn connected to one terminal of the dynamo, whilst the upper plates are connected to the cover and wall of the bowl, which are insulated from the base and so to the other terminal of the dynamo. Experiments by the

Acknowledgment and thanks are due to the various firms mentioned for information supplied and the loan of illustrations.

The Prospectors, Ltd., a new company, is erecting a salt plant at Bucklaw, Victoria Co., Nova Scotia. The output will be largely employed for salting fish.

FORTHCOMING EVENTS

Oct. 6. INSTITUTION OF THE RUBBER INDUSTRY, *London and District Section*, the Engineers' Club, Coventry Street, London, W., at 8 p.m. "Sulphur," by E. Anderson.

Oct. 6. THE TEXTILE INSTITUTE, *London Section*, Clothworkers' Hall, 41, Mincing Lane, E.C. 3, at 5.45 p.m. "Misdescription in the Textile Trades," by A. E. Garrett.

Oct. 6. THE SOCIETY OF ENGINEERS, the Geological Society, Burlington House, Piccadilly, London, W. 1, at 5.30 p.m. "Pulverised Fuel," by E. Kilburn Scott, with lantern illustrations.

Oct. 7. INSTITUTION OF PETROLEUM TECHNOLOGISTS, at the Royal Society of Arts, John Street, Adelphi, London, W.C. 2, at 5.30 p.m. "Recent Development in the Art of Cracking," by A. E. Dunstan.

Oct. 7. THE INSTITUTE OF METALS, *Birmingham Section*, Chamber of Commerce, New Street, Birmingham, at 7 p.m.

Oct. 7. INSTITUTE OF METALS, *North-East Coast Section*, Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. "The Structure of Metals in its Relation to Elastic Failure—Part I," by Prof. F. C. Thompson.

Oct. 8. SOCIETY OF CHEMICAL INDUSTRY, *Nottingham Section*, the University College, Nottingham, at 7.30 p.m. The President will deliver an address on "Publicity in Chemical Industry." The address will be illustrated by films—"Coal and its Products" and "Heavy Chemicals." The meeting is open to all interested, and the following topics will be discussed:—(1) The Need of Publicity, (2) Methods New and Old, (3) Publicity as Exemplified by (a) Advertisements, (b) Letters to the Press, (c) Dinners, (d) Press "News," (e) Films, (f) Exhibitions. Light refreshments will be served to members and Associates.

Oct. 8. THE INSTITUTION OF SANITARY ENGINEERS, Opening Sessional Meeting, to be held at the Cabin Restaurant, Caxton House, Tothill Street, Westminster, London, S.W. 1, at 7.30 p.m.

Oct. 9. INDUSTRIAL LEAGUE AND COUNCIL, Crossway Hall, New Kent Road, London, at 7.30 p.m. "Industrial Policy," by G. Bloomfield.

Oct. 9. INSTITUTE OF METALS, *London Section*, Institute of Marine Engineers, 85-88, The Minories, Tower Hill, London, E. 1, at 7.30 p.m. Address by J. L. Haughton.

Oct. 10. INSTITUTE OF METALS, *Swansea Section*, University College, Singleton Park, Swansea, at 7.15 p.m. Address by Captain Hugh Vivian.

Oct. 10. UNIVERSITY OF LONDON, University College, Gower Street, W.C. 1, at 5.30 p.m. "Water Supply and its Purification" (Lecture I), by Prof. S. L. Raskkovitch. Also on October 17, 24, and 31.

Oct. 10. INSTITUTE OF METALS, *Sheffield Section*, the University, St. George's Square, Sheffield, at 7.30 p.m. Address by W. G. Turner.

Oct. 1[illegible]. SOCIETY OF CHEMICAL INDUSTRY, *Nottingham Section*. Annual Dinner, at the Flying Horse Hotel, Poultry, Nottingham, at 7 for 7.30 p.m. Tickets 5s. each, exclusive of wines. Applications not later than October 9.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

A circular letter with further particulars and a form of application for tickets has been sent out to the members.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

EDITORIAL NOTICES

The Society as a body is not responsible for statements and opinions appearing in the JOURNAL.

Members of the Society, and others, are invited to submit original articles, news, notes and other relevant information to the Editor of *Chemistry & Industry*. Such contributions should be clearly written (preferably typewritten with double spacing), and be accompanied by a stamped and addressed envelope. They will be paid for if inserted. Sources of information should always be given, not necessarily for publication.

Hon. Secretaries of Local Sections and of other Societies are asked to forward notices and reports of meetings as early as possible, and publishers to send books for review, direct to:—THE EDITOR, *Chemistry & Industry*, SOCIETY OF CHEMICAL INDUSTRY, CENTRAL HOUSE, FINSBURY SQUARE, E.C. 2. Telephone: Clerkenwell No. 2429.

Hon. Secretaries of Local Sections and of other Societies are asked to note that announcements of forthcoming events cannot be inserted in the next issue of the JOURNAL *unless they are received not later than Tuesday in any week.*

Matters relating to the Transactions and Abstracts, including Papers intended for insertion as Communications, should be addressed to THE EDITOR OF TRANSACTIONS, at the same address.

LONDON SECTION

The following provisional arrangements have been made: November 3, address by the President (Mr. W. J. U. Woolcock); November 17, Joint meeting with Rubber Institution; December 1 Joint meeting with Oil and Colour Chemists' Association; February 2, Prof. W. A. Bone on "The Constitution of Coal." Times and places of meetings will be announced later.

THE CERAMIC SOCIETY

The autumn meeting of the Refractory Materials Section of the Ceramic Society was held at Wembley on September 18 and 19, with Mr. J. Holland in the chair.

The first item on the programme was a paper by Mr. T. W. Barley entitled "A Comparison of Gas and Coke Fired Drying Stoves." An account was given of the successful use of town gas for drying large moulds in steel works until post-war conditions made it far too expensive. Eventually some experiments were made with the Hüttenes coke-fired, air-blown furnace, and this with some minor modifications has been found very satisfactory. The brick-built furnace is placed at one end of a drying chamber, and the hot gasespass from the furnace upwards on each side of firebrick louvres, between which they are met by a pre-heated jet of compressed air at 80 lb. pressure per sq. in., the products of combustion being thus projected into the drying chamber at a high velocity. Advantages accompanying the use of this type of furnace for drying moulds include economical fuel consumption, little attention required during the run, easy regulation of the temperature by turning on more or less air, economy in space as well as in cost of construction and maintenance, no chimney required, the possibility of placing the furnace at some distance from the drying chamber without serious loss of heat, the guidance to the operator afforded by a satisfactory thermographic chart which may be closely copied, the possibility of using the cheapest available fuel above the grade of dust, the attainment of complete combustion and the possibility of employing ordinary unskilled labour to operate the furnace. These claims are justified by the performance of these furnaces for the past ten months. The efficiency of the apparatus is testified by the fact that all the moulds are thoroughly dried at the end of the run of 15 hours, no mould being found burned or imperfectly dried. The average working temperature employed for mould drying is 225° C., for large cores 200° C., and for small cores 180° C.

The second paper was by Mr. H. S. Houldsworth, M.Sc., on "Some Properties of Clay-Sillimanite Mixtures." The results are given of work undertaken to study the changes in the physical and chemical properties of a clay when mixed with different percentages of sillimanite. The natural commercial sillimanite used contained 32·9 per cent. of silica and 64 per cent. alumina with ferric and titanic oxides. The grading ranged from 11·8 per cent. of material between 5-mesh and 10-mesh size through nine intermediate grades to 18 per cent. of material which passed through a 200-mesh sieve. Test pieces were made of mixtures of Farnley fireclay and sillimanite containing 0, 20, 33⅓, 50 and 66⅔ per cent. of sillimanite respectively, and also others containing 95 per cent. sillimanite with 5 per cent. ball clay, and 90 per cent. sillimanite with 10 per cent. ball clay respectively. The fireclay and ball clay were first ground to pass a 20-mesh. The specimens were fired in a works kiln to cone 6 in 48 hours and to cone 9 in 72 hours, some of the latter test-pieces being subsequently burned for 2 hours at cone 14 and cone 18 respectively in a laboratory gas-fired furnace after reaching the temperature in 3 hours. The drying and firing shrinkages, porosity, true and apparent specific gravities, refractoriness, reversible thermal expansion, and resistance to solution by a soda-lime glass and a basic slag were determined. The results of these experiments may be summarised thus: The addition of sillimanite to clay decreases the drying and firing shrinkages, increases the porosity at the higher temperatures of burning, and when 50 per cent. or more is present increases the refractoriness appreciably. A mixture of 95 per cent. sillimanite with 5 per cent. ball clay has a regular coefficient of expansion from 15° to 1000° C., which is not affected appreciably by differences in the firing temperature up to cone 18. The rapid expansions shown by fireclays from 100°—200° C. and from 500°—600° C. are reduced by the addition of sillimanite. The expansion of a typical fireclay from 600°—1000° C. is less than that of sillimanite in the same range. Sillimanite bonded with 10 per cent. of the ball clay has a marked resistance to chemical attack by soda lime glasses and basic slag. Sillimanite-clay mixtures containing less than 50 per cent. of sillimanite are not appreciably more resistant to such attack than is fireclay alone.

Mr. W. Hugill, M.Met., then read a paper by himself and Mr. W. J. Rees, B.Sc., on "The Influence of Exposure on the Chemical and Physical Properties of Certain Fireclays." Experiments were made to investigate the nature of the changes occurring in fireclays exposed for a fixed period to the weather. The samples of clay included (1) a light grey, somewhat sandy, micaceous clay from Durham, (2) a dark-coloured, compact, fine-grained clay from the Sheffield district, and (3) a light grey, very sandy, and micaceous clay from another locality near Sheffield. The clays were spread evenly over the bottoms of wooden boxes, and left exposed for twelve months. From unexposed and exposed clays small bricks were made and tested. The conclusions drawn from the results of tests were that exposure to the weather removes impurities in the clay to a variable extent, depending on their chemical and physical characteristics. It improves the working properties of the silicous clays 1 and 3, but with the more aluminous clay 2, the general properties and, in particular, the workability, are not materially improved by exposure, though some impurities are removed. Bacteria seem to play an important part in the decomposition of sulphides in clays, and possibly such decomposition may be accelerated by inoculations.

Of the papers presented on the second day, that by Prof. W. Vernadsky "On the Action of Heat on Kaolinite and Kaolinitic Clays," and the paper by Drs. Mellor and Scott on "The Action of Heat on Kaolinite and Other Clays" (Part II.), are controversial in character and largely of theoretical interest. The paper by Mr. Rees on "Alumina-Silica Minerals in Firebricks" bears on a particular aspect of the same subject, and Dr. Hadding's paper on "X-Ray Investigation of Clays and Some Other Ceramic Substances" is concerned with a comparatively new

method which gives results which are apparently open to different interpretations in some cases. All these, though interesting in themselves, are scarcely suitable for short notice in *Chemistry and Industry*, and reference must be made to the original papers.

Mr. W. J. Rees, B.Sc., read a "Note on the Storage of Silica Refractories." It has been noticed from time to time that when silica bricks or blocks have been kept without proper protection from weather action, important changes in physical properties have resulted. In a recent case, silica bricks which had been kept in the open for six months spalled badly in use, whilst normal freshly delivered bricks of the same make and having the same texture, specific gravity, etc., were satisfactory. The good bricks had a cold, crushing strength of 3000 lb. per sq. in., whilst that of the stored bricks was only 2200 lb. per sq. in. Tests were made with bricks, some of which had been left fully exposed to the weather for four months. The results of tests gave definite indications that the loss in strength of silica bricks exposed to weather is in part due to a slight degradation of the bond by hydration and solution in water, as well as to the physical effect of frequent wetting and drying. These tests showed little or no distinction in the behaviour of coarse and fine textured bricks, but in both cases the bricks burned at higher temperatures were more resistant to action by water.

A joint paper by W. Hugill and W. J. Rees on "A Rapid Method for the Determination of True (or Powder) Specific Gravity" includes a description of the apparatus used. This consists of a conical flask, with a long neck at the lower end of which is a wide bulb. At the bottom of the neck is the 250 c.c. mark, and above the bulb the neck is graduated in specific gravities from 2·00 to 2·70, so that the specific gravity may be read off directly without calculation. Liquid is poured into the flask up to the 250 c.c. mark, and exactly 100 g. of dry powdered brick is then gradually dropped into the flask. After standing two minutes to let air bubbles rise, the level of the liquid is read on the graduated neck of the flask. Xylene was adopted as the standard liquid for these tests, being chosen because of its low viscosity and surface tension as compared with water and alcohol, as well as its higher boiling point. Crushing the dry brick to pass a 30-mesh sieve enables results to be obtained accurately within 0·01 per cent. A determination takes from 15 to 20 minutes. The flask is obtainable from a glass-blower in Manchester.

The final paper, by Mr. Rees, described "The True Specific Gravity and After-Expansion of Lime-bonded Silica Bricks." Data are given in a graph and table for 40 bricks from North and South Wales, the Sheffield district, North of England, Scotland and France. The following points are noted:—(*a*) For bricks of lime content between 1 and 3 per cent. there is a sufficiently close relation for practical purposes between the true specific gravity (or powder density) and the degree or extent of quartz conversion. (*b*) For bricks of fine and medium texture there is a close relation between the true specific gravity and the after-expansion as determined by the standard after-expansion test. For works purposes, a rapid determination of the powder density of such bricks gives a definite indication of the permanent volume change which is likely to occur during their use. (*c*) For the raw materials which are in use in this country for the making of lime-bonded silica bricks, the grading of the raw material has in general a greater influence on the rate of quartz conversion than variation in the source or type of the raw material itself. (*d*) For coarse-textured bricks containing large fragments of raw material (*i.e.*, ¼ in. and above in diameter) there is not a close relationship between the true specific gravity and the after-expansion. Possibly for coarse-textured bricks the time of heating in the standard after-expansion test is insufficient.

ACADÉMIE DES SCIENCES

On September 8 Dr. Roux communicated an interesting paper by M. Metilnikov on the heredity of acquired immunity. Experiments on a parasite of the bee showed that the first generation produced from parents immunised against cholera were not immune, whereas the third generation yielded 30 per cent. of immunised larvæ, the immunisation increasing progressively until the eighth and ninth generations gave 75 per cent. of immune individuals. The results are of much interest for the study of human immunisation. M. Leclainche communicated a paper by M. Ducloux on the attenuation of the virulence of the anthrax bacillus, work which had yielded interesting results.

On September 15, M. A. Lumière maintained that on continuing to centrifuge toxic sera to a greater degree than was usual in laboratory apparatus, the serum becomes perfectly harmless. In a previous note Dr. Loisel had stated that in the gas given off by springs at Bagnoles de l'Orne there was an unknown emanation derived from a new radio-active body to which he had given the name of "emilium." Continuing this work, Dr. Loisel showed, in a note presented by M. D. Berthelot, that emilium is found with its characteristic radio-activity in the granitic rocks from which issue the thermal springs.

During the meeting on September 22, M. D. Berthelot described an observation by M. Brylinsky on the Michelson effect. Repetition of this experiment carried out recently in America by Miller showed an unexpected displacement of the interference fringes when the apparatus was rotated. M. Brylinsky states that a variation of as little as 0·001° C. in temperature would suffice to explain the phenomenon so that simple contact between the instrument and the observer during the experiment would produce a sufficient variation of temperature to cause the effect.

J. D. McArthur and Co. are to erect a paper mill at Pine Falls, Manitoba. The cost of construction will be $5,000,000 and the initial daily capacity 200 tons.

CORRESPONDENCE

TECHNICAL WRITING

Sir,—The publishers (John Wiley and Sons) of my little book on "Technical Writing" have sent me a series of clippings recording the pleasant discussion that has been appearing in the columns of your valuable journal on the subject of the English language, and the need for improving our use of it. This discussion was started by your friendly review of my book and Mr. Johnson's subsequent demur to the idea of an Englishman consulting "the book of an American author in order to learn how to write our common language correctly." My friend and associate, Mr. Allen, objected to this suggestion, and asserted that Americans might be permitted to assist in improving the use of our language. He suggested that "we on this side of the Atlantic may be credited with contributing to the improvement of good literature," no less than you gentlemen in England. Whereupon my fellow alumnus of the Royal School of Mines, Mr. Picard, disclosed the fact that I was born and educated an Englishman. To complete the humour of the episode, permit me to say that Mr. Allen also is an Englishman (not even yet a naturalised American, as I am) and a graduate of Cambridge. This ought to mollify Mr. Johnson and save the *amour propre* of our British friends. To them I do not hesitate to say that English professional men—engineers and chemists, for example—commonly use our language with more care and skill than my American friends in the same professions. The cause of the difference is not far to seek. In England the sons of professional men go to school with the sons of others like themselves, that is to say, the children of fairly well educated persons. In the United States the sons of engineers and chemists sit alongside the children of the plumber, the carpenter, and the grocer. The result is that plumbers, carpenters, and grocers in this country usually speak and write better English than those engaged in similar occupations in England, whereas the engineers and chemists show no peculiar superiority in this regard. Furthermore, by reason of our democratic ways of living, the engineers and chemists associate in business, as well as in their sports and home life, with persons not as well educated but as intelligent and successful as themselves. We have no language-tight social compartments, whereas you with a social stratification that survives from feudal days are separated into classes, among which are those who use good English and those who use bad English. The tendency in the United States is to level down the top fraction and to raise the lower fraction of the population, the result being a mediocrity in the use of language, as in other things, that is better than the speech and writing of your lower strata but inferior to that of your upper strata. To use a geologic simile, ours is a confused bedding. Such are the advantages and disadvantages of democracy. In the end the spread of education and the generous service of our universities will improve the language and the intelligence of the whole body of the people.

These observations, I hope, will be deemed pertinent to the discussion. Permit me, sir, to conclude by saying that we engineers, using the word in a broad sense, will do well to accept the aid of anyone sincerely desirous of helping us to use with precision and grace the one instrument—language—that we use most.—Yours faithfully, T. A. RICKARD

PATENT SPECIFICATIONS

Sir,—I have read with interest the recent correspondence in *Chemistry and Industry* on the subject of the English language. Considering the inherent difficulties in explaining complex ideas with the greatest *accuracy*, I think that the language usually employed by chemists reaches quite a respectable standard. It is far different in dealing with patent specifications. Ability to write grammatical English does not seem to be a necessary qualification for a patent agent. Patents taken out by foreigners frequently appear to be mistranslated into English in the most clumsy fashion in such a way that the resulting sentences have no clear meaning. In many cases technical terms are translated wrongly. I am not now referring to the ambiguity often met with in patent specifications which may sometimes be deliberate, but simply to clumsy language due, apparently, to ignorance. Here are some choice specimens taken entirely from specifications I have dealt with in the last two or three weeks. "The excess of 25 grams of formaldehyde have to cause the hardening of the resined product. The resined paraoxybenzylalcohol dissolved in ether and to that added a few drops of concentrated sulphuric acid shows the same deep red colour reaction as the ortho compound does." ". . . maintained at a temperature of 100—120° until all aqueous moisture is removed." In another specification, the example for carrying out the process begins with the word "Yellowlac," when obviously a yellow lake is meant, and the same specification contains the phrase, "being emulsioned while still wet with varnishes."

As the Patent Office employs a large staff of examiners, it seems a pity that a reasonable standard of clarity in language and freedom from error in technical terms is not enforced before a patent is granted. In the meantime, I can only suggest that patentees should safeguard themselves when taking out chemical patents by employing only those patent agents who have competent chemists on their staff.—I am, Sir, etc., PERCY MAY

The Laboratory,
Staple Inn Buildings,
High Holborn, W.C. 1
September 20, 1924

COLLOID CHEMISTRY IN ANTIQUITY

Sir,—The following quotation from Agricola (1561) is an early example of the application of the properties of colloids in a manufacturing process. In his description of the production of salt, he writes: "In order to accelerate the condensation of the brine, when the Master has poured in two casks and as many dippersful of brine, he adds about a Roman

cyathus and a-half of bullock's blood, or buck's blood, or else he mixes it into the nineteenth dipperful of brine, in order that it may be dissolved and distributed into all the corners of the cauldron; in other places the blood is dissolved in beer. . . . When it begins to thicken with the heat, he and his helper stir it assiduously with a wooden spatula, and then he allows it to boil for an hour. After this he pours in a cyathus and a-half of beer."—I am, Sir, etc.,

H. A. AUDEN

120, Whitehedge Road,
Garston

OBITUARY

OTTO HEHNER

(An Appreciation)

To give a brief sketch of such an eventful life as that of the late Mr. Otto Hehner is no easy task, comprising as it does so many episodes of professional and personal interest. It is only possible therefore to recount a few of them, and the writer can but hope that he has made a wise selection. The deceased passed away from the effects of a tropical fever on September 9 in South Africa, whither he was sojourning—it was hoped only temporarily.

Born at Marienberg, Nassau, in 1853, Otto Hehner was educated at Wiesbaden, where his father, Karl Philip Hehner, was a judge in the appeal court of that town. He was originally intended for the church, but ultimately he became a pupil, and later an assistant of the veteran analytical chemist, Remigius Fresenius.

In 1873 he left his native country and became assistant to Prof. G. Bischof at the Andersonian College, Glasgow, the precursor of the present Glasgow and West of Scotland Technical College. He has narrated humorously the professor's linguistic difficulties, as well as his own, which at first were even more circumscribed, conversations having to be carried on with the aid of a dictionary. These difficulties disappeared however with the arrival of a fresh assistant, a young graduate from Tübingen, who was no other than William Ramsay. Thus commenced Hehner's lifelong friendship with Ramsay.

Early in 1874 Hehner became assistant to Dr. Arthur H. Hassall, a physician at Ventnor, who was one of the first to take up the study of foods, mainly with the aid of the microscope, and it was here that he collaborated with Dr. A. Angell on the chemical analysis of butter. It was here also that he first met Dr. W. J. Sykes. Coming to London in 1877 he established a practice as consulting chemist in Holborn. In 1881 he removed to more commodious laboratories at 11, Billiter Square, at which his extensive practice is still being carried on by his successor, Dr. H. E. Cox.

Throughout his career Hehner took an active part in the proceedings of scientific societies. Becoming a member of the Society of Public Analysts in 1876, his association with that Society was continuous, and it is not too much to say that the high status which the Society now holds is due more to Hehner than to any other man, not even the late John Muter, who may perhaps be regarded as the founder, could claim to have done so much towards its development, and incidentally, for the study of the chemistry of foods and drugs. He served as a member of Council from 1880, was Secretary in 1883—1890, and President in 1891.

He was elected a Fellow of the Institute of Chemistry of Great Britain and Ireland in 1878, and from the first he recognised how much that body could do to raise the status of the professional chemist. Members of the profession in all its branches now know the debt they owe to the Institute, through such men as Hehner, for the fruition of its ideals. He served as Vice-President of the Institute for three separate periods of three years each, was many times an ordinary member of Council and of the various sub-Committees, and he held the offices of Examiner (1895—1899) and of Censor (1901—1903). An original member of the Society of Chemical Industry, he was Chairman of the London Section in 1900—1902, a period during which the writer was Hon. Secretary. It became necessary about this time to appoint a Committee to investigate methods for the detection and estimation of arsenic in food materials and products, and mainly through Hehner's efforts a Joint Committee of the Society of Chemical Industry and of the Society of Public Analysts was appointed for this purpose. The time which the writer devoted in collaboration with his friend to this subject will ever be remembered as well spent. Hehner was a Fellow of the Chemical Society, and during the early part of his career he was an abstractor for the *Journal*.

Hehner had held many public appointments as Public Analyst and Agricultural Analyst. On account of his wide knowledge he was called upon to give evidence concerning foods, etc., before parliamentary committees, as well as to render expert advice in the passing of numerous water bills and gas bills through Parliament. He examined waters and advised on water supplies all over the country. During the war most of the glycerin passed through his hands, and he advised many firms how to improve the quality and increase the output of glycerin without any remuneration to himself. On account of this work Lord Moulton sent him a special letter of thanks for his services to the country. As an expert witness he gave evidence on almost all the most important cases where chemistry was involved.

His published papers cover a very wide field, and most of them are to be found in the volumes of the *Analyst*. They include researches on fats and waxes and all descriptions of foods. He collaborated with Angell, Dupré, Carpenter, Richmond and Mitchell. Far more, however, than his published works are those locked up in his archives, many of which may perhaps be lost permanently as they would be but imperfectly understood without his illuminating personality. A few months before his death the writer endeavoured to persuade him to put together some of his notes on Foods and Drugs. His reply was: "I could write reams, but I won't!"

The writer first became acquainted with Hehner in 1887, at the time when H. Droop Richmond was his assistant. The acquaintance afterwards ripened

into a close friendship, to which the following circumstance conduced. Hehner was an ardent freemason as a member of the "Deutsche Pilger Loge" in London, and he had been in the habit of meeting other members of that Lodge at coffee at the "Mecca" first in Eastcheap and afterwards in Mark Lane. The men who used to foregather at the "Kaffee Tich" were all the old type of Germans, one and all loyal citizens of the country of their adoption. No more kindly man ever existed than G. Vogeler, the Secretary of the Lodge and a member of our Society. When the Brothers Newlands set up in practice in London, they were attracted to the table by the presence of Hehner, and by degrees the "Kaffee Tich" became to some extent a gathering of chemists. Of these, Domeier, G. Haller, Hehner, Guttmann, B. E. R. Newlands and the writer were constant attendants, whilst occasionally A. H. Allen, W. J. Sykes, J. L. Baker, W. J. Pope and other chemists who happened to be in London would drop in. Alas! G. Haller and the writer are the only two surviving members of those who used to attend regularly.

During the period in which Hehner was Master of the Lodge one of the brethren introduced a German nobleman as a member. Hehner, who was at all times averse to the German *Junker*, immediately resigned, nor could all the persuasion of his friends induce him to reconsider his decision.

Hehner was a philosopher: his knowledge of other sciences than chemistry—botany, geology and entomology—was far above the average. He was kind-hearted and generous, ever ready to help with advice or in a practical manner any who came to him—and these were many. He was of a highly emotional, excitable and even impetuous temperament, forming strong likes and dislikes, but never vindictive towards those who differed from him. Yet as a critic he was severe and incisive. When about thirty years ago typing reports became common, Hehner for several years typed his own reports: he had no patience with the ordinary lady secretary. About twenty-one years ago, however, he saw the fallacy of this and engaged the services of Miss Grace M. Dollery, to whom the writer is indebted for much of the information contained in this notice. Hehner himself used to say that the large increase in his practice of late years was largely owing to Miss Dollery's method and tact. His death has removed from the world chemical a figure long to be remembered by a wide circle of his professional brethren and others, to whom, individually and collectively, he was a close personal friend.

ARTHUR R. LING

HENRY GEORGE SMITH

By the death on September 19, at Roseville, Sydney, New South Wales, of Mr. Henry George Smith, Australia loses one of her most eminent scientific men. Mr. Smith, who was born at Littlebourne, Kent, 73 years ago, was for many years Assistant Curator and Economic Chemist at the Sydney Technological Museum, and upon his retirement a few years ago he continued his researches in the Organic Chemistry Department of Sydney University. In collaboration with Mr. R. T. Baker, formerly Curator of the Sydney Technological Museum, he carried out a series of investigations extending over 30 years, which have thrown much light upon the scientific characteristics and economic possibilities of the essential oils and other products of the Australian flora. The main results of this work were published in two volumes entitled "A Research on the Eucalypts and their Essential Oils," and "A Research on the Pines of Australia." Mr. Smith was an unflagging worker, and his original papers, contributed to various scientific periodicals, number well over one hundred. Owing to the bulk of his work having been published exclusively in Australian journals it received fuller recognition in Australia and America than in Great Britain.

Mr. Smith was an original member of the Australian National Research Council, and at various times he filled the offices of President of the Royal Society of New South Wales, President of the New South Wales branch of the Australian Chemical Institute (1922–3) and President of the chemistry section of the Australasian Association for the Advancement of Science. In the last-named capacity he delivered his presidential address on the chemistry of the Australian flora at Wellington, New Zealand, in 1923. He was an honorary member of many British and American scientific corporations, and was recently awarded the Syme Prize of the University of Melbourne as an appreciation of his services to scientific research in Australia. His character was marked by simplicity and sincerity, and he will be remembered as an outstanding pioneer of Australian chemistry.

PERSONAL AND OTHER ITEMS

The Minister of Health has appointed Mr. James Picken, B.Sc., A.I.C., to be an Inspector under the Alkali etc. Works Regulation Act, 1906, in place of the late Mr. Harold Bailey, O.B.E., F.I.C.

Monsieur R. P. Duchemin, president of the Union des Industries Chimiques, has been elected president of the Industrial Group of the Conseil Supérieur National Economique de France.

Monsieur L. Labbé, director of technical education in the French Ministry of Education, has been promoted Grand Officer of the Legion of Honour.

Mr. G. A. Edwards has been appointed demonstrator in chemistry in King's College, London.

Prof. W. E. S. Turner, D.Sc., who is paying a visit to the United States, was entertained to dinner on September 4 by the Pittsburgh Section of the American Ceramic Society.

Dr. J. E. Gilpin, sometime professor of chemistry at the Johns Hopkins University, Baltimore, died on August 25, at Chestertown, Md. He will be remembered for his work on the action of chlorides of phosphorus on amides and on the fractionation of crude petroleum by capillary diffusion.

REVIEWS

QUANTITATIVE ORGANIC MICROANALYSIS. By F. Pregl, D.Sc., Ph.D. Translated from the second revised and enlarged German edition by Dr. Ernest Fyleman. Pp. xv+190. London: J. and A. Churchill, 1924. Price 12s. 6d. net.

Accurate analytical work is the foundation upon which all true progress in pure or applied chemistry must be built, and accuracy in analytical operations is in turn dependent upon technique. Microchemistry requires above all else a perfect technique, and, if for no other reason than this, should form part of the curriculum in the training of every chemist. Until the appearance of this translation of Pregl's book we have had no modern work in the English language which could be rightly called, as this book can, a textbook of technique. One cannot but feel that in this country analytical technique does not hold the position it should in our teaching. Microchemical methods are but little known, being to-day confined to the bio-chemists and to a few advanced workers who have recognised for themselves the advantage and the elegance, as well as the accuracy, of microchemical analysis. But there is another aspect of the value of microchemical methods and that is in the training they afford in correct manipulative methods, in scrupulous cleanliness and in the art of handling minute quantities of matter without loss. In offering a welcome to this translation the reviewer recognises that its value does not lie in its appeal to the initiated and converted; it is a book that should be in the hands of every analytical chemist and every serious student; and it should do much to widen the knowledge and appreciation of micro-analytical methods as well as stimulate further investigation with a view to broaden the field of micro-chemistry. To those unfamiliar with the German edition of Pregl's book, this translation will come as a revelation. The reviewer knows of no other work which approaches it in minute detail of technique and manipulation. Far too many descriptions of analytical methods published to-day are so condensed as to be worthless except to the experienced analyst. The beginner frequently obtains results so erroneous as to cause him to lose faith in the methods or he learns faulty methods of manipulation which seriously handicap progress. Pregl's minute detailing of conditions, apparatus and precautions, his full description of manipulation, the discussion of difficulties met with and successfully overcome, offer an inspiring and invaluable object-lesson to all chemists whether made or in the making.

The possibilities of micro-analytical methods in industrial laboratories are manifold, their elaboration and adoption is but a matter of time, whilst their value to the investigator would be difficult to exaggerate. No better introduction to them could be desired than is contained in Pregl's book. Much of the apparatus described is capable of many applications, the general principles have been proven sound and the whole work provides an admirable introduction to the technique of handling minute quantities accurately and with confidence. The translation follows the original with exceptional fidelity and in this loses nothing of Pregl's felicity of description. Indeed, the purist may even complain that in one or two places the translation is too literal and as a result offends, but these few cases are overbalanced by the recogni[illegible] so faithful a translation does convey th[illegible] and feeling of the author. There are b[illegible] in the text and these are of small mo[illegible] cannot but hope that this translation [illegible] the means of inspiring many of our chemists to [illegible] effort after perfection of technique as we[illegible] fuller realisation of the immense import[illegible] of accurate analytical work to progress in bo[illegible] and applied chemistry, and, finally, of the[illegible] of microchemical methods.

H. W. GREENWOOD

A TEXT-BOOK OF INORGANIC CHEMISTRY. Edited by J. NEWTON FRIEND, D.Sc., Ph.D. Vol. II. The Alkali-Metals and their Congeners. By A. J. WALKER, Ph.D., B.A. Pp. xxvi+379. London: Charles Griffin and Co., Ltd., 1924. Price 20s.

The Text-book of Inorganic Chemistry, edited by Dr. J. Newton Friend, advances a step nearer completion with the appearance of Volume II. by Dr. A. Jamieson Walker. This volume deals with Group I. of the Periodic Table—hydrogen, the alkali metals, copper, silver and gold. The ammonium compounds are included after the alkali metals.

The arrangement of the subject matter is on the usual lines. Each element is discussed under the heads of occurrence, history, preparation, physical properties, chemical properties, characteristics of the ion and applications. The chief researches on the atomic weight of the element are then discussed, special attention being paid to modern work. These sections are clearly written, and the treatment is concise and adequate. In the case of the metals there follows a description of the most important compounds and salts of the metal.

Dr. A. E. H. Tutton contributes a short but very interesting summary of the results of his researches on the isomorphism of the alkali metal sulphates and selenates and their bearing on the question of atomic structure.

The treatment of the descriptive part is more on the lines of what one may call the older school of text-book. The wealth of physico-chemical data to which we have become accustomed is lacking here. For example, reversible reactions are not discussed from the point of view of mass action. Quantitative data and equilibrium constants are omitted. No figures are given for the degree of hydrolysis of such salts as the alkali carbonates, cyanides and borates. References bearing on these points are, of course, given, but in a text-book of this nature one might reasonably expect to be informed whether, say, sodium carbonate was much or little hydrolysed in solution. For the properties of solutions of salts generally, such as density, conductivity, viscosity, etc., one is given a reference only. These omissions

are probably dictated by considerations of space, but it is curious to find that for solid salts in many cases rather full (and often widely differing) data are given for density, melting-point, specific heat and even conductivity of the fused salt, in spite of the fact that, compared with the data for the corresponding properties of solutions, these figures are, to say the least, inaccurate and less often required.

With these limitations, which are obviously part of the plan of the volume, however much some may regret them, the author has done his work well. The descriptions are clear and concise, and the numerous references carefully chosen rather than exhaustive. The solubilities of most important salts are given, but there are one or two anomalies. Thus the solubility of potassium hydrogen sulphate is given, but not that of the sodium salt, whilst no solubility data are given for, among others, borax and copper nitrate. There are remarkably few errors in the text. The printing is admirable, and the general get-up of the book a credit to the publishers. An idea of the number of references may be obtained from the fact that the name index extends to eighteen and a half double column pages. A full subject index is also provided. An eight-page table of the dates of issue of the principal chemical journals forms a welcome feature of the volume. JOSEPH KNOX

ANILINE AND ITS DERIVATIVES. By P. H. GROGGINS. Pp. vii+256. London: Chapman and Hall, Ltd., 1924. 18s. net.

This book is one more example of the modern and increasing practice of publishing monographs on single substances or on single parts of processes. The practice arises from the need of the industrial chemist for easily accessible information which shall be both authoritative and complete, and which, owing to the enormous growth of knowledge, he is unable to find in textbooks and dictionaries and cannot always look up in current technical literature.

The present monograph on aniline, which is well produced both as to type and illustrations, is not merely a digest of existing knowledge, but attempts to use the data given as a vehicle "for presenting the business of plant chemistry." There is thus a chapter on flow sheets, and the analysis of costs, and one on thermal factors which, if not set out with the clearness and directness of Mr. K. B. Quinan, illustrates very fairly the methods he advocated in the setting-out of a technical problem in a scientific manner. Following a brief introduction on the beginnings of the dyestuff industry, are chapters on the manufacture of aniline from benzene, in which plant and its working are discussed. Curiously enough the manufacture of nitrobenzene is taken last. The reasons may be surmised, but the inversion of the logical sequence is not helpful to the student for whom the book is intended. The details given are sufficiently full and accurate and there is evidence in this part of the work of first-hand experience of plant which has led the author to give some very useful technical information which is not readily accessible. There is not, however, anything very new, nor do the yields quoted show any advantage over those obtained in this country.

In Chapter IV, eight methods are discussed for the separation of aniline from the reducer charge. The method used in this country, of generating steam for the aniline distillation in a special boiler using the surplus aniline water, is not, on the author's figures, quite the cheapest. It is, however, the cleanest and the healthiest and reduces handling to a minimum.

The remainder of the book is more in the nature of a compilation, and papers which have appeared in scientific and technical journals are freely quoted from. Abstracts from patents, mainly of German origin, are given textually. Under phenylglycine, four German patents are mentioned, but there is no reference to other patents, some of them English, of more recent date, which deal with alternatives to the usual aniline-monochloracetic acid route. One chapter is devoted to the preparation of derivatives of aniline, some of the products being treated summarily, whilst others such as the alkylanilines are considered at some length in a helpful manner. The list given of aniline dyestuffs is incomplete and more accurate information is contained in the "Colour Index" of the Society of Dyers and Colourists. As was to be expected in a book by an American author, special reference is made to the aniline derivatives used as accelerators in the rubber industry.

The book should prove a useful addition to the shelves of the technical chemist, and is certainly interesting by virtue of its insistence on accurate costings and its survey of alternative methods.

A. T. DE MOUILPIED

YEAR BOOK OF THE AMERICAN ASSOCIATION OF TEXTILE CHEMISTS AND COLORISTS. Pp. 165. New York, 1924.

The year book is the only publication of the Association, but reports of sections appear in the American Dyestuff Reporter, just as in England the reports of some societies which have not yet advanced to the position of publishing their own journals appear in the technical press. This association appears to carry out in America similar functions to those of the Society of Dyers and Colourists in this country: thus prizes are given for the solution of technical problems, and a list of American-made dyestuffs is given on similar but less ambitious lines to the Colour Index of the Society of Dyers and Colourists.

The membership of the association is 688 and this is the second year of publication of the year book. Research work is encouraged and reports on the fastness of dyestuffs to light, perspiration, chlorine, etc., are given and standard methods of testing for fastness laid down. These methods are the most interesting part of the volume. It is difficult to understand why this association is not connected with the American Chemical Society, which has its industrial sections and a section devoted to the chemistry of cellulose. In fact, both in England and America there is too much overlapping of societies, and chemists engaged in the textile industries would welcome any effort to simplify the position both as regards meetings of societies and the supply of abstracts. S. H. HIGGINS

COMPANY NEWS

BRITISH GLUES AND CHEMICALS, LTD.

The report for the year ended May 31 announces that, after allowing for depreciation (£31,315) and bad debts, the net profit amounted to £6,293 (£35,814 in the preceding year), to which is added £78,469 brought forward. Out of the total of £84,763, a sum of £76,000 is provided for the estimated taxation liability to May 31 last, the balance of £8763 being carried forward. The dividend on the 8 per cent. cumulative preference shares is in arrear as from October 1, 1921.

SALAR DEL CARMEN NITRATE SYNDICATE

At the recent Government sales of nitrate-bearing lands, the Syndicate purchased two plots estimated to contain 1,756,200 metric quintals of nitrate. The price was roughly £62,000, or 8d. per quintal. The reserves of the Syndicate amount to £85,000.

EVANS SONS, LESCHER AND WEBB, LTD.

A loss of £47,120 (of which £23,005 is accounted for by interest on overdraft) is shown by the accounts for 1923, following a total loss of £113,448 in 1922, including £27,065 for loss on property sold and reserve for further depreciation. The debenture service comes to £3480. There is now an accumulated debit balance to profit and loss of £448,780, and the preference dividend was in arrears for 27 months as at December 31 last. Following the reorganisation of the company it is stated that there has been a steady improvement in the business. The directors report that the company is now on a paying basis. The reconstruction of the capital is under consideration, and the directors expect to be in a position to present a scheme at an early date.

BRITISH CELANESE LTD.

The fifth ordinary general meeting was held on September 25, Sir Harry McGowan, K.B.E. (chairman), presiding. The chairman said that since he last addressed the meeting, when he referred in encouraging terms to the progress then being made and to the general outlook, several factors began to operate against the company. The company had not then established its position in the yarn trade, nor had it put its knitted or woven fabric on the market, and largely depended on the sales of cord. Factory costs were, on the smaller output, relatively high, and were affected by the changes and extensions being made in the factory capacity. Early in the year there was a general stagnation in the textile trades, during which the English markets were flooded with cheap and inferior cord from the Continent. This led to the cutting of prices, which was a serious matter, but though the company was disappointed at the results, due to market conditions, for the second half of the financial year it was convinced the superiority of its product was bound to tell. It therefore spent £37,000, with satisfactory results, in advertising. The sales of yarn, the company's basic product, had steadily developed, so that for September of the present year they were five times as great as those for September last year. The expansion of business had led to the lowering of costs, and the profits so far made in the present year were substantially greater than the total losses made in the year under review. The plant for making circular knitted fabric known as Celanese Trico was being increased by 50 per cent., as orders were in excess of capacity. The difficulties formerly experienced in dyeing had largely disappeared, the dye-house had been extended, and the company now produced 80 per cent. of its own dyes. Outstanding debentures had increased from £300,000 at February, 1923, to £700,000 at February, 1924, the proceeds of which had been expended in increasing spinning capacity and in the installation of knitted and woven fabric plants.

Boots Pure Drug Co., Ltd., announce a quarterly dividend at the rate of 36 per cent. per annum, equal to 1s. 9d. per share.

Bell's United Asbestos Co., Ltd., has declared an interim dividend on the ordinary shares of 6d. per share, less tax.

The Glenboig Union Fireclay Co., Ltd., recommends, after providing for depreciation, a dividend for the year of 15 per cent., less tax.

REPORTS

REPORT ON THE INDUSTRIAL AND ECONOMIC CONDITIONS IN NORWAY, TO MARCH, 1924. By C. L. PAUS, C.B.E., Commercial Secretary, Christiania. Department of Overseas Trade. Pp. 76. H.M. Stationery Office, 1924. Price 2s.

Financial difficulties and labour problems formed the centre of public attention during 1923. The depreciation of the krone resulted in exports being well maintained, though imports also showed an increase. Industries were more active than in the previous year (*cf. Chem. and Ind.*, 1923, 918), but those working for the home market had foreign competition to meet. Large reductions were effected in stocks of manufactured goods, frequently at a loss, and an improved demand is now noticeable. Last winter was better for forest owners than 1922–3; although costs of production fell the price of wood-pulp increased. In general, fisheries had a bad year, debts incurred during the previous good period proving a great handicap, whilst prices of fishery produce fell.

A scheme has been put forward to bring the supply of electric power under public control. No new hydro-electric schemes were commenced in 1923, but some schemes were completed. The question has recently arisen as to the feasibility of exporting hydro-electric power to Denmark.

An improvement was noted in 1923 in the import trade, which was greater than in any year since 1920. This was due to decreased stocks and also to increased activity in some industries leading to a demand for raw materials. In general, imports are obtained from those continental countries with depreciated currencies, Britain and America being at a disadvantage in this respect. Textiles were obtained principally from Germany, but Britain

increased her trade. In the metal trade there is little business between this country and Norway. The cellulose and paper-making industries showed an improvement which resulted in restoration of the demand for heavy chemicals; most of this trade was done with Germany.

In spite of great difficulties the position of most industries improved in 1923. The pulp and paper industries did fairly well, exports of pulp and paper totalling 913,389 tons. Output in the mining industries increased somewhat, 300,000 t. of iron ore and 400,000 t. of pyrites being exported. Molybdenite production was recommenced at one mine with a view to export to Britain. Explosives factories in addition to extending their home trade have found outlets in the Black Sea and South American markets. Some improvement was noted in the electrochemical and electrometallurgical industries, chiefly on account of British demands for carbide; the removal of restrictions on the importation of ferro-alloys into Germany was also of assistance. Exports of aluminium were 12,778 t. in 1923, practically double the 1922 figure, though the zinc industry had a bad year.

Report on the Economic and Industrial Conditions in Lithuania, dated April, 1924. By H. H. Cassells, H.M. Consul, Kovno. Department of Overseas Trade. Pp. 28. H.M. Stationery Office. 1924. Price 1s.

Although the political situation was disturbed during the whole of 1923, the revenue showed a favourable balance, and foreign confidence in the country is indicated by loans from the United Kingdom and Sweden, not of money but of manufactured goods. The situation has retarded industrial developments in Lithuania, but most of the pre-war companies and factories are in operation on a reduced scale. About half the factories produce foodstuffs and beverages, this branch employing 1500 workers in all. Timber and paper are partly manufactured, but some finished paper is made. The metal industries are much below pre-war standard and textile manufacture is undeveloped. The country is essentially agricultural, the chief products being cereals and flax, of which considerable quantities are exported. Plans are being made to develop the other agricultural resources of the country, such as dairy produce.

During 1923 exports totalled 146,794,700 lits (the lit varied between 43 and 47 to the £), against 16,892,400 lits in 1922, and imports 156,627,000 lits against 74,884,600 lits. Of the imports in 1923 textiles formed 31 per cent., foodstuffs 20 per cent. and machinery 14 per cent. Of the total, 81 per cent. was supplied by Germany, and only 5·3 per cent. by Great Britain. The chief exports were timber and foodstuffs, of which Germany took 53 per cent. and Great Britain 27 per cent. Although the imports returned as from Great Britain are so small, in reality they were more owing to dealings through Germany, and there seems to be no reason why an increase should not take place, especially in textiles and coal.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate / Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4¼d. per lb.
Sod. Bisulphite Powder 60/62%	£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—
- Golden .. .. .. 5¾d.—1s. 4d. per lb., according to quality.
- Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.

Arsenic, Sulphide, Yellow 1s. 11d. per lb.
Barytes .. .. .. £3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide .. 3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide .. £30—£33 per ton, according to quantity.
Carbon Black .. .. 7d.—7¼d. per lb. ex wharf.
Carbon Tetrachloride .. £60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green .. 1s. 3d. per lb.
Indiarubber Substitutes White and Dark .. 5d.—9¼d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black .. .. £48 per ton, barrels free.
Lead Hyposulphite .. 7½d. per lb.
Lithopone, 30% .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. .. £16 5s. per ton f.o.r. London.
Sulphur .. .. .. £10—£12 per ton, according to quality.
Sulphur Precip. B.P. .. £56—£57 per ton, according to quantity.
Sulphur Chloride .. 4d. per lb., carboys extra.
Thiocarbanilide .. .. 2s. 6d. per lb.
Vermilion, pale or deep .. 5s. 1d. per lb.
Zinc Sulphide .. .. 7¼d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—
- Brown .. .. .. £12 per ton.
- Grey .. .. .. £16 per ton.
- Liquor .. .. .. 9d. per gall. 32° Tw.

Charcoal .. .. .. £7 15s.—£9 5s. per ton, according to grade and locality.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. ,, ,, 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 9d. per gall. Unrefined.
Wood Naphtha—
- Miscible .. .. 4s. 10d. per gall. 60% O.P.
- Solvent .. .. 5s. 3d. per gall. 40% O.P.

Wood Tar .. .. £4 5s. per ton.
Brown Sugar of Lead .. £43 per ton.

TAR PRODUCTS

Acid Carbolic—
- Crystals .. .. 6½d. per lb. Quiet.
- Crude 60's .. .. 1s. 7d.—1s. 11d. per gall, according to district.

Acid Cresylic, 97/99 .. 2s.—2s. 1d. per gall. Demand fair.
- Pale 95% .. .. 1s. 9d.—2s. 1d. per gall. Not much enquiry.
- Dark .. .. .. 1s. 9d.—2s. 1d. per gall. Quiet.

Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—
- Strained .. .. 7½d.—9d. per gall. Quiet.
- Unstrained .. .. 6½d.—7½d. per gall.

Benzole—
- Crude 65's .. .. 7½d.—9d. per gall. ex works in tank wagons.
- Standard Motor .. 1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
- Pure .. .. .. 1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.

Toluole—90% .. .. 1s. 5d.—1s. 5½d. per gall. Small demand.
- Pure .. .. 1s. 8d.—2s. per gall. Small demand.

Xylol coml. .. .. 2s. 3d. per gall.
- Pure .. .. 3s. 3d. per gall.

Creosote—
- Cresylic 20/24% .. 8½d. per gall. Better demand.
- Middle Oil .. .. } 5d.—6½d. per gall., according to quality and district. Market quiet.
- Heavy Oil .. .. }
- Standard Specification }

Naphtha—
- Solvent 90/160 .. 11d.—1s. 2d. per gall., according to district.
- Solvent 90/190 .. 11d.—1s. per gall. Not much demand.

Naphthalene Crude—
- Market dull. Not much export inquiry. Cheaper in Yorkshire than Lancashire.
- Drained Creosote Salts £4—£6. Quiet.
- Whizzed or hot pressed £7—£9 per ton.

Naphthalene—
- Crystals and Flaked .. £12—£16 per ton, according to district.

Pitch, medium soft .. 40s.—50s. per ton f.a.s.
Pyridine—90/160 .. 19s. per gall. Steady demand.
- Heavy .. .. 12s. per gall. Market dull.

INTERMEDIATES AND DYES

Improvement in dyestuffs business maintained but orders are still only for small quantities. Consumers stocks probably very low.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 7d. per lb.
Acid H. .. .. .. 3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic .. 9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. 1s. per lb. d/d.
Aniline Oil .. .. 8d. per lb. naked at works.
Aniline Salts .. .. 8½d. per lb., naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 1d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 19/31° C. .. 4½d. per lb. Rather quiet.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £85 per ton.
Diethylaniline .. .. 4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline .. .. 2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d.—10d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 2s. 10d. per lb. d/d.
Monochlorbenzol .. .. £63 per ton.
*β*Naphthol .. .. 1s. per lb. d/d.
*α*Naphthylamine .. 1s. 4d. per lb. d/d.
*β*Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 4s. 3d. per lb. d/d.
p-Nitraniline .. .. 2s. 3d. per lb. d/d.
Nitrobenzene .. .. 5½d.—5¾d. per lb. naked at works.

o-Nitrochlorbenzol	2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene	10½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	3s. 11d. per lb. d/d.
p-Phenylene Diamine	10s. 2d. per lb. 100% basis d/d.
R. Salt	2s. 5d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 3d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 3d.—4s. 2d. per lb. naked at works.
m-Toluylene Diamine	4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£47 per ton. Firmer.
Acid, Acetyl Salicylic	3s. 1d.—3s. 3d. per lb., according to quantity.
Acid, Benzoic B.P.	3s. per lb.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 3½d.—1s. 4½d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid, Salicylic	1s. 5d.—1s. 8d. per lb., according to quantity.
Acid, Tannic B.P.	2s. 10d. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
Amidopyrin	13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s.—15s. 6d. per lb. Quiet market.
Benzonaphthol	5s. 3d. per lb. Small inquiry.
Bismuth Carbonate	10s. 6d.—12s. 6d. per lb.
„ Citrate	10s. 3d.—12s. 3d. „
„ Salicylate	9s.—11s. „
„ Subnitrate	8s. 8d.—10s. 8d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Market firm.
Ammonium	1s. 6d.—1s. 9d. per lb. } According to quantity.
Potassium	1s. 4d.—1s. 7d. per lb. }
Sodium	1s. 5d.—1s. 8d. per lb. }
Calcium Lactate	1s. 7d.—2s. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate	4s.—4s. 3d. per lb. Market easier after recent firmness.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Formaldehyde	£49 per ton.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	7s. per lb.
Glycerophosphates—	
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. „
Guaiacol Carbonate	10s. 6d.—11s. 3d. per lb.
Hexamine	3s. 1d.—3s. 3d. per lb.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. „
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£25 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	53s. 6d. per lb. Cheaper.
Synthetic	26s.—35s. per lb., according to quantity. English make.
Mercurials	Market very quiet.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. „
White precip.	4s. 7d.—4s. 8d. „
Calomel	3s. 11d.—4s. „
Methyl Salicylate	1s. 10d.—2s. per lb.
Methyl Sulphonal	26s. per lb.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 6¼d. per lb. for cwt. lots. Not very active.
Paraldehyde	1s. 6d. per lb. in free bottles and cases.
Phenacetin	5s. 9d. per lb.
Phenazone	7s. 2d. per lb.
Phenolphthalein	5s. 6d.—6s. per lb.
Potass. Bitartrate—99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	7¼d. per lb.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz tins. Steady market.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d.—4s. per lb.
Silver Proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 6d. per lb.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Market rather easier. Powder 2s. 1d.—2s. 3d. per lb. Crystal at 2s. 3d.—2s. 5d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	15s. per lb. Easier.
Thymol	17s. 6d. per lb. Very scarce indeed.

PERFUMERY CHEMICALS

Acetophonone	12s. 6d. per lb.	
Aubepine	15s. 3d. ,,	
Amyl Acetate	2s. 6d. ,,	
Amyl Butyrate	6s. 9d. ,,	
Amyl Salicylate	3s. 3d. ,,	Dearer.
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,	
Benzyl Alcohol free from Chlorine	2s. 9d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate	3s. 6d. ,,	
Cinnamic Aldehyde—Natural	18s. 9d. ,,	
Coumarin	19s. 6d. ,,	
Citronellol	17s. ,,	
Citral	8s. ,,	Cheaper.
Ethyl Cinnamate ..	12s. 6d. ,,	
Ethyl Phthalate	3s. 3d. ,,	
Eugenol	10s. ,,	Cheaper.
Geraniol (Palmarosa) ..	35s. ,,	
Geraniol	11s.—18s. 6d. per lb.	
Heliotropine	6s. 9d. ,,	
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose ..	26s. ,,	
Linalyl Acetate	26s. ,,	
Methyl Anthranilate ..	9s. 6d. ,,	
Methyl Benzoate	5s. ,,	
Musk Ambrette	50s. ,,	Dearer
Musk Xylol	13s. 6d. ,,	Cheaper.
Nerolin	4s. 9d. ,,	
Phenyl Ethyl Acetate ..	15s. ,,	
Phenyl Ethyl Alcohol ..	16s. ,,	
Rhodinol	60s. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. 4d. ,,	
Vanillin	26s. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	
Anise Oil	2s. 8d. per lb.	
Bergamot Oil	17s. 6d. per lb.	
Bourbon Geranium Oil ..	36s. 0d. per lb.	
Camphor Oil	65s. per cwt.	
Cananga Oil Java ..	10s. per lb.	Cheaper.
Cinnamon Oil, Leaf ..	6½d. per oz.	
Cassia Oil, 80/85% ..	10s. per lb.	
Citronella Oil—		
Java 85/90%	5s. 9d. per lb.	
Ceylon	3s. 7d. per lb.	
Clove Oil	7s. 6d. per lb.	
Eucalyptus Oil 70/75% ..	2s. 3d. per lb.	
Lavender Oil—		
French 38/40% Esters	27s. 6d. per lb.	
Lemon Oil	3s. per lb.	
Lemongrass Oil	4s. 6d. per lb.	
Orange Oil, Sweet ..	11s. per lb.	
Otto of Rose Oil—		
Bulgarian	40s. per oz.	Dearer.
Anatolian	18s. per oz.	
Palma Rosa Oil	16s. 6d. per lb.	
Peppermint Oil—		
English	65s. per lb.	
Wayne County ..	30s. per lb.	
Japanese	17s. 3d. per lv.	
Petitgrain Oil	9s. 3d. per lb.	
Sandal Wood Oil—		
Mysore	26s. 7d. per lb.	
Australian	21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Nov. 24th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Oct. 9th.

I.—Applications

Irwin, and Johnson and Co., Ltd. Filters etc. 21,947. 21,948. Sept. 17.

Lumsden, Peddie, and Pirbright Co. Filtering-apparatus. 21,872. Sept. 16.

Marks. Lubricants. 22,260. Sept. 20.

Nisbet and Thomson. Apparatus for filtering dust-laden gases. 22,011. Sept. 18.

Roos. Centrifugal separators. 22,203. Sept. 20. (Dutch East Indies, 20.9.23.)

Sedbery. Grinding-mills. 22,073. Sept. 18.

I.—Complete Specifications Accepted

6579 (1923). Coppee and Co., and Kavau. Rotary furnaces. (206,105.)

14,864 (1923). Burt, Bolton and Haywood, Ltd., and China. Producing disruptive forces in films of liquid or suspensions. (221,548.)

17,014 (1923). Nafilyan. Drying or removing the liquid from solutions or suspensions of substances in liquids. (221,598.)

22,753 (1923). Allsop and Sibson. Drying-machines. (221,641.)

5971 (1924). Hertenbein. Rotary filters. (212,907.)

6968 (1924). Imray (International Combustion Engineering Corporation). Pulverising mills. (221,743.)

8888 (1924). Schofield, Tinsley, and Gall. Optical pyrometers. (221,751.)

10,815 (1924). Baglin. Continuous centrifugal dryers. (221,760.)

II.—Applications

Cuylets. Method for removing water from peat etc. 21,754. Sept. 15.

Gensecke, and Metallbank u. Metallurgische Ges. 21,944. *See* XII.

Koppers Co. Purification of fuel gas. 21,739. Sept. 15. (U.S., 7.8.24.)

Nisbet and Thomson. 22,011. *See* I.

Parker. Distillation of coal etc. 21,910. Sept. 16.

Rheinische Metallwaaren u. Maschinenfabrik. 22,154. Sept. 19.

Rude. Production of water-gas from fuel etc. 21,695. Sept. 15.

II.—Complete Specifications Accepted

8717 (1923). Strafford and Pick. Manufacture of carbonised fuel. (221,526.)

9779 (1923). Thermal Industrial and Chemical (T.I.C.) Research Co., Ltd., and Rider. *See* III.

15,329 (1923). Melamid. Cracking or decomposition of materials containing or yielding hydrocarbons. (221,559.)

19,974 (1923). Humphreys and Glasgow, Ltd. Manufacture of carburetted water-gas. (221,622.)

27,348 (1923). Queneau. Retorts for carbonising solid fuels. (221,679.)

29,084 (1923). Still and Petsch. Coke ovens. (221,697.)

III.—Application

Preiss. 22,132. *See* XIX.

III.—Complete Specification Accepted

Thermal Industrial and Chemical (T.I.C.) Research Co., Ltd., and Rider. Dehydration and distillation of tars or oils. (221,528.)

IV.—Applications

British Dyestuffs Corporation, Ltd., Fyfe, and Perkin. Manufacture of anthraquinone dyestuffs. 21,983. Sept. 17.

British Dyestuffs Corporation, Ltd., Baddiley, Hill, and Riley. Manufacture of azo colouring-matters. 21,984. Sept. 17.

British Synthetics, Ltd., and Higgins. Manufacture of azo dyestuffs etc. 21,862. Sept. 16.

Dehn (Budd Manufacturing Co.). Treating metals. 21,785. Sept. 15.

Farbwerke vorm. Meister, Lucius, und Brüning. Manufacture of vat-dyestuffs containing sulphur. 21,758. Sept. 15. (Ger., 19.9.23.)

Farbwerke vorm. Meister, Lucius, und Brüning. Manufacture of condensation products of the anthraquinone series. 21,876. Sept. 16. (Ger., 18.9.23.)

IV.—Complete Specification Accepted

23,349 (1923). Johnson (Badische Anilin und Soda Fabrik). Manufacture of halogenated vat-colouring matters. (221,643.)

V.—Applications

Bayley. Manufacture of viscose threads etc. 21,959. Sept. 17.

British Celanese, Ltd., and Ellis. Treatment of cellulose acetate. 22,153. Sept. 19.

Courtaulds, Ltd., Glover, and Weyenbergh. Production of cellulose compounds. 21,753. Sept. 15.

Courtaulds, Ltd., Gardner, and Napper. Manufacture of viscose threads etc. 21,958, 21,959. Sept. 17.

Draper. Manufacture of viscose silk etc. 21,960. Sept. 17.

Soc. La Cellophane. Manufacture of cellulose films. 22,168. Sept. 19. (Fr., 23.11.23.)

V.—Complete Specification Accepted

23,678 (1923). Spijker. Treating fibres of fibrous products. (221,645.)

VI.—Applications

Bach. Apparatus for dyeing etc. hanks of yarn etc. 22,235. Sept. 20.

British Dyestuffs Corporation, Ltd., and Mudford. Dyeing fabrics containing acetyl silk. 22,163. Sept. 19.

Park. Proofing-composition. 21,894. Sept. 16.

Thies. Dyeing-apparatus. 22,072. Sept. 18.

VI.—Complete Specification Accepted

2084 (1924). Schumacher. Dyeing of cops. (210,765.)

VII.—Applications

Harris. Treatment of alkali solutions containing tin. 22,054. Sept. 18.

Harris. Treatment of alkali liquors. 22,238. Sept. 20.

Kennedy and Lloyd. Method of making arsenical salts. 21,764. Sept. 15.

Llewellyn, Spence, and Spence and Sons. Treatment of aluminous materials. 22,018. Sept. 18.

Synthetic Ammonia and Nitrates, Ltd. Synthetic ammonia process. 22,091. Sept. 19. (U.S., 19.9.23.)

VIII.—Application

British Oil Products Co., Ltd., Fulton, and Hutton. Treatment etc. of enamels etc. 21,820, 21,821. Sept. 16.

VIII.—Complete Specification Accepted

12,237 (1923). Danner. Regulation of temperature conditions in molten glass. (221,633.)

IX.—Applications

Agasote Millboard Co. Wood substitute. 21,750. Sept. 15. (U.S., 21.2.24.)

Martin. Manufacture of iron cement. 21,853. Sept. 16. (Fr., 17.9.23.)

IX.—Complete Specifications Accepted

17,266 (1923). Berkeley and Stenhouse. Preserving timber and leather. (221,699.)

2269 (1924). Angelis, do. Heat-insulating material. (210,459.)

6857 (1924). Wikkula. Porous concrete. (221,742.)

X.—Applications

Buckle. Powder for welding steel and restoring burnt steel bars etc. 22,232. Sept. 20.

Hendrick. Alloying ferrous metal surfaces. 22,023. Sept. 18.

Marks (Canada British Syndicate, Ltd.). Metal-coating compositions. 22,184. Sept. 19.

Marks (Merco Nordstrom Valve Co.). Alloys. 22,259. Sept. 20.

Tafel. Process of treating ingot iron. 22,049. Sept. 18.

Wüst. Production of tin from alloys containing iron. 21,756. Sept. 15. (Ger., 22.1.24.)

X.—Complete Specifications Accepted

9892 (1923). Mathesius. Production of titanium steel. (221,529.)

17,043 (1924). Western Electric Co., Ltd. (Western Electric Co., Inc.). Metallic compositions. (221,770.)

XI.—Application

Marschalko. Primary batteries. 22,180. Sept. 19.

XI—Complete Specifications Accepted

13,116 (1923). Haddon and Burnett. Accumulator grids or plates. (221,539.)

13,118 (1923). Haddon, Burnett, and Fullilove. Accumulator plates. (221,541.)

21,269 (1923). Shields. Increasing the life of graphite or carbon electrodes. (221,634.)

XII.—Application

Genseke, and Metallbank u. Metallurgische Ges. Process of purifying oils etc. 21,944. Sept. 17.

XIII.—Application

Marks (Canada British Syndicate, Ltd.). 22,184. *See* X.

XIII.—Complete Specification Accepted

15,133 (1923). Johnson (Diamond State Fibre Co.). Manufacture of synthetic gum. (221,533.)

XV.—Applications

Bendixen and Ehrenreich. Process for tanning fish skins etc. 22,169. Sept. 19.

Bergmann and Immendorfer. Process of removing hair from hides. 21,848. Sept. 16. (Ger., 19.9.23.)

XV.—Complete Specifications Accepted

17,266 (1923). Berkeley and Stenhouse. *See* IX.

30,378 (1923). Pansky. Preparation of gelatin. (221,702.)

XVIII.—Complete Specification Accepted

16,781 (1923). Ling and Nanji. Augmenting the yield of alcohol in the fermentation of amylaceous mashes. (221,592.)

XIX.—Applications

Menz. Separation of scale-producers from water. 22,143. Sept. 19.

Posseyer. Clarifying sludge etc. 22,133. Sept. 19.

Preiss. Method of removing phenol etc. from waste waters etc. 22,132. Sept. 19.

XIX.—Complete Specification Accepted

32,627 (1923). Imray (Soc. of Chemical Industry in Basle). *See* XX.

XX.—Applications

Austerweil. Production of terpene alcohols. 22,165. Sept. 19. (Ger., 19.9.23.)

Binz. Method of producing organic compounds. 22,178. Sept. 19.

Hirzel. Process of preparing benzyl resorcinol. 22,090. Sept. 19. (U.S., 19.9.23.)

Naugatuck Chemical Co. Manufacture of styrol etc. 21,751 and 21,755. Sept. 14 and 15. (U.S., 7.5.24 and 24.4.24.)

XX.—Complete Specifications Accepted

15,427 (1923). MacEwen. Manufacture of arsenical therapeutic preparations. (221,565.)

19,981 (1923). Rheinische Kampfer Fabrik Ges. Production of aromatic sulphonic acids. (202,975.)

32,627 (1923). Imray (Soc. of Chemical Industry in Basle). Manufacture of the phosphorus-containing nuclear substance of milk casein. (221,716.)

XXI.—Application

Jos-Pe Farbenphoto Ges. Multiplex colour photography. 21,829. Sept. 16. (Switz., 13.2.24.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*Algiers:* Pharmaceutical chemicals, (338). *Argentina:* Paper, (B.X./1243). *Belgium:* Paper, (326); ironmongery, (327); medical and pharmaceutical supplies, (328). *Brazil:* Chemical products, (344). *British India:* Photographic goods, (318); metal sheets, (The Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, London, S.E. 1); steel material (The Directors of the Madras and Southern Mahratta Railway Co., Ltd., 25, Buckingham Palace Road, London, S.W. 1). *Canada:* Hardware, cutlery, oils, perfumes, soaps, (319). *Chile:* Paper, cement, hardware, (347). *Egypt:* Iron, centrifugal pumps, lead, leather, rubber, brass, copper, (337); iron, (A.X./1321). *France:* Tinplate, (329). *Latvia:* Rubber, (333). *Netherlands:* Metal, zinc plates, caustic soda, borax, naphthalene, yellow ochre, soap, (C.X./1181). *New Zealand:* Iron, (323). *Peru:* Paints, enamels, (349). *Poland:* Leather, (334). *South Africa:* Cast iron, (A.X.1312). *Spain:* Hardware, (335). *Switzerland:* Petrol, oil, artificial fertilisers, (336). *Uruguay:* Oils, (B.X./1249).

The Production of Soda in the Union of South Africa

There is only one notable occurrence of soda in the Union, namely, that at the Pretoria saltpan. This pan is a crater-like depression some 200 feet below the surrounding country, and about 28 acres in extent. The bed of the pan, from which in the dry season all the liquid evaporates, consists of a black mud containing masses of trona, or solid crude carbonate of soda. The mud, which has been proved by boreholes to be at least 200 feet deep, has the following analysis: Moisture at 120° C., 50 per cent.; Na_2CO_3, 16 per cent.; NaCl, 15 per cent.; $CaCO_3$, 3 per cent.; insoluble matter, 12 per cent., and organic matter, 4 per cent. Recent geological work has proved the pan to be an explosion crater, similar to those which have formed the diamond pipes, and of post-Karoo age. The pan contains three valuable ingredients: (*a*) Saline mud, described above; (*b*) layers of trona or crystallised carbonate of soda; (*c*) saline liquor, containing approximately 10 per cent. soda and 15 per cent. common salt. In 1912 the South African Alkali Co. started to work these deposits at first winning only the trona, as that gave the greatest immediate profit, some 21,000 tons being produced. The trona at the surface then gave out, and the company turned its attention tothe mud. It was, however, found impossible to treat the mud, as the liquor obtained by leaching will not filter, neither will the impurities settle in a reasonable time. In 1919 the original company failed, but fresh capital has been introduced and, under entirely new control, the erection of a plant, designed to produce 8 tons of soda and 16 tons of salt per day, has been completed, and it is hoped will commence work almost immediately. This plant is the outcome of prolonged experiment and shows promise of success.—(*S.A.J.I., July,* 1924.)

Notes on Plants and Products

Chemical Stoneware includes a great variety of products, and as the requirements of users are so diversified, manufacturers usually only stock material that is standardised, such as acid-proof bricks, packing, pipes and fittings. Thus, over 80 per cent. of the chemical stoneware of Maurice A. Knight, of Akron, Ohio, is made to order from customer's specifications. This firm claims that stoneware made to order is not more expensive than products kept in stock, because each piece, whether for stock or to order, is handled and made individually. The catalogue issued by Messrs. Knight gives a good deal of information on the uses and limitations of chemical stoneware, as well as plans and scale drawings of towers and parts of chemical stoneware suitable for absorption, condensation, drying and neutralisation. Material for the construction of towers, tanks, digesters and floors is described, and other subjects such as apparatus for elevating liquids, receivers, jars, jugs, acid-proof cement, kettles, generators and general chemical stoneware are also dealt with. The catalogue contains much information of value to the user of stoneware.

Sulphate of Ammonia is a product which must possess two important qualities in addition to standard composition; it must be both dry and neutral. The plant required to make the highest grade of sulphate of ammonia is described in a pamphlet issued by W. C. Holmes and Co., Ltd., Huddersfield, a firm which has had a long and wide experience in supplying such plants to gasworks and by-products works. Two processes are discussed, the Adam process, used at the Beckton Works of the Gas Light and Coke Co., and the Talk o' th' Hill process, installed at Talke, by the colliery firm of that name. Both processes are designed to ensure a regular output of the highest-grade of ammonium sulphate without undue complication and at the lowest cost. For the working of the processes, the pamphlet will be found an interesting guide, and Messrs. Holmes are prepared to submit designs to suit the requirements of existing plants. The same firm also supplies complete gas-making plant, horizontal rotary washers, and plant for chemical works.

Messrs. James Gordon and Co., Ltd., of Windsor House, Kingsway, London, have recently opened a branch office at 110, Waterloo Street, Glasgow, under the management of Mr. A. D. Burgess. This firm specialises in instruments and appliances for boilers.

West's Gas Improvements Co., Ltd., Manchester, has been awarded one of the contracts for a new gasworks at Prague. Another contract was placed in France, and a third locally.

PUBLICATION RECEIVED

QUALITATIVE CHEMICAL ANALYSIS OF INORGANIC AND ORGANIC SUBSTANCES. By H. W. Schimpf, Ph.D., M.D. Fourth edition, revised by A. I. Cone. Pp. ix. 201. London: Chapman and Hall, Ltd., 1924. Price 8s. 6d.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

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EDITORIAL

MR. WOOLCOCK'S address as President of the Society of Chemical Industry deals with a topic which is familiar to us all, but needs impressing on us so urgently that practical results will follow. His topic is familiar but his manner of treating it is stamped with his own personality, and some of his arguments possess an originality which arrests our attention. Amongst other points he deals with the desire inherent in many men to attempt tasks for which they are untrained and often unfitted. An editor who has had no editorial training is compelled to blush when his temerity is indicated even in the mild way Mr. Woolcock has chosen. Many men have opportunities provided by happy chance of attempting some new vocation or some new addition to their existing occupations. The novelty of it is its charm; the man who has spent many hours a day for twenty years in drawing wills and conveyances does this work so easily that it loses its inherent interest. The man who analyses heavy chemicals for a similar length of time is ultimately bored by it, though he may do such work better than he can do anything else. The unaccustomed occupation which such men undertake becomes an absorbing interest because of its novelty and corresponding difficulty. Such men as we have been describing become enthusiastic about a new pursuit, and often delude themselves into thinking that their enthusiasm compensates for lack of experience. If they are wise they know that they will always be inferior, in a number of very important respects, to the thoroughly trained man. They can never attain to his judgment on vital issues. If they are not wise they will, even then, do well to read Mr. Woolcock's observations and preserve an outward show of becoming humility. We ourselves hover between these alternatives. The chemist who is brought in contact with the industrialist will only in very exceptional cases become a good man of business. What he can do is to attain an interest in the business problems and an understanding of them even if the solution is beyond his power. The man of business concerned in chemistry will as a rule never be a chemist, but he should cultivate that acquaintance with chemists and chemistry which will make him interested in chemical difficulties. It is not important that these men should know what the other man knows; it is important that each should be interested in the work and knowledge of the other.

* * *

Mr. Woolcock also reminds us that the discoveries of the greatest importance to industry were not made in industrial research but in work undertaken for the extension of our knowledge. It seems to us that this fact is well worth insisting upon, and we are glad that our President has mentioned it. The greatest revolutions in industry and the most striking of new manufactures are due most of all to those who have created and developed the new sciences. We have only to consider how many men and women are employed in the manufacture and use of telephones, motor-cars, gas engines, dyestuffs, artificial silk and crystal sets to be convinced of this. The researches of Darwin, Mendel and Pasteur have been responsible for immense changes in agriculture and medicine. Our modern educational system is inadequate, unless it provides opportunities for the ninety-and-nine to learn their special subjects, and for the one to think and search and so enlarge human knowledge. The same methods do not suit both the ninety-nine and the one. Intensive and rapid pouring of facts from the teacher on to and into the student is a sort of forcible feeding similar to the mechanical contrivances in use for increasing the weight and nutritive properties of the domestic fowl. It is adopted in many schools and universities in several countries. The leisurely and unsystematic procedure of our British older universities provides a suitable environment and a fertile soil for the culture of our future Faradays, Leibigs and Lavoisiers. Even the ninety-and-nine are the better if they have time in which to think, perchance to dream. The more original the teacher, the more original the student. A system of education which aims at

giving the largest amount of knowledge in the shortest space of time is damned.

The Chemical Trade Journal pleasantly chaffs us about a recent editorial, in which we referred to a probable mistranslation of the German word *Leim*, and reminds its numerous readers that a full account of the glue pearls appeared in its columns some weeks before any notice appeared in any other English-printed journal. We are not dejected; should aught annoy us, we refuse to be annoyed! Any disappointment caused by this priority is abundantly compensated by the gracious epithet conferred upon us by the *Chemical Trade Journal* of "stately." For nearly two years we have striven to be stately; we knew that we were dignified, but we were not perfectly sure that we had attained stateliness. It shows what may be done by persistent effort. If only we might receive some lessons in deportment from Lord Curzon, we think our education would soon be complete. As a substitute we have been reading some Deportmental Ditties. In questions of speed in publishing scientific information we suppose that all the weekly journals which deal with chemistry are as speedy as is reasonably possible, and the little back-chat—if that is not too familiar a term for a stately journal—we trust will not ruffle the plumage of any of the editors. None of us attains to the degree in slowness of the old Greek athlete who entered a race with five competitors and came in seventh. If our recollection is correct, he performed this feat by handing his hat and coat to a friend who ran along the track with him, encouraging him to greater speed by frequent and cursory observations. But even the friend, encumbered as he was, got in ahead, or perhaps we should now say, finally obtained priority.

* * *

The psychology of chemists is a topic upon which much might be written. There is an interesting and helpful criticism in last week's *Nature* of the series of pamphlets written for the Wembley Exhibition and this explains some of the difficulties confronting the chemist as propagandist. The reviewer states that the man in the street is usually incapable of abstract thought and that so far as possible things must be presented to him in concrete and predigested form; the language must be simple, concrete and familiar. A little later the reviewer expresses his disappointment that "Chemists and their Work" contains no pithy remarks on the psychology of the chemist. It is quite easy to make such pithy remarks, but whether the man in the street described by the reviewer would have welcomed them or understood them is another question; one requires a considerable acquaintance with chemists to appreciate such philosophical reflections, and the pamphlets were intended for readers who have a very slight acquaintance with chemists or chemistry. It is not to be supposed that the pamphlets referred to are as good as they might be, but they are at any rate a beginning, and such a method of interesting the public in chemistry essential. The writers of the pamphlets and ot writers who will in futuro attempt such a task only learn by practice, and we are not inclined accept the sweeping assertion of the reviewer t the scientific worker is not well fitted to play part of propagandist to the man in the street. agree that the task is difficult, but we are satisi with the success of the first hasty experiment, c fident in the belief that the next time it may even better done. The problem of interesting public in science is too important to be neglected the scientific worker; it is not too difficult for h to attempt. Nearly twenty-four thousand of pamphlets have been sold by Messrs. Benn Brothe and the sale continues.

* * *

In the Report of the Committee of the Privy Coun for Scientific and Industrial Research, Sir Willi McCormick and Sir Frank Heath condemn t too early specialisation of some scientific studer They are convinced that in the last two years school life science must not be allowed to absorb t whole of the student's attention, to the exclusion the humanities and to the detriment of his gene education. We opine that many editors in ma countries will agree with this view. Any branch science is exacting and will absorb as much time can be given to it. The day is not long enough for study, even if supplemented by a considerable pa of the night. Our own belief is that those who are devote their lives to the pursuit of science will ha but little time, after they have attained to years discretion, for learning subjects outside their ov domain. It is therefore essential that while they a still students they shall learn those branches of huma knowledge which are interesting and inspiring b will be of no immediate practical use to them in the professional lives. For the great mass of humani the schools are intended to teach the useful subjec In the case of those who are to be highly educated t school is the one and almost the only opportuni of learning the subjects which will have no immedia effect on their professional work. We are incline to think of all these subjects literature is the mo fascinating. To read the greatest of the world writers in the language they wrote,, is not difficul It is difficult to write elegant Latin verses or goo French prose, but anyone with brains enough t understand tautomerism or thermodynamics coul fairly easily learn to enjoy Horace or Theocritus if h did so at school. The question is, is it worth while We think we never yet met anyone who went so fa as this who did not think it worth while. Will no someone start a Society for the Diffusion of Useles Knowledge? There is a great deal to be said for th old idea of knowledge for its own sake. The world too much with us, late and soon, getting and spendin we lay waste our powers. Books such as De Morgan "Budget of Paradoxes," the "Rejected Addresse and Strachey's "Life of Queen Victoria," should be the subject of a compulsory examination to quali for the F.I.C. or F.C.S. We are willing to help setting the papers.

CHEMISTRY AND INDUSTRY*

BY W. J. U. WOOLCOCK, C.B.E.

Introduction

In the first talk I have to give as President of the Society of Chemical Industry I want to make my position perfectly plain. My predecessors in the chair have been uniformly either distinguished scientists or well-known industrialists—in the case of my immediate predecessor he was both. I am neither. For reasons which seemed good to your Council, and found acceptance among the members of the Society, you have chosen a person whose qualifications are not those which have hitherto been demanded. Whatever the advantages may be, and of these I am in complete ignorance, there are certain disadvantages which are very apparent. I cannot with authority give you to-night a discourse on some abstruse scientific subject or on the industrial application of some outstanding discovery. I can, at best, only offer you some observations of a more or less detached observer in the world of scientific and industrial chemistry. Similar talks have been arranged for me in different parts of the country, and in due course I hope to develop what I conceive to be the fundamental theme which should predominate during my year of office.

We are all members of a unique Society—the Society of Chemical Industry. It is the only Society in this country which represents both the scientific and industrial sides of chemistry. In such a position it is given to members of the Society to exert, if they will, a very beneficial influence, not only on behalf of themselves, nor even on behalf of all those engaged in the practice of the science or the control of the industry, but on the nation at large. It is an influence for good which is only bounded by the enthusiasm and self-sacrifice which they are prepared to put forth.

On future occasions I shall have a good deal to say on what I conceive to be the true policy of the Society in its domestic affairs and in its relations with the numerous other societies, both scientific and industrial, which represent chemistry, pure and applied, in this country.

To-night in this preliminary talk I have chosen as the subject "Chemistry and Industry" because it enables me to range over a number of topics to illustrate what I want to say.

Chemistry and Industry

I postulate first: That for the benefit of the nation there must be the closest working together of the scientist and the industrialist. This I think you will have no difficulty in accepting. On it I want to make one or two observations. The first is that it wants saying at the present time. The rush of modern life is conducive to short memories. Immediately after the war we had no difficulty in realising the interdependence of scientist and industrialist. To-day I think there is a tendency not to insist on this interdependence as much as formerly, and I want to do what I can to-night to emphasise its essential character. It is not difficult to see how, apart from the mere effluxion of time, various causes have tended to weaken the bond. The boom in trade which followed immediately after the war found British chemical industry at its high-water mark. Chemists found employment easily. The industrialists had no difficulty in realising the necessity for a sufficient staff of chemists. The value of research work was realised as never before. Then came the slump, which hit chemical industry in common with all other industries although not as severely as some others. Economies had to be effected in all departments and much work which was not of a character immediately remunerative was stopped. I have no doubt that every chemist in this room feels that the economies which had to be made were begun in the wrong place. It is only human for us to feel that we are the most indispensable of all the units employed in a chemical works. I am prepared to contend that the chemist is most indispensable, but it would be easier to sustain this contention if the relationships between scientists and industrialists were even closer than they are to-day.

Circumstances over which I have had little control have placed me in a position which has given me the opportunity of observing both sides in their native element. Human beings suffer from many common weaknesses. The lack of a proper appreciation, the one of the other, between scientists and industrialists is due to one of these weaknesses. Looking around you will find men with really first class scientific brains who with their gifts for original chemical investigation are a national asset. They appear to be utterly unconscious of this, but would agree with you if you suggested that politics, finance, industry or organisation work is their true forte. The same thing is true of the business man. Those industrialists, who have made good to-day and are likely to retain their positions, have among them men who are quite ready to take on the work of a scientist, or a politician, or a financier, and as for the work of an organiser—there is nothing in it. This weakness for attempting to do the other man's job should be combated.

If the close co-operation which has developed between scientist and industrialist is to be maintained we must each of us have a little better appreciation of the work we are engaged upon and not be too ready to undertake other work in the mistaken idea that, although we have not been trained for it, some spark of genius has made us more competent to undertake it than the man who has spent his life at the job.

There is one other observation I want to make while I am in what I fear you may regard as a censorious mood. I come in contact with a number of our younger men at the period when they have just finished their training and are looking for some work in the industry. In talking to them I am never left in any doubt as to the excellent amount of knowledge thay have obtained. What I am sometimes doubtful about is how far in the course of their training they have been taught to use their

* Address delivered before the Manchester Section, on October 3.

commonsense. The industrialist pays more for commonsense and manipulative skill than he does for mere scientific knowledge of a subject. If we are to bring the two sides more closely together we must not allow the enormous range now covered by the science of chemistry as taught in our Universities and colleges to so occupy time that there is none left for the practice of clear thinking and the exercise of commonsense. A scientific training is not necessarily a handicap in business. Indeed, I find more and more of our best manufacturing firms are taking well-educated young men, often with a University training, and making of them most excellent business men. The experience of one of the best known firms in Manchester confirms this opinion and an interesting case came under my own observation. A young man, a mathematical scholar of Cambridge, came to me about a year ago looking for work. As far as I could see he had no technical qualification whatever, and I told him so. Whereat he rose in his wrath and demanded how I dared penalise him merely because he had a good mathematical brain. I was so impressed by his turning of the tables on me that I found him a very humble subordinate position in the office of a member of my association. I anticipated he would not survive the drudgery for three months. I am very glad to say that he is still there and if he continues on his present lines will make a very good position for himself.

But let us look on the other side of the picture. I think the industrialist has been very much responsible for the long time it has taken to eradicate the idea from some minds that there are two kinds of science—pure and applied. And yet how many years ago was it when Huxley said that "What people call applied science is nothing but the application of pure science to particular classes of problems." The chemical manufacturer is apt to consider that the applied science which he practices differs in some way or other from the pure science of the chemist. This misunderstanding militates against the co-operation for which I am pleading to-night.

The industrialist, particularly when times are bad, is apt to consider any research which is not directed to the solution of some urgent problem which has arisen in his works as a waste of time. I have read somewhere that "discoveries in applied science may produce a reformation, but those in pure science lead to revolutions." The industrialist may reform his process, but if he goes a step further he may have such a discovery made in his laboratories as will revolutionise his whole business. In the intense world struggle for business with which we are face to face, it is the revolutionary discovery to which we must look for help. I think we need reminding that while some discoveries have been born out of the necessity of finding an answer to a problem, far greater in number and subsequent importance are those which have been made in researches undertaken for the extension of our knowledge.

But great advances in bringing together the scientist and the industrialist have been made in recent years. The formation of the Association of British Chemical Manufacturers has been of use in this connexion. It has brought the manufacturers into such close contact that it has tended to level up the ideals of the less progressive to those of the more enlightened. The gain to the manufacturers has been obvious, but there has been an equal gain to the scientists, not perhaps quite so obvious. It is a threefold gain; first, the progress of the industry is essential if employment is to be found for all those who are being trained as chemists. Secondly, the success of co-operation among the units of the industry tends to foster co-operation between the different branches—technical and non-technical—in the same firm. And, thirdly, the levelling-up of ideals due to co-operation among the manufacturers makes for better conditions under which the chemist works.

The joint meetings of local branches of the various Societies have assembled together the research chemists in University Laboratories and Works Laboratories, the chemists from chemical factories, and the industrialists who are members of the Society of Chemical Industry. This, to my way of thinking, is all to the good. In the present stage of fierce international competition there is no room for petty differences between Societies of any nation, but it is the time for a uniting together of all the National Societies.

I must leave for another occasion the part which I believe the scheme for a Chemistry House must play. Suffice it to say that I believe it to be an essential step to further co-operation between the Societies.

There has, however, been one other factor which has overshadowed all others this year in stimulating co-operation between science and industry. I refer to the British Empire Exhibition. In the early days of preparation for the Exhibition no provision was made for scientific displays. It was a question of money, and neither the Government nor the Exhibition Authorities seemed willing to provide it. It is to the everlasting credit of British Chemical Science and Industry that at this point the decision was taken that Chemistry should be represented even if no other science were there, and that Chemistry would finance its own exhibit. I like to think that this decision had considerable influence on the Government, which ultimately, through the Department of Overseas Trade, provided funds to enable other sciences to be shown at the Exhibition.

It was in January, 1923, that the Joint Scientific Chemistry Committee was appointed with Dr. Levinstein as its Chairman. The Committee was extremely fortunate in securing his services. The presence in the Chair of a man who combined scientific knowledge with industrial experience was invaluable, and he gave freely, both time and money, to make the project a great success. As the work of the Committee progressed, the Government relented and placed at the disposal of the Royal Society a sum of money to be spent on a scientific exhibit and provided a home for it in the Government Pavilion. Here, you will see, were great possibilities for all sorts of friction, overlapping of work and clashing of interests. None of these things happened. The representatives of the Royal Society, the premier scientific society of the world, worked together not

only with the representatives of other scientific societies, but of industrial associations as well. You will pardon me, I am sure, if I publicly acknowledge the unique compliment which was paid me as a representative of industry by appointing me a member of the Exhibition Committee of the Royal Society. Now, let us look at the results that flowed from this co-operation. The Royal Society found itself with a sum of money and a home for its exhibit provided by the Government. The Joint Committee of the other societies and associations had a similar sum at its disposal provided by these other societies and associations. The next step was to prevent overlapping. The Joint Committee's arrangements were well forward for the Chemistry Exhibit. The Royal Society therefore left this branch of science entirely to the Joint Committee, and concentrated all its limited financial resources on Physical and Biological Sciences. The only place where there was danger of overlapping was the borderland between physics and chemistry, and a few conversations on the question were sufficient to settle this point. I would like to add that the Royal Society went so far as actually to obtain for the Joint Committee some of the specimens you will find in the Chemical Hall. The contribution of the Manchester Literary and Philosophical Society, for example, consisting of Dalton's original diagrams, was set off by the work of Sir William Bragg and Prof. W. L. Bragg, accomplished 120 years later and shown side by side with them.

I believe the credit for the easy settlement of the borderland problem should be given to Sir William Bragg, who, in the course of one of our meetings, proposed the formula: "The outside of the atom to the Joint Committee: the inside to the Royal Society." In such familiar terms do these great scientists treat these, to us, infinitely little bodies!!!

Now, let us look at the even closer co-operation which prevailed among the societies and associations represented on the Joint Scientific Chemistry Committee. Here you had our own Society, the Chemical, the Institute of Chemistry, the Association of British Chemical Manufacturers, the Society of Petroleum Technologists, the Society of Dyers and Colourists, the Institution of Chemical Engineers, and the Pharmaceutical Society, all represented, each contributing to a common fund, and all striving together for a common purpose. What was the result? There was presented to the whole world a wonderful picture in a very beautiful setting of the present state of British Chemical Industry. I think the most impressive feature was the demonstration of the way in which each tiny portion fitted into the general scheme and the completeness of the range of products shown. But it went further than this. We expected a large number of intelligent foreign visitors to visit the Exhibit, and their numbers far exceeded our most optimistic estimates. We, therefore, set ourselves to answer an anticipated question, which we were certain to be asked: Whether this display merely showed a Chemical Industry which was a war product; whether, in fact, to put it another way, we were being typically British and developing an industry merely to hand it over to someone else. The answer was in the Scientific Section. Here was indicated some of the research work which had been going on. Here was the guarantee that, as your Chairman used to say, the stream of invention was flowing not sluggishly but freely in this country. The co-operation of the scientist and the industrialist had demonstrated that British Chemical Industry in all its present-day completeness had come to stay.

We went further. We realised that a large number of scientists scattered over the face of the globe would be unable to visit the Scientific Exhibit, and that even those who could visit it would want a reminder of what they had seen. So "Chemistry in the Twentieth Century" was produced, edited by your ex-President, Dr. Armstrong, and the book has had a remarkable sale.

One other point of view was considered, and again your Society must be given the credit. There is a large public which is interested in science. It is well represented by the numbers of middle-aged men who somewhat diffidently visited the Scientific Exhibit. If one got into conversation with them you found it was a case of: "Did a little chemistry when I was a boy; still like to read about it." For this class of visitor there were prepared a series of eight pamphlets on various branches of Chemical Industry, written in a popular style and edited by Dr. Miall, the editor of *Chemistry and Industry*. Thousands of these pamphlets were sold at the Exhibition, and I have no doubt did an immense amount of good.

I think I have said sufficient to-night to convince you that the results already obtained by the closer co-operation of those engaged in Chemical Science and Chemical Industry have amply justified the efforts which have been made. I believe it to be the settled policy of your Council to continue these efforts. The branches of the Society are on the threshold of a new winter session, and the Council is anxious that in every branch it shall find support for this movement.

I am confident we shall not look in vain to Manchester.

METALLURGY AND MINING IN CANADA

The Victoria Syndicate, Ltd., has been incorporated and is sponsored in Canada by the Mond Nickel Co. It is reported to be a combination of the Central Mining and Investments Corporation and the Mond interests. It has commenced an active investigation of the gold and silver districts of northern Ontario and north-west Quebec. Percy E. Hopkins, formerly of the Mines Department of Ontario Government, and now Chief Geologist for the Mond Nickel Co., is making a survey of the territory. The Mond Nickel Co. has blown in another furnace, which will bring the production up to the highest war-time peak. This company is now the largest producer of nickel in Ontario.

THE EARLY HISTORY OF ANTIMONY

By HARRY HYMAN, Ph.D.

The part played by antimony in the early history of chemistry is generally overlooked, its claims to an all-important position being overshadowed by its great rival, gold. There is a considerable amount of evidence, however, that antimony and its compounds must have proved of fascinating interest to many of the early chemists, and it is indeed probable that the study of this metal led to more developments in the early history of the science than did that of the precious metal. This fascination became in some cases so absorbing that entire lifetimes were devoted to its study, and the specialisation which we are inclined to attribute to the economic conditions of the present era was in force several centuries ago. The result of this intensive study was the publication of several books dealing entirely with this metal, all of which remain as landmarks in the steady progress of the science.

From our present knowledge of the chemistry of antimony it is not surprising that so many devotees worshipped at its shrine. It is capable of forming a large number of compounds and is very responsive to all the chemical processes known in the past few centuries. Many of its compounds are of medicinal value and can also be employed in the arts. In the case of gold, fewer compounds are produced, whilst its costliness and scarcity prevent their application for general purposes. If it were not for the belief that some compound of gold would yield the *elixir vitæ*, the substance that would prolong life indefinitely, the chemistry of this substance would not have been so assiduously pursued.

As early as the sixteenth century Du Chesne wrote: "There are six hundred very good properties in antimony," and in the following century Webster in his "Metallographia" says "for there is scarcely any one mineral that is more largely treated of than antimony." The "chemical dispensatories" of the period contain innumerable descriptions for the preparations of its various compounds, its oils, balsams, infusions, tinctures, flowers, and if it cured all the illnesses and diseases for which claims were made, then it had the just right to be termed the universal panacea. Its compounds were used both internally and externally, for mild complaints or critical conditions, for toning the system, cleansing the blood, as a cure for fevers, wounds, skin diseases, smallpox and every complaint imaginable.

One of the earliest books on the subject appeared in Leipzig in 1604, "The Mysterious Gem of Antimony," by Alexander Von Suchten. This was a complete treatise on the subject, consisting of over five hundred pages and provided with an index. It was divided into two sections, the first dealing with its compounds and their medicinal properties, and the second with the extraction of the metal. The book was an important one at the time and went through many editions. Von Suchten flourished in the latter half of the sixteenth century and lived at Danzig. He possessed the double qualifications of chemist and poet. An English translation of his work by Dr. Cable was published with the following title page: "Alex. Von Suchten's Of the Secrets of Antimony: in Two Treatises. Translated out of High-Dutch by D. C. a Person of Gr… Skill in Chymistry. To which is added B. Vale… gain Salt of Antimony, with its Use. London, P… It and are to be sold by Moses Pitt at the Whitustry in Little Britain, 1670." those

Twenty years later, that is in 1624, there …ly, the also in Leipzig, another treatise on th… of the namely, "The Triumphal Chariot of …tween the by Basil Valentine. This was also a c…technical— treatise and extended to six hundre…lling-up of went through many editions and wa…ufacturers into several languages. An English trans…hemist Richard Russell appeared in 1678 and a La… version, with a commentary by Theodore Kerckringius, was issued at Amsterdam in 1685. An English translation of the latter work with a biographical preface was made in 1803 by A. E. Waite.

Very little is known about the actual life of Valentine. He is alleged to have been a Benedictine monk living in South Germany during the fifteenth century, but modern historians are inclined to the view that such a personage never existed. It is more than probable that the various works attributed to him, including the "Triumphal Chariot," were written by his editor, John Thölde, who was born in the latter half of the sixteenth century: but why they should have been issued under another name is a mystery which has not yet been satisfactorily explained. The author, whoever he was, must have been an experimenter of more than average ability, as many of his writings contain first descriptions of important chemical reactions and compounds. Complete instructions are given for the separation of the metal from its ores, and for the preparation of various compounds, many of which were advocated for medicinal purposes.

In 1660 Guerner Rolfinck published at Jena a "Chemical Dissertation on Antimony." This was issued in pamphlet form and contained an account of a debate held in the medical lecture room of the University. Rolfinck was one of the most learned men of his day. Born in Hamburg in 1599, he received his education at the universities of Leyden, Oxford, Paris and Padua, and subsequently became professor of chemistry at Jena. According to Stahl, he played a great part in bringing the science of chemistry into shape and laying a foundation stone on which many subsequently built. Besides possessing a profound knowledge of languages, philosophy, science and medicine, he was a keen anatomist and was bitterly disappointed when any criminal escaped him. One unfortunate person on being brought to the gallows requested that he might not be "rolfincked" after his death. Rolfinck, on hearing this, exclaimed, "Ha! you scoundrel, you are too 'putrid' for me, else I would have rolfincked you with my scalpel." The phrase remained for a considerable time a popular one as an equivalent to dissect.

Thirty years later, *i.e.*, in 1690, a useful German booklet on the metal was written by John Bernhard Horn, and about the end of the century a Frenchman.

Nicolas Lemery, issued his "New Curious Chemical Secrets of Antimony," a well-informed book of close on six hundred pages. Lemery was one of the most ledg[illegible]ous chemists of his day, and was noted for the a repr[illegible] of his writings, in which all traces of mysti- membe[illegible]re removed. He was trained as an apothecary Society[illegible]r travelling for several years settled down in from th[illegible]here he gave practical demonstrations and itself with[illegible] His fame spread and students from all provided by[illegible]rope flocked to attend his classes; from of the other [illegible]e no fewer than fifty students in one sum at its dis[illegible] hear him. Owing to religious difficul- and associati[illegible]o England for a short period, and after lapping. T[illegible] France led a rather unsettled life. He well f[illegible]715. He wrote a valuable treatise on [illegible]mistry which was published at Paris in 1675, and went through eleven editions. It was translated into Latin, German, English and Spanish.

Almost a century later, in 1791, a book was published in this country by George Pearson, M.D., F.R.S., under the title, "Experiments and Observations to Investigate the Composition of James's Powder," the history of which is largely associated with this element. James's Powder was a favourite nostrum of the eighteenth century, and consisted chiefly of oxide of antimony and phosphate of lime. The inventor was Dr. Robert James, grandfather of G. P. R. James, the novelist, and an intimate friend of many of the famous literary men of that century. He formed a close acquaintance with Dr. Goldsmith through the latter's publisher, a Mr. John Newbery, who, besides conducting a bookseller's business, also carried on a large trade in the sale of patent medicines. Newbery arranged a contract with James to sell his fever powder and pills, the publishing business of the former affording ample scope for the advertisement of these products. The powder was claimed to be a valuable remedy for "Fevers, Small Pox, Measles, Pleurisies, Quinsies, Acute Rheumatism, Colds and Inflammatory Disorders." Goldsmith himself was a frequent user of nostrums, firmly refusing the services of qualified physicians. He even made it one of his hobbies to prescribe for others. "I do not practice," he once said: "I make it a rule to prescribe only for my friends." "Pray, dear Doctor," said Beauclerk, "alter your rule, and prescribe only for your enemies." Contrary to this advice, Goldsmith continued his practice, and when seriously ill sent his servant to Newbery's shop for a dose of the powder. The remedy aggravated the malady, and although physicians were called in he died shortly afterwards. Soon after his death, Hawes, his surgeon-apothecary, formed the opinion that the powder had had no beneficent effect on his patient, and published a trenchant pamphlet entitled "An Account of the late Dr. Goldsmith's Illness as far as relates to the exhibition of Dr. James's Powders," 1774. This was vigorously replied to by Newbery's son, but the controversy appeared to have had little effect on the sale of the nostrum. During the illness of George III in 1778, it was recommended for that monarch, and the King himself prescribed it for Princess Elizabeth.

Horace Walpole, though inclined to be rather cynical, had much to say in favour of Dr. James's remedies. In 1764 he thus wrote to Sir Horace Mann: "James's Powder is my panacea: that is, it always shall be, for thank God! I am not apt to have occasion for medicines: but I have such faith in this powder, that I believe I should take it if the house was on fire. Have you ever had any of it? or shall I send you a parcel of papers?" Thomas Gray and William Cowper also put their faith in the powder, and Henry Fielding and Samuel Johnson were among others who offered words of praise. The last-named showed his

Frontispiece of the Latin version of Basil Valentine's "Triumphant Chariot of Antimony," Amsterdam, 1685. In the Library of the Royal Technical College, Glasgow. James Young Collection.
[Actual size.]

appreciation by writing a dedicatory preface in his best literary style for James's work, a "Medical Dictionary, with a History of Drugs" (3 vols., 1743).

Enough has been written to show the influence which a compound of antimony exerted on the literary vagaries of the eighteenth century. That this element played an important part in the development of chemistry during the sixteenth and seventeenth centuries there can be no shadow of doubt, and at the present day it continues to uphold the worthy traditions of a glorious past.

FORTHCOMING EVENTS

Oct. 10. UNIVERSITY OF LONDON, UNIVERSITY COLLEGE, Gower Street, W.C. 1, at 5.30 p.m. "Water Supply and its Purification," by Prof. S. L. Rushkovitch. Also on October 17, 24, and 31.

Oct. 11. NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, Lecture Theatre of the Institute, Newcastle-on-Tyne, 2 p.m. (1) "Safety Lamps giving warning of Gas," by Dr. W. M. Thornton. (2) "The Heat due to Strata Movement and its Effect on Certain Coal-Seams," by Prof. H. Briggs, A. L. S. Owen and J. Wilson. (3) "The Washing of Fine Coal by the Froth-Flotation and Concentrating-Table Processes at Oughterside Colliery, Cumberland," by J. G. Scoular and B. Dunglinson.

Oct. 11. SOCIETY OF CHEMICAL INDUSTRY, *Nottingham Section.* Annual Dinner, at the Flying Horse Hotel, Poultry, Nottingham, at 7 for 7.30 p.m. Tickets 5s. each, exclusive of wine.

Oct. 13. INSTITUTE OF METALS, *Scottish Section*, 39, Elmbank Crescent, Glasgow, at 7.30 p.m. "Brass Foundry Costing," by J. Stirling.

Oct. 13. THE INSTITUTE OF BREWING, *London Section*, Engineers' Club, 39, Coventry Street, W.C., at 7.30 p.m. Discussion on "The Characteristics and Peculiarities of the Season's Malt."

Oct. 15. ROYAL INSTITUTE OF PUBLIC HEALTH, 37, Russell Square, London, W.C. 1, at 4 p.m. "Physique in Relation to National Efficiency," by Sir W. Milligan, M.D.

Oct. 15. INSTITUTE OF CHEMISTRY, *London Section*, 30, Russell Square, London, W.C. 1, at 8 p.m. A number of Fellows and Associates from abroad will speak of the position of chemistry in their respective countries.

Oct. 16. INSTITUTION OF THE RUBBER INDUSTRY, *Manchester Section*, 16, St. Mary's Parsonage, Manchester, at 7.30 p.m. "Some Problems in the Rubber Industry," by H. Standring.

Oct. 16. THE INSTITUTION OF MINING AND METALLURGY, Geological Society's Rooms, Burlington House, Piccadilly, London, at 5.30, "Hygrometry for Deep Mines," by J. S. Jones.

Oct. 16 and 17. UNIVERSITY OF LONDON, King's College, Strand, London, W.C. 2, at 5.30. (1) "Organic Radicals"; (2) "Theory of Oxidation Processes," by Prof. Dr. H. Wieland.

Oct. 16. THE CHEMICAL SOCIETY, Burlington House, Piccadilly, London, W. 1, at 8 p.m. (1) "The Influence of Catalysts on Carbonisation," by R. Lessing and A. Banks. (2) "The Photosensitive Formation of Water from its Elements in the Presence of Chlorine," by R. G. W. Norrish and E. K. Rideal. (3) "Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXIV. Further Experiments on the Walden Inversion," by J. Kenyon, H. Phillips, and H. G. Turley. (4) "The Directive Influence of Substituents in the Glyoxaline Nucleus on Substitution in the Benzene Nucleus of Phenylglyoxalines—the nitration of 2-phenylglyoxaline and its carboxylic acids," by F. L. Pyman and E. Stanley.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

A circular letter with further particulars and a form of application for tickets has been sent out to the members.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The price of Volume VIII (1923) to members of the Society is 7s. 6d., and to non-members 12s. 6d., post free in each case.

Fellows of the Chemical Society have the privilege of purchasing the volume at the price of 10s. post free.

A set of Volumes II to VIII inclusive can be purchased by a member of the Society at the price of £2 2s. 6d., and by a non-member at the price of £3 15s., post free in each case.

CHEMICAL SOCIETY'S ANNUAL REPORTS

The Council of the Chemical Society has decided to increase the price of future issues of the Annual Reports on the Progress of Chemistry, and the volume for 1924 (XXI) which will be issued next year will be sold to the public at 10s. 6d., plus postage. To members of the Society of Chemical Industry will be given the privilege of purchasing the volume at 9s., post free. Orders, accompanied by the appropriate remittance, should be sent to the Assistant Secretary, Chemical Society, Burlington House, London, W. 1, before the end of the present year.

DEATHS

Allen, John (Original Member), of Phœnix Chemical Works, Upper North Street, Poplar, London, E. 14. On August 30, 1924.

Bamber, H. Kelway G. (elected 1894), of Stone Castle, Greenhithe, Kent. Cement Works Manager. Killed in motor accident on September 20, 1924.

Brown, E. Hilton (elected 1890), of 156, Artillery Mansions, Victoria Street, London, S.W. 1. Analytical Chemist. On September 11, 1924.

Hehner, Otto (Original Member), Panplatts, Pan Station P.O., Transvaal, South Africa. Consulting Chemist. On September 9, 1924.

SOCIETY OF PUBLIC ANALYSTS

Five papers were read at the meeting held in the Chemical Society's Rooms on October 1, Mr. G. Rudd Thompson in the chair.

A paper on "The Determination of Coconut Oil and Butter Fat in Margarine," by G. D. Elsdon, B.Sc., and Percy Smith, discussed the methods suggested for calculating the percentages of butter and coconut oil present in margarine from a consideration of the Reichert-Polenske-Kirschner process. The authors attempt to show that there is some uncertainty in these calculations and, from analyses of a large number of mixtures of known composition, they attempt to introduce some improvement. The Blichfeldt process is discussed, and the opinion given that this has no particular advantage over the processes now generally in use—a modification of this process suggested by the authors is found to be inferior to the Kirschner process though somewhat more rapid.

"A Preliminary Note on the Composition of the Fat of Goat's Butter" was presented by F. Knowles and J. C. Urquhart, B.Sc. Owing to the increasing number of herds of goats in the country, and consequent increase in sale of butter obtained from this source, the authors raise the important point whether or not it is legal for this product to be sold as "butter." Analyses are given of samples of the fat of goat's butters where the usual conventional methods were employed. Particular attention is directed to the Polenske value, which varied from 4·9 to 8·7, and which, if interpreted in the light of the usual standards for cow's butter, would erroneously be assumed to indicate adulteration.

"The Quantitative Estimation of the Degree of Hydrolysis of Gallotannin by Tannase" was discussed by Miss W. N. Nicholson, B.Sc., and D. Rhind, B.Sc. Tannase disintegrates gallotannin, gallic acid being produced. The activity of tannase can therefore be measured by estimating the unchanged gallotannin. Such a method has been devised by Rhind and Smith (*Biochem. J.*, 1922, **16**, 1). It can also, however, be measured by estimating the amount of gallic acid produced by the enzyme. A method for the estimation of gallic acid produced by tannase has been described by Freudenberg and Vollbrecht (*Z. physiol. Chemie*, 1921, **116**, 277). In this method the gallic acid formed by the action of tannase on gallotannin or methyl gallate is estimated by titration with sodium hydroxide, litmus paper being used as an indicator. It is assumed by Freudenberg and Vollbrecht that, under the condition chosen by them, only the carboxyl group in the gallic acid reacts with sodium hydroxide. This method has now been tested and has been found not to be reliable. Concordant results, however, have been obtained by using a slight modification of Mitchell's colorimetric method for the estimation of small quantities of gallic acid (*Analyst*, 1923, **48**, 2). This method has been in constant use during the last eighteen months in the work on tannase and has been found to give good results.

In considering "The Pemborton-Neumann Method for the Estimation of Phosphorus," Miss M. B. Richards and W. Godden, B.Sc., A.R.C.S., show that the chief sources of error in this estimation are: (1) absorption of carbon dioxide by the alkali used to dissolve the ammonium phosphomolybdate precipitate; and (2) the use of a wrong factor. Errors due to (1) may be eliminated by boiling with excess of acid before the final titration. (2) Instead of Neumann's factor 0·001268, the authors use the factor 0·001365, believing that the formula of the precipitate obtained by their procedure is $(NH_4)_3PO_4, 12\,MoO_3$. The use of this new factor, combined with the method of precipitation and washing detailed in the paper, gives results in close agreement with those obtained by gravimetric analysis.

Mr. W. S. Shaw, M.Sc., read a paper on "The Application of 'Formol Titration' to the Kjeldahl Method of Estimating Nitrogen," in which he said that, in order to eliminate distillation the formol titration method was adapted to the estimation of nitrogen after the usual digestion with satisfactory results. The colourless solution is diluted and boiled to expel sulphur dioxide, neutralised and left slightly acid, and made up to 250 c.c. Twenty-five c.c. of the solution is rendered alkaline with normal sodium hydroxide solution, re-acidified with 0·1 normal sulphuric acid, boiled, cooled rapidly, and titrated with 0·1 normal sodium hydroxide solution with phenolphthalein as indicator. Five c.c. of formaldehyde solution (commercial formalin of determined acidity) is added, the mixture allowed to stand for a few minutes, and the acidity titrated with 0·1 or 0·2 normal sodium hydroxide solution. The acidity due to the formaldehyde solution is corrected for, and the nitrogen calculated.

METALLURGICAL AND MINING NOTES FROM CANADA

The British Empire Steel Corporation has received an order from Germany, for 100,000 t. of iron ore which will be shipped from the company's mine at Wabana, Bell Island, this year.

The value of the mineral production of British Columbia for the year 1923 was $41,304,320. This is $6,145,477 greater monetary value than the output of 1922, an increase of 17·5 per cent.

Palladium is being produced at the Saltchuck Mine, B.C., and the concentrates shipped to the refinery at Irvington, N.J.

The annual financial statement of the McIntyre Porcupine Mines Ltd., shows that 360,140 t. of ore were treated of an average value of $9·69, and containing in all 157,702, fine oz. gold and 27,550 oz. of silver. The annual dividend, which has been 15 per cent., is to be increased to 20 per cent.

The Wright-Hargreaves Mining Co., is increasing its milling capacity from 150 to over 400 t. of gold ore daily.

The Hollinger Co., which has been handling 6500 t. of ore per diem, expects to have a throughput of 8000 t. within two months. When this is accomplished it will be the largest gold producing mine in the world.

REVIEWS

The Theory and Application of Colloidal Behaviour. Edited by R. H. Bogue. Vol. I.—Theory. Pp. xxx+444. Vol. II.—Applications. Pp. xxvii+445-829. New York: The McGraw-Hill Book Co., 1924. Price £2.

This work consists of a series of essays on various aspects of the subject by a number of authors. The editor states in the preface that it is an attempt to meet the need for a comprehensive treatise on the colloidal state and its more general applications. Unfortunately the book itself falls short of the promise of the preface.

The treatment of theoretical aspects in the first volume is decidedly scrappy. The editor hails the Donnan equilibrium (attributed to Prof. "Frank" G. Donnan) as a general factor in colloidal behaviour, and the first two papers, by J. A. Wilson and the late Dr. J. Loeb, are mainly concerned with the properties of proteins seen in the light of this theory. Other authors in this volume either ignore the theory altogether or point out its very limited applications. H. B. Weiser, who gives a good summary of what is known so far of the properties of jellies, points out that, however useful the Loeb-Wilson theory may be in explaining the swelling of gelatin, it is obviously inapplicable to the parallel phenomenon of the swelling of rubber in benzene.

There is a good deal of overlapping in the papers in this volume. Prof. Freundlich writes with his usual clarity on the sensitisation of suspensoids by minute quantities of emulsoids, but the same matter is dealt with more briefly by A. W. Thomas in a section on the mutual reactions of colloids, a portion of the subject also partly covered by J. H. Northrop in a chapter on colloidal suspensions. There is also a tendency, particularly noticeable in the two latter papers, to emphasise the work of the authors themselves, which, however desirable it may be on other occasions, is scarcely what is looked for in a comprehensive treatise.

There are several remarkable omissions in the work as a whole, and such fundamental matters as dialysis, the ultramicroscope and the Tyndall cone are not even mentioned in the index. No attempt is made to give the reader any appreciation of the specialised technique of the subject except in isolated cases. The division of the subject matter into "theory" and "applications" seems to have been made with a view to the equal size of the volumes, and papers on the body fluids, enzymes and catalysis are included under "theory."

The second volume is much more satisfactory in covering the wide field of the applications of colloid chemistry, and indicates both the results so far obtained and the directions in which further work is required. The seventeen papers summarise the colloidal features presented by minerals, soils, metals, fuels, smokes, silica, cereals, fruit jellies, cellulose, rubber, leather, gelatin, and casein. Photography, sanitation and diet are also discussed from the colloidal point of view. The matter in a few of these sections is not otherwise easily available, and the technical chemist will find this volume much more useful and interesting than many parts of the first book.

The volumes are well produced, but the reading of proofs might have been more careful; the editor suffers from an inability to spell proper names in the usual way, and an eminent British chemist is referred to as Föerster.

P. C. L. Thorne

Carbid und Acetylen, als Ausgangsmaterial für Produkte der Chemischen Industrie. By Prof. Dr. J. H. Vogel and Dr. Ing. Armin Schulze. Pp. 130. Leipzig: Otto Spamer, 1924. Price, paper, 5 g.mk., bound, 6 g.mk.

As indicated in the preface, the first 100 pages of this book, dealing with the physical and chemical properties of acetylene and the use of acetylene as a raw material for the chemical industry, are practically identical with the corresponding sections of "Das Acetylen," by Prof. J. H. Vogel (Otto Spamer, 1923), very slightly amended and amplified in places. These are followed by a new section on the cyanamide industry (10 pages) and by name and subject indices. The sections on the physical and chemical properties of acetylene are an excellent summary of what is known on the subject with very full references to the literature. On pp. 9 to 11, three divergent sets of figures are given without correction for the limiting explosive compositions of acetylene-air mixtures.

The section on the use of acetylene as a raw material in chemical industry deals with the manufacture and properties of chlorinated products, carbon black, graphite, hydrogen, acetaldehyde, acetic acid, acetone, alcohol and their derivatives, also of artificial rubber, varnishes and allied products. This section appears to be an excellent account of German industrial methods. The authors state on p. 97 that they have mainly confined themselves to German and Swiss methods. The book would be more valuable had it included some account of industrial developments elsewhere.

On p. 103 the authors refer to the manufacture of synthetic acetic acid and so forth at "a works at the Shawinigan Falls in Quebec, Canada."

The section on cyanamide manufacture is too short to allow of adequate treatment of the subject, and here again attention is almost entirely confined to German methods and developments.

In spite of the defects indicated the book can be recommended to those who do not possess a copy of the 1923 edition of "Das Acetylen."

Ernest Fyleman

BRITISH PORTLAND CEMENT MANUFACTURERS

The Hon. F. C. Stanley and Messrs. A. White, A. Brooks, and G. E. V. Cranage have resigned from the board. The new directors are Lord Meston, Sir J. A. Horne, Mr. W. J. Firth and Mr. P. J. Pybus. An interim dividend on the ordinary shares of 5 per cent. less tax (the same as the interim dividend last year) has been declared.

REPORTS

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1923–24. Pp. 139. Cmd. 2223. H.M. Stationery Office, 1924. Price 3s.

The expenditure of the Department of Scientific and Industrial Research for the financial year 1923-24 was £515,382, including £33,367 expended on headquarters administration and made up of £274,297 from the Exchequer, £42,761 from the interest and £103,187 from the capital of the Million Fund, and £85,251 from fees for tests and special investigations. The balance of £9886 was met from the grant in aid of £39,500 voted in 1921-22 for increasing developments of the Department's researches. The balance of £29,614 has been carried forward and supplemented by £15,000 voted in the estimates for 1924–25. The estimated net expenditure for 1924–25 is £328,281.

During the year 291 grants were made to research workers and students in training at a cost of £45,303. Other expenditure was as follows: National Physical Laboratory, £162,290, a large part of which was met by fees and other payments; the Fuel Research Board, £46,319, (receipts £3978); the Geological Survey, £58,115; Building Research Board, £8960; grants to 23 research associations, £103,187. The balance of the Million Fund at March 31, 1924, was £618,318. Further grants have been promised to the Research associations for the photographic, woollen and worsted, cotton, scientific instruments, and linen industries, and grants have been offered to others. A research association for the sugar industry is being formed.

In the Report of the Advisory Council it is stated that reviews of nine research associations have furnished evidence of the progress of co-operative research. For the greater part, the research associations are stated to be fulfilling the hopes held at the beginning of the scheme, which as a whole has justified its inception. Many of the investigations have been planned to expose the basic scientific facts underlying technical operations, and team work is being encouraged in the scientific staffs. After careful consideration, from a broad standpoint, of consultative work carried out by the associations, it is advised that the extent of such work should be watched carefully, and should be strictly limited.

The committees report that the associations have been administrated economically, and consider that further aid to associations should take the form of block grants diminishing annually in amount and so graduated as to make the ultimate change over to complete independence a relatively easy matter. Thus, the British Portland Cement Association has carried out valuable scientific work and the industry is receiving subscriptions to carry on without further State assistance. Further assistance is needed for the research association for the woollen and worsted industry, and extra grants will probably be given to the cotton and linen research associations. Special consideration has been given to the British Scientific Instruments Research Association, which is stated to have achieved valuable practical results. The improvement effected by the Glass Research Association in the general outlook and technique of the industry is appreciated, but the committee was not so favourably impressed with the scientific results achieved. As the present financial position of the industry affords no prospect that funds will be found to continue the association, steps will be considered to provide for research in this industry. The facilities at the disposal of the Fuel Research Board are to be increased to test promising plant or processes for the low-temperature carbonisation of coal, and to press forward the physical and chemical survey of the national coal resources. The Chemical Research Board has now been provided with a chemical laboratory close to the National Physical Laboratory, and it has been decided that the grant to the Institute of Metals for the study of corrosion of metals should cease and that this work should be carried on by the Chemistry Research Board under a committee presided over by Prof. H. C. H. Carpenter, Dr. D. G. Bengough being in direct charge of the investigations.

In discussing grants to research workers and students in training, the Report states that the standard of the work done by the students has been definitely raised, and observes in relation to the reports they have sent in, that bad style and bad work frequently go hand in hand. The defect is attributed to too early specialisation, and the Advisory Council considers that in the last two years of school life science should not be allowed to absorb the whole of the student's attention to the exclusion of the humanities and the detriment of his general education. When the student has graduated, and is serving his apprenticeship to research, he should be encouraged to devote attention as part of his training to the historical and cultural aspects of his subjects. Students specialising in chemistry still preponderate, but there is a small increase in the number of those specialising in the biological sciences. The Council notes with approval a tendency for chemistry students to pay more attention to topics with a biological training.

Arrangements have been made with the Royal Institution for the continuance of Sir William Bragg's researches on the X-ray analysis of crystals. The proposals for the international protection of scientific property put forward by Senator Ruffini were considered, and it was concluded that not only were the proposals impracticable, but that if they were put into force they would have an unfortunate influence on the outlook of workers in pure science.

The National Physical Laboratory is investigating the proposal to adopt a wavelength of light as a standard of length, and has carried out important work on the maintenance of standards, alloys, methods of producing pure metals, minor metals, and the structure of metals and alloys.

Good progress has been made with the survey of the national coal resources by the Fuel Research Board, and it is hoped shortly to publish recommendations on sampling. The work on carbonisation has been continued, and interesting results have been obtained with the Lessing process, applied to separate low-temperature tar into light spirit, heavy oils and

pitch. Other work of the Board bears on internal combustion engines, boiler tests (carbon dioxide recorders), the hydrogenation of oils and coals, and domestic heating, a report being in preparation on the last-named subject. The research work on the direct fermentation of cellulose has failed so far to throw any further light on the problem, but it is still being continued, and progress has been made with the translation on a technical scale of the laboratory experiments on the fermentation of sugars resulting from the hydrolysis of cellulosic material.

Advances have been made by the Food Investigation Board in investigating the freezing of tissues, the preservation of foods, engineering problems of storage and other problems. Work has been carried out to enable the determination of the constitution of any mixed glyceride, on the synthesis of the higher aliphatic acids, and on the deposition of fat in yeast and plant cells.

Useful work is recorded in the report of the Building Research Board, which has investigated the causes of the setting of Portland cement and plaster of Paris, the production of fire-resisting cement, the strength of asbestos cement roofing and the economic firing of kilns. The main aim of the Stone Preservation Committee is to devise methods of recognising the nature of decay in a variety of stones subjected to varying conditions, and it is hoped to gain further insight into the various causes of decay, though reliable conclusions cannot be drawn until the investigation has proceeded much further.

The Chemistry Co-ordinating Research Board has continued work on the slow oxidation of hydrocarbons to form formaldehyde (*cf. J.*, 1923, 42, 415 T). The experiments on the synthesis of formaldehyde from carbon monoxide and hydrogen under compression were abandoned, but as it appears that an oily product containing methyl alcohol can be obtained from carbon monoxide and hydrogen by using high pressures and suitable catalysts, the advisability of further research is being considered. The conditions for the successful production of carbon tetrachloride have been ascertained and attention is being given to the production of methyl chloride. Experiments with the view of finding a cheap disinfectant in place of formaldehyde, have given little prospect of success, but attention is being paid to the recovery of formaldehyde after use in disinfecting wool. The Board concluded that it was impossible to arrive definitely at the cause of the Oppau explosion, but thought that there existed pockets of ammonium nitrate either unmixed with ammonium sulphate or mixed with a proportion insufficient to prevent detonation, a conclusion in close agreement with that reached by the German committee of enquiry. The process for the treatment of aluminium so as to produce a surface film of oxide which would readily absorb other suitable protective substances, and thus become highly resistant to corrosion has been examined, and a patent has been applied for. It is recommended that a grant should be made to Prof. I. M. Heilbron in aid of research on certain fish oils the chief constituent of which is a hydrocarbon.

The Engineering Co-ordinating Research Board has financed researches on light alloys, electro-deposition, strength and properties of ferrous materials at high temperatures, fatigue of materials, and various other metallurgical questions. The preparation of a gelatin with low ash content and apparently free from nitrogenous impurities has been accomplished by the Adhesives Research Committee, which has also studied the production of gelatin and high-grade glues from bones, horn-pith and various waste materials. Thus, an odourless and tasteless gelatin having very strong adhesive powers has been prepared from fish skins. Investigation at Bristol University on the nature of adhesion has continued to yield interesting results, though general conclusions cannot yet be drawn. The Fabrics Co-ordinating Research Committee has investigated the action of fire-proofing agents, the deterioration of fabrics and rubber, methods of water-proofing and other problems. The Gas Cylinders Research Committee has instituted work on the physical properties of the so-called "non-permanent" gases, and interesting work has been carried out under the Lubrication Research Committee, which proposes to publish an account of the results obtained. Valuable work has also been done by the Illumination Research Committee, the Forest Products Research Board, the Physics Co-ordinating Research Board, the Radio Research Board, the Current Meters Committee, and the Dental Investigation Committee.

Report of the Government Chemist upon the Work of the Government Laboratory for the Year ending March 31, 1924. Pp. 36. H.M. Stationery Office, 1924. Price 1s. 6d.

During the year 390,421 samples were examined at the Government Laboratory and at chemical stations, an increase of 46,968 compared with 1922–23. There has been an increase of more than 21,000 in the number of samples examined at chemical stations, whilst the number examined at the central laboratories in London has risen from 225,073 to 251,009, an increase of 25,936. Samples of wine, sugar and tea have increased, and there are notable increases in the number of samples of wort, exported beer and spiritous preparations. The number of samples of beer examined for the detection of dilution is again high, being 5079. The number of samples of imported beer has risen from 1361 to 15,283, and of exported tobacco and snuff from 8533 to 17,718. Both these large increases are due to the establishment of the Irish Free State, and the necessary examination of goods passing to and from that country. The work in connexion with the Safeguarding of Industries Act has involved the examination of nearly 8000 samples. The Dangerous Drugs Act and the Dyestuffs (Import Regulation) Act, continue to impose considerable work on the Department. The total number of samples for the Admiralty was 410, which does not include the sea-water samples forwarded by the Admiralty for the determination of salinity.

Of the 867 samples of butter examined during the year, 10 contained more than 16 per cent. of water; three samples described as "hard butter" were preparations of palm kernel fat; and two were described in error as "milk-blended" butter. Out of 455 samples of margarine, five were found to contain more than 16 per cent. of water, but there

was no evidence of excess of butter in any of the samples. The proportion of fat in cheese was found to vary from 8·6 to 38·1 per cent., or from 21·0 to 56·9 per cent. of the dry matter in the cheese; some of the cheese had thus been made from skimmed milk, but no exception could be taken, as there are no appropriate regulations to control composition.

Examination of tinned cream showed that it contained 23 to 54 per cent. of fat, and the preserved cream from 51 to 67 per cent. Out of six samples of tinned sterilised milk examined, two were found to have been deprived of about one-quarter of their fat. The others were not adulterated, but three of them containing ordinary whole milk, bore the new condensed-milk label. Of the 263 samples of condensed milk taken under the Public Health (Condensed Milk) Regulations which came into force on October 1, 1923, 53 samples were reported against. All were, however, found to be free from chemical preservatives. Thirty-six samples of sheep-dips submitted during the year were reported to be defective. Samples of river water, effluents and sea-water were also examined. Various deficiencies and impurities were found in fertilisers and feeding-stuffs.

An enquiry was made under the Merchandise Marks Act into the composition of various agricultural materials, and it was found that one out of seven samples of ground oats, contained 15 per cent. of tapioca flour; another sample contained 85 per cent. of barley and tapioca. Three samples of pea meal were found to contain 5, 25 and 33 per cent. of maize and barley, and four samples of barley meal were found to contain 25, 30, 40 and 50 per cent. of oat refuse and weed seeds, whilst a sample of fish meal contained 10 per cent. of ground cereals and refuse. Two samples of copper sulphate contained 50 per cent. of sulphate of iron.

Altogether, 47,733 samples of beer were examined for assessment of duty. Out of 292 samples of brewing materials tested, 140 were malt, corn, brewing sugars and exhausted grain, and 152 yeast foods and miscellaneous substances used, or proposed to be used, in the preparation of beer. Ninety samples were found to contain arsenic in slight excess of the legal limit. Many duty-free spirits, including methylated spirits, specially denatured spirits and other manufacturing spirits were examined, and the naphtha represented by all these samples with one exception was approved as fit for methylating purposes. Examinations were also made of samples of sugar, glucose and saccharin, tea, tobacco, and wines. None of the 153 samples of matches examined was found to contain white phosphorus.

In connexion with the work done by the Office of Works in the strengthening of the roof of the Great Hall at Hampton Court some oak panels which had been repainted about a hundred years ago were examined. Traces of the original azure blue were found on the wood. This had been covered over with a coating of white lead, and then with a Prussian blue paint. Since Prussian blue was discovered about 1710, it is clear that the blue paint could not have been put on earlier than this date. It is known that the final oak-coloured paint was applied early in the last century.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate	£38 per ton d/d. Normal business.
Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid ..	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton, carr. paid.
Sod. Bichromate	4¼d. per lb.
Sod. Bisulphite Powder 60/62%	£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst. ..	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes White and Dark	5d.—9¼d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P.	£56—£57 per ton, according to quantity.
Sulphur Chloride	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£12 per ton.
Grey	£16 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 15s.—£9 5s. per ton, according to grade and locality.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. ,, ,, 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 10d. per gall. 60% O.P.
Solvent	5s. 3d. per gall. 40% O.P.
Wood Tar	£4 5s. per ton.
Brown Sugar of Lead	£43 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6¼d. per lb. Quiet.
Crude 60's	1s. 7d.—1s. 9d. per gall, according to district. Market flat.
Acid Cresylic, 97/99	2s.—2s. 1d. per gall. Demand fair.
Pale 95%	1s. 9d.—2s. 1d. per gall. Better enquiry.
Dark	1s. 9d.—2s. 1d. per gall. Quiet.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6d.—6½d. per gall. Small demand.
Benzole—	
Crude 65's	7½d.—9d. per gall. ex works in tank wagons.
Standard Motor	1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Benzole—	
Pure	1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5d.—1s. 5½d. per gall. Small demand.
Pure	1s. 8d.—1s. 9d. per gall. Small demand.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	8½d. per gall. Little demand.
Middle Oil, Heavy Oil, Standard Specification	5d.—6½d. per gall., according to quality and district. Fair business passing. Small demand from America.
Naphtha—	
Solvent 90/160	11d.—1s. 2d. per gall., according to district. A shade firmer.
Solvent 90/190	11d.—1s. per gall. Not much demand.

Naphthalene Crude—
Cheaper in Yorkshire than Lancashire. Demand rather better.
Drained Creosote Salts £4—£6. Quiet.
Whizzed or hot pressed £6—£9 per ton.

Naphthalene—	
Crystals and Flaked	£12—£16 per ton, according to district.
Pitch, medium soft	40s.—45s. per ton f.a.s. Market very flat. No business.
Pyridine—90/160	18s. 6d.—19s. per gall. Steady demand.
Heavy	12s. per gall. Market dull.

INTERMEDIATES AND DYES

Business in dyestuffs has been better since the beginning of the month and further improvement is expected.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb.
Acid H.	3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1d. per lb. Improved demand.
Acid Sulphanilic	9¼d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	8d. per lb. naked at works.
Aniline Salts	8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4½d. per lb. Rather quiet.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene	9d.—10d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
Monochlorbenzol	£63 per ton.
β-Naphthol	1s. per lb. d/d.
α-Naphthylamine	1s. 4d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.

m-Nitraniline ..	.. 4s. 3d. per lb. d/d.
p-Nitraniline ..	.. 2s. 3d. per lb. d/d.
Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene	.. 10½d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 3s. 11d. per lb. d/d.
p-Phenylene Diamine	.. 10s. 2d. per lb. 100% basis d/d.
R. Salt	.. 2s. 5d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 3d. per lb. 100% basis d/d.
o-Toluidine ..	.. 10d. per lb.
p-Toluidine ..	.. 3s. 3d.—4s. 2d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £47 per ton. Firmer.
Acid, Acetyl Salicylic	.. 3s. 1d.—3s. 3d. per lb., according to quantity. Market firmer.
Acid, Benzoic B.P.	.. 3s. per lb.
Acid Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric ..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 3½d.—1s. 4½d. per lb.. less 5% for ton lots. Market very weak.
Acid, Gallic ..	.. 3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	.. 6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	.. 1s. 6d.—1s. 8d. per lb., according to quantity.
Acid, Tannic B.P.	.. 2s. 10d. per lb. Market quiet.
Acid, Tartaric ..	.. 1s. 1½d. per lb. less 5%.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
Amidopyrin ..	.. 13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone	.. 15s.—15s. 6d. per lb. Quiet market.
Benzonaphthol ..	.. 5s. 3d. per lb. Small inquiry.
Bismuth Carbonate	.. 10s. 6d.—12s. 6d. per lb.
„ Citrate ..	.. 10s. 3d.—12s. 3d. „
„ Salicylate	.. 9s.—11s. „
„ Subnitrate	.. 8s. 8d.—10s. 8d. „
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Market firm.
Ammonium ..	.. 1s. 6d.—1s. 9d. per lb. } According to quantity.
Potassium ..	.. 1s. 4d.—1s. 7d. per lb. }
Sodium ..	.. 1s. 5d.—1s. 8d. per lb. }
Calcium Lactate	.. 1s. 6d.—1s. 9d. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate ..	.. 4s.—4s. 3d. per lb. Market easier after recent firmness.
Chloroform ..	.. 2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Formaldehyde ..	.. £49 per ton.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.
Glycerophosphates—	
Iron	.. 8s. 9d. per lb.
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. „
Guaiacol Carbonate	.. 10s. 6d.—11s. 3d. per lb.
Hexamine ..	.. 3s. 1d.—3s. 3d. per lb.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	.. English make offered, 120s. per oz.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. „
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £25 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 52s. per lb. Cheaper.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials ..	.. Market very quiet.
Red oxide ..	.. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. „
White precip. ..	.. 4s. 7d.—4s. 8d. „
Calomel ..	.. 3s. 11d.—4s. „
Methyl Salicylate	.. 1s. 10d.—2s per lb.
Methyl Sulphonal	.. 26s. per lb.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 2s. 6½d. per lb. for cwt. lots. Not very active.
Paraldehyde ..	.. 1s. 6d. per lb. in free bottles and cases.
Phenacetin ..	.. 5s. 9d. per lb.
Phenazone ..	.. 7s. 2d. per lb.
Phenolphthalein ..	.. 5s. 6d.—6s. per lb.
Potass. Bitartrate— 99/100% (Cream of Tartar) ..	.. 88s. per cwt., less 2½% for ton lots.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	.. 7¼d. per lb.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Saccharin ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. 6d.—4s. per lb.
Silver Proteinate ..	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite— Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	.. 75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate ..	.. Fair demand. Powder 2s.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 5d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.

Sulphonal..	15s. per lb.	Easier.
Thymol ..	17s. 6d. per lb.	Very scarce

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine ..	15s. 3d. ,,	
Amyl Acetate	2s. 6d. ,,	
Amyl Butyrate	6s. 9d. ,,	
Amyl Salicylate	3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,	
Benzyl Alcohol free from Chlorine	2s. 9d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate..	3s. 6d. ,,	
Cinnamic Aldehyde—Natural..	18s. 9d. ,,	
Coumarin	19s. 6d. ,,	
Citronellol	17s. ,,	
Citral	8s. ,,	
Ethyl Cinnamate	12s. 6d. ,,	
Ethyl Phthalate ..	3s. 3d. ,,	
Eugenol ..	10s. ,,	
Geraniol (Palmarosa)	33s. 6d. ,,	Cheaper.
Geraniol ..	11s.—18s. 6d. per lb.	
Heliotropine	6s. 9d. ,,	
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose..	26s. ,,	
Linalyl Acetate ..	26s. ,,	
Methyl Anthranilate	9s. 6d. ,,	
Methyl Benzoate..	5s. ,,	
Musk Ambrette ..	50s. ,,	
Musk Xylol	13s. 6d. ,,	
Nerolin ..	4s. 9d. ,,	
Phenyl Ethyl Acetate	15s. ,,	
Phenyl Ethyl Alcohol	16s. ,,	
Rhodinol ..	60s. ,,	
Safrol ..	1s. 10d. ,,	
Terpineol ..	2s. 4d. ,,	
Vanillin ..	26s. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. ..	15s. 6d. per lb.	
Anise Oil	2s. 8d. per lb.	
Bergamot Oil	16s. 6d. per.	Cheaper.
Bourbon Geranium Oil ..	35s. per lb.	Cheaper.
Camphor Oil	65s. per cwt.	
Cananga Oil Java	10s. per lb.	
Cinnamon Oil, Leaf	6½d. per oz.	
Cassia Oil, 80/85%	9s. 9d. per lb.	Cheaper.
Citronella Oil—Java 85/90% ..	5s. 9d. per lb.	
Ceylon	3s. 3d. per lb.	Cheaper.
Clove Oil ..	7s. 6d. per lb.	
Eucalyptus Oil 70/75%..	2s. 3d. per lb.	
Lavender Oil—French 38/40% Esters	28s. 6d. per lb.	Dearer.
Lemon Oil	3s. per lb.	
Lemongrass Oil ..	4s. 6d. per lb.	
Orange Oil, Sweet	11s. per lb.	
Otto of Rose Oil—Bulgarian	40s. per oz.	
Anatolian	18s. per oz.	
Palma Rosa Oil	16s. 6d. per lb.	
Peppermint Oil—English	65s. per lb.	
Wayne County ..	30s. per lb.	
Japanese	18s. per lb.	Dearer.
Petitgrain Oil ..	9s. 3d. per lb.	
Sandal Wood Oil—Mysore ..	26s. 7d. per lb.	
Australian	18s. 6d. per lb.	Cheaper.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Dec. 1st; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on October 16th.

I.—Applications

Beale, Lunsden, Peddie, and Pirbright, Ltd. Filtering apparatus. 22,846. Sep. 27.

Descombes and Tivalu. Desiccation. 22,372. Sept. 22. (Belgium, 22.9.23.)

Farbenfabr. vorm. F. Bayer und Co. Apparatus for producing intimate mixture between gases and liquids. 22,361. Sep. 22. (Ger., 4.1.24.)

Marks (Sanford Riley Stoker Co.). Pulverising machine. 22,474. Sept. 23.

I.—Complete Specifications Accepted

30,026 (1923). Rafn. *See* XIX.

6256 (1924). Stockman. Crushing or reducing machines. (222,039.)

10,094 (1924). Aktiebolaget Separator. Preventing injurious reaction between a centrifugally treated liquid and air. (218,250.)

10,290 (1924). Edelstahlwerk Röchling Akt.-Ges. and Ziegler. Regenerative furnaces. (218,978.)

II.—Applications

Caspari. Low-temperature distillation of fuels. 22,564. Sep. 24. (Ger., 27.9.23.)

Dempster and Sons, Ltd., Illingworth Carbonization Co., Ltd., Illingworth, and Toogood. Apparatus for carbonisation of fuel. 22,705, 22,706. Sep. 25.

Fairbrother (Jackson Research Corporation). Extracting oil from oil-bearing sands. 22,355. Sep. 22.

Fairbrother (Jackson Research Corporation). Process of distilling shale. 22,445. Sep. 23.

Gray. 22,468. *See* III.

Hermann and Perkin. Distillation and carbonisation of carbonaceous materials. 22,470. Sep. 23.

Marks (Catlin Shale Products Co.). Distillation of carbonaceous material. 22,348. Sep. 22.

Moreschi, and Soc. Anon. Aloformia. 22,492. *See* XX.

Pink. Production of oil gas. 22,683. Sep. 25.

Soc. Anon. Le Pétrole Synthétique. Synthetic manufacture of hydrocarbons. 22,322. Sep. 22. (Fr., 19.10.23.)

Sutcliffe. Manufacture of fuel. 22,365. Sep. 22.

Synthetic Ammonia and Nitrates, Ltd., and Humphrey. Production of combustible gases. 22,595. Sep. 24.

II.—Complete Specifications Accepted

30,162 (1923). Warnant. Gas-producer. (222,003.)

1308 (1924). Coninck. Combustion of fuel. (210,419.)

4611 (1924). Mond (Metallbank und Metallurgische Ges.). Internally-heated fuel distillation shafts. (222,033.)

III.—Applications

Gray. Treatment of hydrocarbon compounds. 22,468. Sep. 23. (U.S., 26.9.23.)

Oberschlesische Kokswerke und Chem. Fabr., Damm and Russig. Purifying crude naphthalene. 22,477. Sep. 23.

Soc. Anon. Le Pétrole Synthétique. 22,322. *See* II.

III.—Complete Specification Accepted

29,313 (1923). Weil, and Chemische Fabrik in Billwarder vorm. Hell und Sthamer Akt.-Ges. Manufacturing pure anthracene and pure carbazole. (221,999.)

IV.—Application

British Dyestuffs Corporation, Ltd., Baddiley, Horsfall, Jackson, and Shepherdson. 22,484. *See* XIII.

IV.—Complete Specifications Accepted

13,246 (1923). Imray (Soc. of Chemical Industry in Basle). Manufacture of intermediate products for making azo-dyestuffs. (221,843.)

26,476 (1923). Bloxam (Akt.-Ges. für Anilin-Fabrikation). Manufacture of dyestuffs for wool of the safranine series. (221,975.)

26,703 (1923). Morton (Hoffman-La Roche und Co.). Manufacture of o-o-diacyl derivatives of diphenolisatine. (221,976.)

3711 (1924). Holliday and Co., Clayton, and Stokes. Yellow colouring-matter of the pyrazolone series. (222,031.)

V.—Applications

British Celanese, Ltd., and Ellis. Treatment of cellulose derivatives. 22,423. Sep. 23.

Clough. Machines for scouring wool etc. 22,723. Sep. 26.

Dreyfus. Manufacture of cellulose products. 22,697. Sep. 25.

Garrow. Treatment of sawdust etc. 22,857. Sep. 27.

Harrison, and Lustrafil, Ltd. Manufacture of artificial silk. 22,277. Sep. 22.

V.—Complete Specifications Accepted

22,218 (1923). Dean. Apparatus for sizing and drying artificial silk and the like. (221,944.)

31,715 (1923). Bergmann, Immerdorfer, and Loewe. *See* VI.

3501 (1924). Soc. de Brevets Textiles. Improvement of vegetable fibres. (211,467.)

VI.—Applications

British Dyestuffs Corporation, Ltd., Blackshaw, and Lawrie. Mordanting, dyeing, etc. cellulose-acetate materials. 22,485. Sep. 23.

Byrom, Lithgow, and Downham and Co. Hank-dyeing machines. 22,378. Sep. 23.

Geigy Akt.-Ges. Preparation of printing pastes. 22,339. Sep. 22. (Ger., 22.10.23.)

Holtmann und Co., Ges. Calico etc. roller printing and inks therefor. 22,572. Sep. 24. (Ger., 14.12.23.)

VI.—Complete Specifications Accepted

29,797 (1923). Silver Springs Bleaching and Dyeing Co., Ltd., and Hall. Dyeing cellulose acetate products. (222,001.)

31,715 (1923). Bergmann, Immerdorfer, and Loewe. Treatment of animal fibres. (208,563.)

VII.—Applications

Govers. Preparing siliceous material. 22,699. Sep. 25.

Hooper. Production of cyanides, cyanamides, ammonia, etc. 22,407. Sep. 23.

Moreschi, and Soc. Anon Aloformia. Manufacture of iodine and bromine from natural waters etc. 22,493. Sep. 23.

Soc. Chimique de la Grande Paroisse, Azote et Produits Chimiques. Production of mixed ammonium and potassium salts. 22,575. Sep. 24. (Fr., 8.11.23.)

Synthetic Ammonia and Nitrates, Ltd. Method of producing nitrogen-hydrogen mixture for synthetic production of ammonia. 22,268. Sep. 22. (U.S., 21.9.23.)

Synthetic Ammonia and Nitrate, Ltd., and Humphrey. Ammonia synthesis. 22,594. Sep. 24.

VII.—Complete Specifications Accepted

23,570 (1923). Casale. Apparatus for the catalytic production of synthetic ammonia. (221,956.)

25,698 (1923). Texas Gulf Sulphur Co. Burning of sulphur. (211,831.)

VIII.—Applications

Automatic Bottle Machine Corp. and McNish. Glass furnaces. 22,679. Sep. 25.

Salerni. Abrading materials. 22,425. Sep. 23.

VIII.—Complete Specification Accepted

15,328 (1923). Kallen. Refractory mass. (221,852.)

IX.—Applications

Soc. Lap. Obtaining polished surfaces in cement. 22,790. Sep. 26. (Fr., 29.9.23.)

Soc. Lap. Process for coating metals upon cement surfaces. 22,791. Sep. 26. (Fr., 29.9.23.)

Spackman. Manufacture of cementitious materials. 22,329. Sep. 22. (U.S., 22.9.23.)

IX.—Complete Specifications Accepted

15,333 (1923). Marks (Wiggin's Sons Co.). Controlling the setting of plaster. (221,853.)

15,684 (1923). Clegg and Whittaker. Manufacture of artificial stone or marble.

X.—Applications

Coles. Electrodeposition of metals. 22,405. Sep. 23.

Deutsche Gasglühlicht-Auerges. Manufacture of pure zirconium. 22,590. Sep. 24. (Ger., 25.9.23.)

Marks (Du Pont de Nemours and Co.). Alloys. 22,579. Sep. 24.

Martin, and Sankey and Sons. Stainless iron and steel. 22,514. Sep. 24.

Poole. Flux for soldering aluminium etc. 22,499. Sep. 24.

Salerni. Hardening steel. 22,424. Sep. 23.

X.—Complete Specifications Accepted

15,238 (1923). Marks (Cobb Electro Reduction Corp.). Reduction of ores. (221,848.)

16,539 (1923). Allmänna Ingeniorsbyran H. G. Torulf. Sintering ores. (200,090.)

19,483 (1923). General Electric Co., Ltd. Manufacture of hard alloys. (213,214.)

XI.—Applications

Coles. 22,405. *See* X.

Elektrizitäts Akt.-Ges. vorm. Schuckert und Co. Electrolytic cells. 22,455. Sep. 23. (Ger., 3.10.23.)

Genese and Peto. Electric batteries. 22,753. Sep. 26.

XI.—Complete Specifications Accepted

31,392 (1923). Kalling. Electric furnace. (222,008.)

3551 (1924). Dragonetti. Selenium cells without inertia. (211,161.)

7233 (1924). Western Electric Co., Ltd. (Western Electric Co., Inc.). Soldering. (222,044.)

XII.—Applications

British Oil Products Co., Ltd., Fulton, and Hutton. Treatment of oils for medicinal purposes. 22,513. Sep. 24.

Riedel Akt.-Ges. Process for splitting fats, oils, and waxes. 22,680. Sep. 25. (Ger., 14.11.23.)

XII.—Complete Specification Accepted

5994 (1923). Silica Gel Corporation. Treating oils, waxes, and the like. (195,055.)

XIII.—Applications

British Dyestuffs Corporation, Ltd., Baddiley, Horsfall, Jackson, and Shepherdson. Manufacture of colour lakes. 22,484. Sep. 23.

British Oil Products Co., Ltd., Fulton, and Hutton. Treatment of paints etc. 22,512. Sep. 24.

Heyl. Mineral pigments. 22,747. Sep. 26.

White (Goodrich Co.). Heat-plastic materials. 22,568. Sep. 24.

XIV.—Complete Specifications Accepted

18,439 (1923). Naugatuck Chemical Co. Halogenating the dry latices of india rubber etc., and compositions and articles made therefrom. (201,898.)

27,784 (1923). Duke. Vulcanising rubber. (221,992.)

931 (1924). Wild. Utilization of vulcanised rubber waste. (222,016.)

XV.—Application

Farb. vorm. Meister, Lucius, und Brüning, Kränzlein, and Voss. Manufacture of tanning substances. 22,465. Sep. 23.

XVII.—Application

Corn Products Refining Co. Method of making starch-converted dextrose. 22,350. Sep. 22. (U.S., 11.4.24.)

XVIII.—Complete Specifications Accepted

15,797 (1923). Boidin and Effront. Manufacture of diastases by means of oxidising ferments. (221,860.)

XIX.—Applications

Blunk, Fries, and Imhoff. Sewage purification plants. 22,417. Sep. 23. (Ger., 7.5.24.)

Everaert and Lescarde. Preservation of eggs etc. 22,626. Sep. 25. (Belgium, 25.9.23.)

Imhoff. Sewage purification. 22,416. Sep. 23. (Ger., 15.7.23.)

Stead. Preservation of milk powders. 22,671. Sep. 25.

XIX.—Complete Specifications Accepted

26,460 (1923). Industrie en Handel Maatschappij "Hag." Preparing caffein-free coffee beans. (206,145.)

30,026 (1923). Rafn. Treatment of liquids by heat for sterilisation and other purposes. (208,140.)

XX.—Applications

British Oil Products Co., Ltd., Fulton, and Hutton. 22,513. See XII.

Hefti and Schilt. Manufacture of esters. 22,380. Sep. 23.

Johnson (Badische Anilin und Soda Fabrik). Manufacture of organic compounds. 22,557. Sep. 24.

Moreschi, and Soc. Anon. Aloformia. Manufacture of halogen derivatives of natural gases etc. 22,492. Sep. 23.

XX.—Complete Specification Accepted

14,046 (1924). Chemische Fabrik vorm. Sandoz. Manufacture of the cardiac glucoside of bulbus scillæ. (217,247.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*Australia*: Artificial and pure silk (352); Copper plates (A.X./1338); *Canada*: Steel (A.X./1343); *Czechoslovakia*: Pig iron (361); *France*: Oils, fats for soap-making (364); *France and Near East*: Leather (365); *India*: *Burma and Ceylon*: Cast iron (357); *Netherlands*: Indiarubber ware, glass bottles (369); Silk (371); *United States*: Leather (381); leather (B.X./1259).

Notes on Plant and Products

Atmospheric Pollution is now engaging much attention in consequence of the work of the Advisory Committee on Smoke Pollution. The evil effects of smoke are obvious, but in gauging them some means of measuring the amount of pollution is required. Such a means has been provided by two instruments designed by Dr. J. S. Owens and described in a pamphlet issued by the makers, C. F. Casella and Co., Ltd., 49-50, Parliament Street, London, S.W. 1. The first is an automatic instrument for measuring suspended impurity which, in outline, consists of a device which filters two litres of air at regular intervals through filter paper, thus forming a record from which density can be read by comparison with a calibrated scale of standard tints. The second instrument is designed to obtain a deposit from dusty air on a cover glass, on which the dust particles can be counted by means of an eye piece micrometer. The pamphlet gives a description of the instruments and full directions for use. Messrs. Casella also publish catalogues and pamphlets relating to instruments for surveying, engineering, and meteorology, pressure and vacuum gauges and recorders, thermometers, counters, temperature and humidity recorders and other scientific instruments.

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during September has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:—

The total number of applications received during the month was 449, of which 361 were from merchants or importers. To these should be added 12 cases outstanding on September 1, making a total for the month of 461. These were dealt with as follows:—Granted—326 (of which 289 were dealt with within seven days of receipt). Referred to British makers of similar products—79 (of which 65 were dealt with within seven days of receipt). Referred to Reparation Supplies available—31 (all dealt with within two days of receipt). Outstanding on September 30, 1924, 25.

Of the total of 461 applications received, 385 or 84 per cent. were dealt with within seven days of receipt.

Foreign Company News

The Cie. des Mines d'Anzin and the Etablissements Kuhlmann have founded a company with a capital of 10,000,000 francs for the manufacture of nitrogen products and chemical products in general.

The Société des Ciments du Calaisis is building a large cement factory at Sangatte. The factory will include two rotary ovens giving a total annual production of 80,000 to 100,000 metric t.

The Cie. de Bethune has started work at its new synthetic nitrogen factory at which the by-products of coal are utilised.

The Société Soie Artificielle de Tubize, the British Celanese Co., and several silk manufacturers in Lyons are founding a company with a capital of 65,000,000 francs to work an artificial silk factory at Vénissieux (Rhône). It is intended to begin work at the end of 1925 and to produce 500 kg. of cellulose-acetate silk per day.

PUBLICATIONS RECEIVED

Special Reports on the Mineral Resources of Great Britain. Vol. XXVIII. Refractory Materials, Fireclays, Analyses and Physical Tests. By F. R. Ennos, B.A., B.Sc., and A. Scott, M.A., D.Sc. Memoirs of the Geological Survey. Pp. ii+84. H.M. Stationery Office, 1924. Price 3s.

Isotopes. By F. W. Aston. Second edition. Pp. xi+182. London: E. Arnold and Co., 1924. Price 10s. 6d.

Fourth Annual Report of the Scientific and Industrial Research Council of Alberta, 1923. Printed by order of the Legislative Assembly. No. 10. Pp. 76. Edmonton: J. W. Jeffery, 1924.

Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year 1923—1924. Cmd. 2223. Pp. iv+139. London: H.M. Stationery Office, 1924. Price 3s.

Report of the Government Chemist upon the Work of the Government Laboratory for the Year ending March 31, 1924. With Appendices. Pp. 36. H.M. Stationery Office, 1924. Price 1s. 6d.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

VOL. 43 NEW SERIES — LONDON, OCTOBER 17, 1924 — NO. 42

EDITORIAL

HE is not dead, says Ptolemy in the prologue to his Almagest, who has given life to science. What do we mean by giving life to such a science as chemistry? And how is the process to be effected? The life of chemistry may be measured amongst other ways by its effect on the community. The theory of numbers, we feel sure, deserves to be a science, but it is difficult to imagine that Wilson's propositions on prime numbers will ever create new industries or be of any practical use. Not that we are prejudiced against Wilson; he was a north countryman and a fisherman and had other good qualities. Judged by its effect on the community chemistry must be not only alive, but in the prime of life. Mr. Woolcock has recently expounded this to us in unmistakable terms and now tells us the subtle arts by means of which the least unsophisticated of chemists achieve their publicity. The life of a science may also be judged by the rapidity of its progress; here again chemistry comes out well from the trial; see in "Chemistry in the XXth Century" how rapidly it is now developing. The future developments are not within our imaginations, but will certainly be prodigious. Future generations will continue the struggle of the highest point of man's wit with the efficacy of Nature. We have witnessed artificial silk; some day when wood is expensive the raw material for this industry will be artificial cellulose or synthetic formose. We imagine, however, that one of the most striking symptoms of a robust vitality is the interest taken in the science by the great mass of mankind. The exhibition at Wembley has rendered most valuable service in this respect to many of the sciences. Chemistry, mechanics, electricity and other branches of science have made an irresistible appeal to millions of visitors. The chemical and engineering exhibits have been thronged by people of all ages. Even so learned an exhibit as that of the Royal Society has been visited by numbers beyond the limit of our vision. Those who have been to Wembley half a dozen times are very grateful to it; those who have not been there at all have missed an impressive sight, an epitome of the British Empire, infinite riches in a little room, the latest achievements of human ingenuity and a triumph of British organisation. We trust that next year we may again pass through the Alchemists' Gate, drink tea in Hong Kong, admire the carving of Burma, the natural products of Canada and Australia, watch the biscuits made for temporarily assuaging the hunger of a younger generation and study the value of gravity by that powerful Attwood's machine, the scenic railway.

* * *

The historical side of science is urged, as worthy of study, by such eminent men as Sir William McCormick and Sir Frank Heath. It has long been a favourite hobby of the amateur, who lacks a profound knowledge of the subject. Turning for a moment to marine biology, it seems that the Romans, though familiar with the oyster and the murex, were unacquainted with the mermaid. A well-known Latin writer commences his oration with the following surprising remarks: If a painter chose to depict a figure the upper part of which was a beautiful woman but the lower part was a fish's tail, when you were admitted to view his picture, could you refrain from laughing? Such pictures are now common and excite no emotion. A friend of ours who takes an absorbing interest in politics tells us that this image explains the whole political situation and the cause of the present general election. The Labour Party, he argues, does not quite deserve the description of beautiful, the upper part is, indeed, fair but not beautiful, something like the late Mr. Justice Cozens Hardy. According to his view, just as many a cricket eleven, so, too, the Labour picture is disfigured by an ugly

tail, composed as most tails are of extremists. A tail is in fact an extremity, the personification of the limit. Now tails sometimes include stings and sometimes rattles; whether Mr. Ramsay MacDonald sought an election to avoid the stings and arrows of his outrageous followers or whether he was rattled, our friend is not certain. In his opinion the late Government has handled several of the most important questions very well; in finance and in foreign politics he considers them to have been skilful and reasonable. The picture, otherwise so pleasing, is spoilt by the hideous tail; the Prime Minister has been cajoled or forced into a situation which is considered fishy. The Primo Minister was led into wrong by a vision of right; the Attorney-General laboured at his brief, but his explanation was obscure. *Decipimur specie recti: brevis esse laboro, obscurus fio.* Now, whether the Premier seeks a general election to avoid the attacks of the Conservatives or the Liberals or his own extreme followers—or, as our friend calls them, prodders—is not clear. Prof. Gowland Hopkins showed last year at Cambridge that many organic compounds are conveniently broken up by the simultaneous action of two reagents, the one greedy for oxygen and the other greedy for hydrogen. A similar process has recently affected the Labour Party. Mr. Ramsay MacDonald attacked by those who think he has gone too far and by those who think he has not gone far enough, hopes by an election to shake off some of the enemies of the mermaid and at the same time to acquire a less dangerous and noisy tail as a support to that sweet reasonableness which is apparent now that he is, like so many Mermaids, on the rocks. To avoid any misunderstanding we may state that the friend we have been quoting is neither Sir Alfred Mond, nor Sir John Brunner, nor Mr. Miller-Jones.

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The firm of Messrs. Longmans, Green and Co. is well known to chemists. Has it not published "Mellor" and "Thorpe," and some other familiar books? It is perhaps not so widely known that it has been publishing books for a couple of hundred years, and that it owns the publishing business of Messrs. Rivington, established in the year 1711. A pleasant and chatty account of the House of Longman, written by Mr. Harold Cox, appears in the *Edinburgh Review* this month, and gives a number of such pieces of information. We were tempted after reading it to glance at our own meagre store of books, and notice how many of our old favourites were published by them. Of Messrs. Longman's earlier publications we found few, but they furnished us with "Scott's Minstrelsy," published in 1812, and "Cowper's Poems," published in 1817. "Kirby and Spence's Entomology" of the year 1837 we used to read with delight, and some volumes of the "Cabinet Cyclopædia," edited by the Rev. Dionysius Lardner in the year 1831, and still worth reading. Our edition of "White's Selborne" is the offspring of Longmans in 1837, and a well-printed book too. Coming to more modern times, we found a favourite bed-side book, "Macaulay's History," and some old school books with which we struggled in former years: "Kennedy's Latin Grammar" and "Williamson's Differential." Longmans have published books of every sort—literature, classics, mathematics and science. It is no little achievement to have published for two hundred years, during the reigns of eight British Sovereigns. The firm was well established in the '45 and a sturdy veteran when oxygen was discovered in 1774—in fact, celebrating its fiftieth anniversary. We can imagine the then proprietors having an extra bottle of madeira in some mansion in Savage Gardens or other fashionable resort of the period. Let us wish them a further spell of another two hundred years; may they continue to publish as good books as those we have mentioned and to be successful and happy! *Chemistry and Industry* has often had occasion to turn to Mellor and to Thorpe, and we fancy that some of the articles we have published by the Rev. Basil Valentine White would have taken different shapes had not "White's Selborne" been handy to assist him in their compilation. It is a matter of regret to find that Basil Valentine himself is considered to be almost a legendary person.

* * *

Dr. Levinstein has given us a history of the dyestuff industry in its early days, which contains information new to most of us, and presents to some extent a line of argument different from the usual ones. He has sources of information, including his own retentive memory, which make his account unusually interesting and give it the authority which belongs only to those who write at first hand. Thanks to him and to Prof. G. T. Morgan, we know the most essential facts in the early history of the coal-tar colours and the present state of their manufacture in this country. As to the future of the industry in this country, in America, in France and in Switzerland, only a political candidate could speak with any assurance, and the history of countries which enjoy the system of elections shows a number of instances of electoral prognostications which have turned out to be exaggerated. In the case of the British Dyestuffs Corporation, Mr. Sidney Webb a few days ago announced that the Government would veto the proposed agreement with the Interessen-Gemeinschaft. Will some new agreement or some new policy take its place? The chief difficulty in recommending any policy is the ignorance most of us possess of the details of the business of the Dyestuffs Corporation. There is no good reason why these business details should be disclosed to the public, and yet indirectly the public is a good deal concerned. In many such difficulties, the writing down, in accurate terms, of the essential facts is a method of indicating the only possible policy. Probably a careful judicial survey of the whole position, looking at the dyestuff problem from the national point of view, would be of great value. The directors of the Dyestuffs Corporation are bound to consider the problem mainly, even almost exclusively, from the point of view of their own shareholders. Hardly anyone else has now the detailed information necessary for an impartial survey of the situation.

THE BRITISH EMPIRE EXHIBITION

The British Empire Exhibition at Wembley is a veritable microcosm; it includes countries from every continent ranging from the tropical to the polar. It comprises amusements, art, music, engineering, coal mining and every other industry, and it has a scientific side which is almost equally varied. In several of our previous issues we have described in considerable detail the exhibits of chemistry and chemical engineering; we have not had an opportunity of mentioning all of those that deserved mention, but in this article we hope to rectify the more important of these omissions. We have also not done justice to that wonderful exhibition of Pure Science arranged by the Royal Society. The Royal Society excluded chemistry from its arrangement so as to avoid clashing with the exhibits in the Palace of Industry, and it generously helped in that province which forms the "debatable land" between chemistry and physics. Its own exhibit, in the British Government Pavilion, contains important and interesting exhibits dealing with geophysics, zoology, botany and physiology, but the greater part is taken up by a most valuable physical exhibit. The structure and nature of matter, electricity and the atom obviously are of supreme interest. The handbook prepared by the Royal Society is very helpful; it is readable and good. It would be twice as good if it were twice as long: perhaps even its excellence would have varied with the square of its length. There is not a chapter in it which does not make the reader wish for more. Sir Joseph Thomson, Sir William Bragg, Sir Ernest Rutherford and Dr. Aston have written the portion which deals with atomic physics; it is fortunate for the public that they each have a gift for popular exposition. They have themselves done original work of the highest quality and considerable quantity, and the apparatus and devices shown are of historical importance. These include the apparatus by which the existence of electrons was detected and their mass and velocity measured, the earliest photographs of positive ray spectra, Fleming's original rectifying valves, Aston's mass spectograph, Wilson's photographs of ionising particles, Joly's photographs of the haloes caused by radioactive minerals, early incandescent lamps of the period 1880—1882, Crookes' tubes, Bragg's ionisation spectrometer, diffraction gratings and extremely delicate apparatus for refinements in measurement, ultra-micrometers, crystals of metals and sections illustrating the structure of metals and alloys. There are besides these very many other pieces of apparatus illustrating the phenomena of heat, electricity, light, explosions and many astronomical exhibits of singular interest.

The exhibits and the handbook also deal with such interesting topics as relativity, the structure of stars, spectra, the rare gases, the atmosphere, its water vapour, the phenomena of rain and thunderstorms, the origin of man, the circulation of the blood, muscular work and mimicry. There is an excellent chapter on weather forecasting by Colonel Gold, with special mention of cyclones. Prof. Woodward describes the skulls of the earliest men, and shows casts of the Piltdown skull and that recently found at the Rhodesian Broken Hill mine. The Natural History Museum shows diagrams illustrating Mr. Carruthers' work on the evolution of the carboniferous corals. One must have more time; there is so much to learn, so much to see, so many people to talk to, so much to read, and alas, so much to write.

PALACE OF INDUSTRY

The Chemical Section

History relates that when the famous French author Stendhal wished to write a sentimental novel, he used to re-read a few dozen pages of the Penal Code, "to acquire the atmosphere," as he said. To write about the British Empire Exhibition, the Official Catalogue provides an unfailing stimulus. Repeated visits have brought, not weariness, but the conviction that at least another year is wanted before the average human brain can grasp the details of the unrivalled pageant of industry and Empire that is set out at Wembley. The effect of the Exhibition cannot yet be measured, but the interest taken by the public in the Chemical Section, as well as in the scientific exhibit which shows so strikingly the vigour and resource of British chemistry, suggests that even those who still try to solve the question, "When is a chemist not a chemist?" will realise what is the true answer. The Exhibition is so packed with food for thought that it is perhaps as well that exigencies

of time and space strictly limit the length of this account, otherwise one might go on for ever. Mention cannot be made of all the thousands of exhibitors and the myriads of exhibits, and to avoid any question of precedence the different firms will be dealt with in alpbabetical order.

The stand of Baird and Tatlock (London), Ltd. is so arranged that the first thing to catch the eye is a fascinating little model of a laboratory bench, and when this has been inspected there are enough interesting things to tempt a lengthy stay. One visitor, after inspecting the latest types of balances and hydrogen-ion concentration apparatus went away richer by a number of handsome publications, which the publishers modestly call "circulars." There was one of Electric Furnaces and Pyrometers, others on Apparatus for the Determination of Hydrogen-ion Concentration, Electrometric Titration Apparatus, the "Hurrell" Homogeniser (a new high-speed film mill), and a tempting list of pure chemicals, reagents and stains. One can only advise those interested to obtain these circulars.

A stand which is an excellent illustration of the wide meaning that must be attached to the words "chemical industry" is that of F. W. Berk & Co., Ltd., a firm which has manufactured and merchanted chemicals since the Franco-Prussian war. Acids, which are the firm's pride, are to be seen—accumulator, sulphuric, dipping, hydrofluoric, hydrochloric acids, as well as organic acids. The protection of ships against corrosion and fouling requires the use of large quantities of chemicals annually, and of these products suboxide of copper, sulphocyanide of copper, and the red and yellow oxides of mercury are on show. Messrs. Berk also exhibit tin oxide, hydrogen peroxide in liquid form as well as in solid form for export, alkaloids, mercury salts and a wide range of crude drugs. The visitor will also see the products which the firm imports, particularly sulphur, mercury, potassium salts, earths, ochres and many other materials, and will note the care with which packing is carried out, an important consideration for consumers at home or abroad.

British Drug Houses, Ltd., provide at their stand an elegant brochure which gives an interesting account of some of the firm's chief products, such as various aids to beauty. Readers of this *Journal* will think rather of the "B.D.H." fine chemicals, of their invaluable series of standardised solutions and reagents for analysis, of their indicators for use in the determination of hydrogen-ion concentration and last, but not least, of the B.D.H. insulin. In an exhibition, it is difficult to show everything the firm makes, so it must be remembered that the B.D.H. list of chemicals for research and analysis already includes the names of over 3000 substances, and is continually being added to. A feature of the list is that, although it refers mainly to chemicals of definite purity, the prices are also given of commercial qualities, so that a convenient source is available of [illegible] quantities of commercial grades that can be bou[illegible] bulk, but not easily by the pound.

The aim [illegible] British Dyestuffs Corporation has been to [illegible] the public. There is no overwhelming displa[illegible]ffs in bottles to dismay the onlooker, but the sheen of silks, the glow of many coloured textiles to arouse his interest. And while he is looking at the exhibit showing the Indian process of knot dyeing, his eye will be caught by a model of a two-bay shed illustrating the manufacture of a simple dyestuff in all stages from the coal-tar to the grinding and weighing machine. All the products yielded by the process in actual practice are to be seen in bottles placed in a separate stand. Those "experienced in the art" will be able to obtain at the stand a booklet on the dyeing of artificial silk which describes the various kinds of artificial silk and their dyeing properties. The Cellutyl colours have been specially manufactured for the purpose of dyeing "Celanese," a cellulose acetate silk, and brilliant examples of the results they give are to be seen in cases. The thoughtful visitor will do well to ask for the Corporation's brochure on "The British Dyestuffs Industry, 1856-1924," and in it he will find an excellent account of the vicissitudes of the industry, and will gather something of the magnitude of this undertaking, born out of the stress of war.

The stand of Brunner, Mond and Co., Ltd., and their associated companies is one of the most interesting in the Chemical Section, as it is also the largest. The Brunner Mond specialities—soda ash, caustic soda, sodium bicarbonate, soda crystals, "Crescent laundry soda," "Crex," calcium chloride, ammonium chloride, ammonium carbonate, and sulphate are too well known to need comment. Perhaps the most significant item in the display is silicate of soda, a subject to which Messrs. Brunner Mond have devoted extensive research work for a number of years past. One of its most valuable applications is for the hardening of concrete, and Messrs. Brunner Mond now supply a special grade, known as P. 84, for this purpose, which contains 3·3 molecules of silica (SiO_2) to 1·0 molecule of soda (Na_2O). The result of treatment is that all the pores are completely filled to a depth of ¼ in.—½ in. with a silicious mortar or binding material, giving an intensely hard outer layer, a feature of the stand being the motor-driven abrasion machine demonstrating the great increase in hardness of concrete treated in this way. Silicate of soda in many different grades is also used in making acid-proof cements, as a size for paper, for making soaps, and as an adhesive, and further important developments may be expected.

The Castner-Kellner Alkali Co., Ltd., Runcorn, exhibit at the same stand a large range of electrolytic sodium and chlorine products, including caustic soda, bleaching powder, liquid chlorine and sodium peroxide. The Electro Bleach and By-Products, Ltd., Middlewich, are showing bleaching powder, caustic soda, soda crystals and ammonium carbonate. A wide range of heavy chemicals is shown by Chance and Hunt, Ltd., Oldbury, including sulphuric, nitric and hydrochloric acids, sodium sulphide, saltcake, pure table salt, caustic soda, ammonium carbonate and oxide of iron pigments. The Buxton Lime Firms Co., Ltd., Buxton, show lime in practically all forms, including a very pure form of hydrated lime containing almost 100 per cent. $Ca(OH)_2$. The Synthetic Ammonia and Ni-

trates, Ltd., Billingham, have a very interesting exhibit of ammonia and sulphate of ammonia which is made from the nitrogen of the air by a modification of the Haber process.

Essential oils are the speciality of W. J. Bush and Co., and on their stand there they are in quantity. All the perfumes of the Spice Islands seem to have been ravished for our delectation, and the pleasant habit of allowing names of localities to appear on the stand is a further delight, for who can resist products from Mitcham, Messina or Grasse? But there are also harmless dyes for colouring food, flavouring and fruit essences, fixed oils, fats and waxes, synthetic vanillin of perfect purity, many chemicals ranging from benzoic and salicylic acids to isinglass, gelatin and menthol. There are ammonium chloride and anhydrous aluminium chloride, chloroform and cream of tartar, potassium bromide and sodium bicarbonate. There is ample choice and everything of guaranteed purity.

Burt, Boulton and Haywood, Ltd., have a joint exhibit with the Midland Tar Distillers, Ltd., the Southwestern Tar Distilleries, Ltd., and Synthite, Ltd. Pride of place is, of course, given to coal tar and its products such as refined tar, Tarphalte and Tarvia "B" for road work, pitch for briquetting and varnish, lamp carbons, greases, naphtha, anthracene oil, naphthalene, creosote, phenol, cresol, toluol, benzol, ammonia in various forms, syntan, "Superac Z" (a rubber accelerator), and even lawn sand. There are models of continuous tar-distilling plant, for the use of which Messrs. Burt, Boulton and Haywood are prepared to grant licences, as well as a complete model of a creosoting plant. Of much interest are the specimens of Synthite, either as an amber-coloured substance for use in making electrical varnish, as a plastic material, or, in its final form, as a hard solid in many beautiful colours used as an ornament or an insulator. Synthite, Ltd., are the largest makers of formaldehyde in the British Isles and consequently make a feature of their 40 per cent. vol. material.

The Clayton Aniline Company, Ltd., has arranged its stand so as to provide a survey of the manufactures of the firm, samples and exhibits being shown to illustrate the stages of the working up of raw materials into finished products and the industrial applications of the dyestuffs thus obtained. Textiles, leather, painting and printing are a few of the industries that use the company's dyes. Prominence is given to the Clayton Aniline Company's well-known Magenta, shown in the form of powder and crystals.

The soap made by Joseph Crosfield and Sons, Ltd., could provide the writer with many a text, but when the audience is a chemical one, caustic soda, glycerin and silicate of soda constitute ample themes. The difficulty with silicate of soda is rather to suggest uses for which it is not fitted. A material that can be used for cementing high-speed abrasive wheels or dust-proofing concrete, for sizing paper or making ink is not an ordinary product. There it is, as glass or solution, and there is carbosil, doucil (the new base-exchanging and vapour-absorbing material), and even cement. This is merely a glimpse into the wide field of the heavy-chemical industry, as illustrated by Messrs. Crosfield and Sons.

One of the earliest manufacturers of Magenta was Dan Dawson Brothers, a firm founded in 1858, which also made Soluble Blue, Chrysoidine and Bismarck Brown. To-day the works of the Colne Vale Dye and Chemical Co., Ltd., stand on the same site at Milnsbridge, near Huddersfield, as the original factory of Dan Dawson Brothers. At the company's stand one can see the same colours as those made by its predecessors, and many others besides to show the immense strides that have been made since those early days. There are dyestuffs for textiles, paper, jute, leather, wool, ink, paint and varnish, whether blues for inks, nigrosine for boot polish, or Bismarck brown for leather or furniture. The firm watches carefully over the quality of its products, and maintains a research staff to investigate its manufactures and discover new ones.

A chemical engineering firm such as W. J. Fraser and Co., Ltd., of Dagenham, is rather at a disadvantage in an exhibition, as there is not space for the installation of large plants. Messrs. Fraser and Co., however, have instructive models showing the working of various types of chemical apparatus and photographs are shown in number, so that the visitor can appreciate the chief features. Autoclaves, stills, condensers, dephlegmators, heaters, coolers, driers, stirring gear, pans, tanks, pumps, conveyors are a few of the types of apparatus made at Dagenham, and one cannot conclude without mentioning the Mills-Packard sulphuric-acid plant, of which Messrs. Fraser are the British agents.

The Gas Light and Coke Company, Ltd., continues to grow in size, and fearsome statistics are to be had showing the miles of piping needed to supply its myriad customers with millions of cubic feet of gas. This, the chief side of its activities, is only hinted at in the Chemical Section, but the exhibit has driven home to the visitor the importance of the gas industry, not only as a source of heat, light and power, but as a source of indispensable chemicals. Thus the stand contains specimens of tar, pitch and naphthalene in various forms, carbolic acid and its numerous derivatives are there in array, there are ammonia, toluol, solvent naphtha and the prussiates of potash and soda, as well as beta-naphthol and salicylic acid. Of interest are the various shades of Prussian and bronze blues both in paste, lump and powder form, all guaranteed to be pure colour.

Self-contained manufacture is the keynote of the stand of the Bradford firm of Hickson and Partners, Ltd., who state that the only raw materials they purchase from outside sources are sodium nitrate, crude benzol, and sulphur either elemental or as pyrites. A case shows how the various products are obtained, starting from crude benzol. Messrs. Hickson usually sell their intermediates to other dyemaking firms, which carry out the production of the finished dyestuffs. Aniline is a speciality, but a few finished dyestuffs are produced, two important ones being magenta (sold under its original British name of "Roseine") and sulphur black. The firm owns the British Patent rights of Vidal's sulphur blacks, of which a series is now marketed.

Messrs. Hickson take a just pride in the perfection of their plant, so that products of consistent purity can be obtained, and much importance is rightly attached to their research department, which is devoted exclusively to the development of new products.

The lover of fine chemicals will find much of interest at the stand of Howard and Sons, Ltd., whose products also include those of their branch house, Hopkin and Williams, Ltd. All the chief pharmaceutical chemicals are on show, some of the specialities being benzoic acid and benzoates, salicylic acid and salicylates, anæsthetic ether, isopropyl alcohol for making perfumes, the caseful "bismuth carb. P.B.," and many other bismuth salts, calomel, hydrogen peroxide in 10 vol. and 20 vol. strength, the well-known Howard's magnesium sulphate, sodium bicarbonate and sodium sulphate, synthetic menthol, and various volumetric solutions. Perhaps the most interesting exhibit is the fine range of quinine salts and synthetic quinine derivatives, the latter furnishing some valuable anæsthetics. Hopkin and Williams, Ltd., are, of course, known as the makers of standard analytical reagents, in the production of which this firm was the pioneer in the Empire, and on their stand will be found many other fine chemicals, amongst which are a series of thorium salts used in making gas mantles, uranium and cerium compounds for ceramic products, and cerium salts used in tanning and dyeing.

The exhibit of Johnson, Matthey and Co., Ltd., can be classified in sections. One section illustrates the rare and precious metals in which the firm has so long specialised, gold, silver, platinum and related metals being shown in natural or crude form and in the finished state after refining. The early development of platinum as a commercial metal is largely the history of the firm, and it is interesting to note that the standard metre kept in Paris is also made by them. Another section includes preparations of gold for use in electroplating, photography, and in ceramics, the indispensable nitrate and cyanide of silver, metallic oxides used to impart colour to enamelled ware, lustres for ceramic wares, underglaze colours, glaze and body stains, and colours for use on glass. Antimony, bismuth and mercury and various of their salts are to be seen, and completed articles made from metals supplied by Messrs. Johnson, Matthey, round off a fascinating display.

It would be a confession of ignorance not to be able to say what products are to be found on the stand of the Mond Nickel Company. Everyone knows the Mond nickel and the Mond sulphate of copper, so a visit can be paid to the firm's second stand in the Palace of Engineering, where Henry Wiggin and Co. are ready to educate the prospective client in the uses of the alloys of nickel [illegible] copper and zinc (nickel-silver), with copp[illegible]d with chromium. There are the Ferry [illegible]onstantan alloys used in electrical resista[illegible] Brightray and Redray alloys with their [illegible] to high temperatures, and Corronil, an [illegible] remarkable resistance to heat and cor[illegible]dmirable little booklets are to be obtained from Messrs. Wiggin which set out the history of the different alloys and give tables of mechanical and chemical properties. Cobalt both as metal and as compound is the subject of another booklet and there are also interesting exhibits.

Chemical manufacturers will be attracted by the display of ebonite goods on the stand of David Moseley and Sons, Ltd., a firm which has been making these goods for a long time, some of them still being in use after 25 years' service. There are pipes, bends, taps, pumps, sparge boxes and specialities for all trades, in addition to hose and all sorts of mechanical goods. Tyres are predominant on this stand, but the illustrations of the work that can be done with ebonite should not be missed.

The exhibit of Murgatroyd's Salt Works, Ltd., shows that salt can be as much a fine chemical as it is, ordinarily, a heavy chemical. This firm specialises in the production of two qualities of salt, one of medicinal quality which conforms to the requirements of the British Pharmacopœia, and the other of analytical quality, guaranteed analytically pure. Salt for all the ordinary purposes is also supplied by the firm in any amount or quality.

Newton, Chambers and Co., Ltd., as would be expected, concentrate on the exhibition of the many applications of "Izal," but they have other claims on the interest of the chemist, despite the claims of the many informative exhibits on their stand. They supply cast iron and steel work for chemical factories and by-products plants, they own collieries, distil coal and make a variety of chemicals.

The whole stand of the Nobel Industries, Ltd., is so interesting that there is some danger of neglecting the exhibit of Necol Industrial Collodions, Ltd., which is owned by the former company. Collodion is used in modern industry for a great variety of purposes, and the Necol collodions are supplied in colours and possessing qualities to suit the user's requirements. Other products of this firm are collodion cottons and pyroxylin for all technical and industrial purposes. The industrial applications of the firm's products to leather and other materials are well illustrated.

One cannot but call attention once more to the charming rubber "garden" on the stand of the North British Rubber Co., Ltd., with its loggia, its rubber fountain with rubber water-lilies and goldfish. The crazy paving illustrates one of the forms of the Paraflor rubber carpeting which has been supplied by this firm to so many exhibitors at Wembley, over 30,000 sq. yards having been laid. Such a convenient floor covering will find many uses, whether in the home or in industry, and the rubber "garden" will linger in the memory as a pleasant reminder of the company and their products.

Anthraquinone dyes for silk and cotton and acid alizarine dyes for wool are the specialities of Scottish Dyes, Ltd., who apply the name Caledon Colours to their products to show what good things come across the border. Two new colours produced by this firm are Caledon Red Violet 2RN and Caledon Brilliant Violet R, and samples show the fine shades

they produce, the former colour being used in combination with Caledon Red BN for dyeing casement curtains. The firm's standard products are shown together wlth textiles on which the dyes have been used, and there are also interesting specimens of intermediates, amongst which mention may be made of methylamino hydrochloride, phthalic anhydride and naphthanthraquinone. Other dyestuffs of interest are Solway Green and Solway Blue Black, which are equivalent, respectively, to Alizarine Cyanine Green and Alizarine Blue Black. Here again the evidence of careful manufacture supported by sustained research will convince visitors of the ability of the industry.

The familiar "Metro" brand calls attention to the stand of the South Metropolitan Gas Company, at the sign of the Benzene Ring. Here wood stained in delicate shades with creosote competes for attention with the samples of smokeless fuel, and the dazzle of sulphate of ammonia draws the eye from the cabinets containing a selection of Metro chemical products. Intermediates for dyes, sodium sulphide for the tanner or dye-maker, "hypo" for the photographer, sodium salts for the glass maker, ammonium chloride for the galvaniser or for making electrical batteries, all these are shown. And there is sulphuric acid of all strengths and enough coal-tar products —benzol, toluol, solvent naphtha, creosote oils, cresylic acid, pyridine and anthracene—to impress the most incurious with the mystery and value of raw coal.

Spencer, Chapman and Messel, Ltd., are so well known as makers of sulphuric acid that nothing need be said about their product, save that it is to be seen in all strengths, whether for accumulators or for laboratory or other use on their stand, flanked by displays of hydrochloric and nitric acids. There are also samples of saltcake, nitre cake, and iron oxide for use in industry. The simplicity of the display is highly effective.

Messrs. Stafford Allen and Sons have provided an exhibit that combines interest with instruction. Plants that yield the perfumes for which the firm is noted are shown growing in pots; there are specimens illustrating the yields and qualities of essential oils obtained, and there is a small extraction press to show how the oils are extracted. Packed products complete a stand which is notable for the care with which it has been thought out. Numerous specimens are shown of crude and refined drugs, the packing and display of which is most creditable.

The Thermal Syndicate, Ltd., has an impressive collection of their Vitreosil articles made in fused silica ware and technical difficulties seem to offer no hindrance to the production of any form or size of apparatus within reasonable bounds. An objection has been raised that Vitreosil ware is fragile; this is true, but in actual practice it has been found that more care is taken of articles made of Vitreosil, so that it actually lasts longer. The well-known "Vitreosil" gas globes are a special feature of the stand, but the chemist will find all the important laboratory material and the manufacturer will be interested in the basins, beakers and balloons for use in making mineral acids, some fine, large condensing coils, coolers, distillation apparatus, Glover tower fittings, plant for the production of acids, in fact for any process in which resistance to corrosion and changes of temperature is necessary.

Thos. Tyrer and Co., Ltd., have a representative display of their "Sterling" brand chemicals, important products being their bismuth salts, hypophosphites, mercurials, siccatives, acids and ethers and a large number of granular and scale preparations. Salts of nickel, antimony, manganese, barium, potassium, copper, zinc and tungsten and other metals are also being shown, but it is to be regretted that reasons of safety have prevented the exhibition of their acetone, amyl acetate, pyroxylin and collodions, which are now utilised by so many industries and in so many forms. The analyst is catered for equally with the pharmacist, and photography, rubber vulcanisation and anti-fouling compositions, to mention but a few, all pay tribute to the "Sterling" brand chemicals.

One cannot add much to the previous note about the United Alkali Company, and if there possibly is anyone in any industry that does not know their products, a visit should be paid at once to the company's stand. There can be obtained a pamphlet which describes the company's manufactures and their applications. Agriculture, building and decorating, ceramics and cements, disinfectants and cleansers, dyes, explosives, food products, tobacco, leather, medicine, metallurgy, paint, paper, textiles, oils and fats, all are furnished with some product from bath crystals to paranitrophenol, from chlorine to zinc chloride, from acetic acid to baking powder. For the technician another booklet is provided which summarises the chief manufactures of the United Alkali Company, namely, mineral acids, ammonia, bleaching agents, disinfectants, salt, and, of course, soda ash and various sodium salts. It is of interest to mention the company's Chloros disinfectant, which, when used in the proper proportion for sterilising sewage has been found to have no ill effect upon fish. This disinfectant is also largely used, on account of its detergent and sterilising action, in breweries and distilleries, and it is of value for cleaning bottles. To give a further illustration of the wide field covered by this old-established company, other manufactures included standard copper, purple ore, sulphur, calcium carbide, commercially pure antimony pentachloride, arsenic, and even chloroform.

PALACE OF ENGINEERING

Insulating and packing materials of every description are exhibited by Attwater and Sons on their stand. All the most approved types of insulating material for electrical work are there and the chemical engineer will find packing suitable for every kind of joint, belting, mica, vulcanised fibre, and some interesting bakelite and ebonite products. Much depends on material used for packing and insulation, and the products of a firm which has specialised in these materials will repay close attention.

The stand of Sir W. H. Bailey and Co., Ltd., also contains a good deal of interest to the chemical engineer. The Bailey air compressors and vacuum

pumps are well known and so are the Bailey pumps, whether ram, piston, centrifugal, rotary or hand pumps. A variety of hydraulic plant is illustrated and the inquirer can obtain information about products ranging from fusible plugs and acid pumps to steam injectors, autographic recorders and turret clocks.

Bell's Poilite and Everite Co., Ltd., show a variety of their well-known Poilite and Everite products, but the biggest display of Poilite flat sheets is to be found on the acres of roofs at the Exhibition which are lined exclusively with Poilite. Everite roofing sheets of various forms are shown, and it is worth noting that the makers claim that Everite becomes stronger with exposure, and as it is impervious to weather and resists fire, rot, and chemical action, it is an attractive material for the constructional work in chemical factories.

Centrifugal machines and hydro-extractors monopolise the stand of Thomas Broadbent and Sons, Ltd. There are machines to be seen in metal or plan which are driven by steam, belt, electricity or water and are used for drying granular materials such as sulphate of ammonia, naphthalene, sugar, nitrates and crystals, or for separation, decantation, clarification, precipitation, degreasing and many other processes. The firm takes a just pride in its products and ensures that they shall represent the latest practice with the help of an efficient technical staff that specialises in problems of centrifugal separation.

Fire-clay goods of all types are exhibited by the Glenboig Union Fire Clay Co., Ltd., a firm which not only profits from the experience accumulated during a very long period of years, but directs its application with the help of a fully equipped laboratory which is responsible for the examination of all the raw material used, of every phase of manufacture and of the finished products. The exhibit includes fire bricks of every description, acid-resistant bricks, special bricks for metallurgical furnaces, gas retorts, bricks for retort settings, coke ovens, glass and chemical furnaces, sewage pipes, junctions and many other manufactures essential to industry. For the Glenboig bricks, it is claimed that they are of unequalled quality for use in furnaces, being extremely resistant to great heat, changes of temperature, and wear.

Amongst the exhibits of the Gwynnes Engineering Co., Ltd., are a steam turbine-driven pump of the two-stage impulse type, some of the "Invincible" multi-stage pressure pumps for work such as drainage and loading oil, fire pumps of various types, sewage traps designed to permit the use of centrifugal pumps for handling liquids which contain solid material that would choke the pump if it had access to the impeller, and a number of the "Invincible" ball-joints for flexible connexions in many sizes.

When admiring the refrigerating machines exhibited by J. and E. Hall, Ltd., it should be remembered that this firm has been working continuously at Dartford since 1785, so that it is one of the oldest engineering firms in the world. It made the first paper machine and the first trunk engine installed in a ship, and has associations with Richard Trevithick, of locomotive fame. Nowadays, the firm concentrates its attention almost entirely on refrigerating machinery, which is well represented on the stand. There is a large tandem steam-driven carbon dioxide machine for use in refrigerator ships, a high-speed, electrically-driven, enclosed ammonia machine for making ice, a twin-compressor, marine-type, carbon dioxide machine (also electrically driven) for large provision chambers, a steam-driven carbon dioxide machine fitted with a multiple-effect compression system designed to increase the output when external temperatures are high, a small ammonia machine suitable for small cold stores, and a high-speed ammonia machine that is specially designed for small-scale work whether in shops or for the home. The chemical engineer will find much of interest on this stand, and the user of cold storage will find food for thought.

The "P & B" evaporators are to be found on the stand of Aiton and Co., Ltd., of Derby, a firm which specialises on pipe work—the specimens of corrugated steel expansion pipes on show have led to many questions as to "how is it done?" The evaporator on the stand is one of the Prache and Bouillon plants, for which the sole licence in the Empire is held by P. and B. Evaporators, Ltd., the plants being made at Derby. The special feature claimed for this plant is that it solves the problem of make-up feed water, thus avoiding losses due to scale, corrosion and priming, as well as those due to excessive blow-down and low evaporative efficiency. Working is unusually economical and other virtues are claimed for the plant, of which a full description, with working figures, is given in a booklet issued by P. and B. Evaporators, Ltd.

On the stand of Pott, Cassels and Williamson one would expect to find centrifugal machines, and there they are. Little can be said of moment about a firm that, not long ago, delivered an order of 75 electrically driven centrifuges to one of the largest sugar factories in the East Indies. These machines were of the overdriven type, a special feature of the suspension being the solid steel spindle combined with ball and sleeve bearings and self-adjusting rubber buffers. Many types of centrifuge are made to suit each particular class of material, and the firm is always glad to advise on the best type of plant to use.

The Pulsometer Engineering Co., Ltd., show the "Flexala" and "Resiline" centrifugal pumps, which are specially designed for pumping liquids or sludge containing solid or abrasive materials. The pumps are fitted with a rubber-coated impeller with flexible vanes of rubber, thus providing another application of rubber in which its resistance to erosion is utilised.

Near the Bessemer Gate is an exhibit which should not be missed—that of the Ruths Steam Accumulator Co., Ltd. A system of steam accumulation which gives a fuel economy of 15 to 30 per cent., increases the output of the factory by 10 to 30 per cent., and reduces the boiler surface by something like 25 per cent, is worthy of close consideration by every steam user. The Ruths steam accumulator has already been described in this Journal, and its

merits are open for consideration. A particularly striking example of the reduction of boiler heating surface by equalising the boiler load with the Ruths Steam Accumulator is given on the stand; the number of boilers required was reduced from four to two.

Piping of all kinds, for high-pressure steam, refrigeration, gas and water, whether high or low pressure, telephone equipment, boilers, both marine and land, superheaters, turbines and tube wells dominate the display of Stewarts and Lloyds, Ltd. For every purpose for which a pipe can be used this firm has a suitable type, and in case there should be anyone so bold as to doubt, there are test pieces in abundance. There are specimens that have been subjected to cold expansion and cold flattening and cold crushing; some have been "concertinad" while cold; others have been turned inside out, and to make assurance doubly sure there is a small electric motor that compresses and releases a 3-inch expansion bend every 30 seconds, so that by the time the Exhibition closes the bend will have been tortured over 200,000 times, and it could probably continue. To show the capacity of the firm, there is a steel billet weighing one ton, with a piece of tube made from a similar billet, and near by 1-inch gas tubing is bent to spell out "Stewarts and Lloyds, Limited," to show the quality of the material. The secret is that all stages from raw ore to finished article are controlled by the firm, so that quality can be insured and maintained.

Allen West and Co., Ltd., of Brighton, show a variety of switches that are of interest to chemical engineers, as they are designed to stand rough handling, are practically "fool-proof," and perfectly dust-tight; they can also be made "water-tight" to Admiralty specification if required. Another exhibit on the stand is the insulating material developed by Messrs. Allen West and Co., which is used on their switches and other electrical plant.

The power house in the Electrical Section contains some of Messrs. Allen West and Company's switches, and, amongst other apparatus of interest, are three centrifugal separators used for purifying the lubricating oil for the turbines. These centrifugal separators are made by the De Laval Chadburn Co., Lted., and represent the latest type of well-known De Laval centrifuges. The De Laval Chadburn Co., realising that each liquid possesses its own peculiar features, offer to investigate each particular problem so that a bowl can be designed to give the maximum efficiency of separation.

PETROLEUM IN HÉRAULT, FRANCE

As a result of exploration made by the Ministries of Commerce and Public Works and on the advice of the consultative scientific committee on petroleum, a boring near Gabien has passed through petroleum deposits corresponding to a flow of 25 litres per hour. Information on the results of the analyses will be given at a later date.

SOME THOUGHTS ON THE BRITISH DYESTUFF INDUSTRY*

By Dr. HERBERT LEVINSTEIN, MSc., F.I.C.

During each of the last three years you have done me the honour to invite me to speak to you on the British Dyestuff Industry, but it was impossible to discuss the British Dyestuff Industry without alluding, however briefly, to the British Dyestuffs Corporation. It would have been very distasteful to me to say to you one word which might conceivably have had the effect of adding a difficulty, something which might have been construed into a criticism of those in the middle of a task. The position now is in itself so critical that I cannot conceive that any remarks of mine will add to the embarrassment of the chairman, the Government directors or their colleagues on the board of the British Dyestuffs Corporation, and I feel that having kept silent for three years this silence may be misconstrued if it is maintained longer.

Let me recall to you something of the early history of the dyestuff industry in Great Britain. It is often thought that when Perkin discovered Mauvein—the first aniline dye—and proceeded to manufacture it, the British contribution to this industry ceased. The Germans, we are told, with their superior knowledge and love of chemistry, their greater idealism and devotion to abstract thought, took this "small English seed" and made out of it "the precious German garden"—I am quoting from a very eloquent speech made by Dr. Duisberg at the Perkin Jubilee Dinner in 1906. This is, I am persuaded, far from the correct view.

The two outstanding personalities in the Dyestuff Industry in the first fifteen years after the discovery of Mauvein were Englishmen—Perkin and Nicholson. The famous Caro, afterwards of the Badische company, whose great period came later, and Martius, afterwards one of the leading figures in the A.G.F.A., were both in Manchester at Roberts, Dale and Co. Peter Griess was in England, as was Leonhardt—afterwards with Cassella—subsequently the founder of the Farbwerk Muelheim. That distinguished personality, Otto Witt, was at Williams, Thomas and Dower. May I remind you that Witt is the author of that classical report on the German Chemical Exhibit in Paris in 1900. This we can now match with our own publication, "Chemistry in the Twentieth Century," edited by Dr. E. F. Armstrong, a permanent, fascinating and encouraging record of the British chemical science exhibit at Wembley. In a similar way your own British colour index replaces the old Schultz and Julius.

Meister, one of the founders of Meister, Lucius and Brüning, was in business in Manchester. We had, too, not only the factories named and Perkin's colour works, but also those of Simpson, Maule and Nicholson—for fourteen years the largest coal-tar works in the world—under the brilliant direction of Nicholson. That great chemist and great man Hoffman was their adviser. Before 1865 Read Holliday and Sons, L. J. Levinstein and Sons, and

* Abstract of address to the Society of Dyers and Colourists at Bradford, on October 9, 1924.

Dan Dawsons were in existence, and there was no difficulty in getting good chemists adequate in number for the requirements of the industry at that time.

The point I wish to make is that the people who subsequently founded and developed the big German dye works learned their business in England. They found that a lot of money could be made in the dyestuff industry when a knowledge of chemistry was combined with energetic salesmanship. But they also realised that energetic salesmanship was not alone sufficient. They had seen how Perkin had to devise new technical applications before his new chemical invention could be marketed. Hence they developed the technical sales organisation, which is such a very important department of the trained colourist. I must also add that it was in England that the Germans learned how to manufacture complicated chemicals on a large scale.

It was then, on experience gained in this country, that there was built up that great German industry which in 1913 had magnificent sales and strong research organisations, wonderful factories and very good experimental dye houses. But the principles which distinguish the aniline dye industry, an industry unique because dependent for success on inventions, were not introduced by the Germans.

It is worth while to consider these points in a little detail:—

Perkin himself tells us that he had to discover not only Mauvein, but also the tannic acid method of fixing basic dyes before he could sell Mauvein for colouring cotton. There was no method known for fixing basic dyes on cotton. The dyeing instructions, the working out of new dyeing and printing methods, were part and parcel of the industry in England from the very commencement, and were not introduced to the industry by the Germans. Nor did the Germans introduce the methods of systematic research with which their name is so frequently associated. It is very instructive to glance for a moment at the earlier patents.

The year 1856 gave us Perkin's Mauvein.

In 1859 there were patents for Violets from Greville Williams, R. D. Kay, Beale and Kirkham and Price. Further, in this year we have the Magenta patent of Renard Frères and Franc, and also Gerber and Keller.

In 1860 we notice Medlock's famous Magenta patent, first used by Simpson, Maule and Nicholson, and further patents for Violets by J. Dale, Caro, Richard Smith and Coleman. In the same year Gerard and De Laire transferred to Simpson, Maule and Nicholson patents for obtaining an improved Violet.

In 1861 came Laurent and Casthelaz with their Nitrobenzol Magenta process.

The following year, 1862, was a most productive year to which Perkin contributed what was then considered a new class of violets. Simpson, Maule and Nicholson brought out Phosphine, which they did not patent, Roberts, Dale produced Manchester Yellow, and above all, Simpson, Maule and Nicholson discovered the Aniline Blues, Gilbee Soluble Blue and Nicholson made Alkali Blue.

In 1863 came Hoffman's Violet, the patent of which was transferred to Simpson, Maule and Nicholson, and in 1866 Bismarck Brown—or Manchester Brown—was put on the market by Roberts, Dale, the patent being dated 1863.

Methyl Violet, discovered by Lauth in 1861, was brought on the market by Poirrier and Chappat in 1866. This firm oxidised dimethylaniline and patented the production of the Violet so obtained.

This is a wonderful record of work, and you will observe that whenever the names of Germans occur they are always Germans who were in the employment of British firms. The important patents were taken out by Englishmen, by Frenchmen and by German chemists working in English factories.

These inventions, the result of systematic research, developed the industry far beyond Perkin's original discovery. They also taught the German companies in the most practical way possible the money that could be made out of judicious research—in this case largely other people's research. In fact, in those early days the German companies infringed these patents to the despair of the inventors.

Until 1876 there was no adequate patent protection in Germany, consequently German dyestuft factories could exploit the discoveries made by English and French dyestuff chemists.

Hoping to protect himself, Nicholson refused to patent his discovery of Alkali Blue (1862), far and away the most beautiful blue then known. This availed him nothing. According to Ivan Levinstein (Presidential Address to the Society of Chemical Industry in 1902), the Germans made a profit of half a million pounds out of Nicholson's invention.

The advantage of being able to use the research work of other nations without paying a toll is not without example at a later date. The orientation of the dye industry in Switzerland was due to the absence of patent protection in that country until a much later date.

The discovery of synthetic Alizarine in 1869, almost simultaneously by Graebe, Liebermann and Caro in Germany, and Sir W. H. Perkin in England, is another instance of the depressing results of inadequate patent protection. Both processes were patented in England. Neither could be patented in Germany. Graebe and Liebermann's English patent was acquired by the Badische. The latter exchanged licences with Perkin, who thus acquired by arrangement the monopoly in this country for the manufacture of Alizarine, but in Germany there were other makers beside the Badische. There was no monopoly. Anybody could make Alizarine who wished to do so.

The Franco-Prussian War of 1870–1 followed closely on the discovery of Alizarine, and for two years the German development was impeded. In the course of this war great profits were made by the British dyestuff companies. What happened afterwards is of great interest to-day.

In 1869 Perkin had already sold one ton of Alizarine; in 1870 this was increased to 40 tons, and in 1871 to 150 tons.

The Germans, owing to their war, could only start in 1871, but even in that year they sold 220 tons.

In 1873 they sold two and a half times as much Alizarine as Perkin.

In the following year Perkin retired from the contest, and sold his business to Brook, Simpson, and Spiller. Nicholson had already gone. The two great figures disappeared from the English works. There is little wonder in this. To find themselves outdone by the Germans in marketing their own inventions, to find the Germans selling many times the quantities of the dyes they had themselves discovered, was a most discouraging state of affairs.

The Franco-Prussian War over, and with the builders of the British dyestuff industry removed, the future of the German industry was easier. What happened is common knowledge.

In the first place the Alizarine trade passed almost entirely into German hands. In 1881 they made the Alizarine convention and cleared in that year a million pounds profit. They wrote off the cost of their old works, constructed new ones with excellent laboratories and staffed them with good research chemists. The Germans understood, as apparently some never will understand, that only great sales justify great research organisations. It is equally true that only great sales organisations can attract the best research chemists. The reason is not far to seek. The inventor in a dyestuff factory always draws a royalty on the turnover or profits of the dye he has discovered. His income depends therefore on the efficiency of the sales department of the firm for which he is working.

The examples given of Nicholson's Alkali Blue, and of the synthesis of Alizarine, will convince you that those who lived in those days had reason to attribute the decline of the industry to the absence of patent protection in Germany. That subsequently our English patent laws acted detrimentally to the British industry is generally admitted. But in the manufacture of many dyes the Germans had another great advantage. They had no heavy duty on spirit as in England. In 1902 (Silberrad, *J.S.C.I.*, 1902) the cost in England of diethylaniline from duty-free alcohol would have been 5½d. per pound. The actual cost of this product from duty-paid alcohol was 2s. 5½d.

Thus it was more profitable to manufacture dyestuffs in Germany than in Great Britain. Purely commercial, very human and natural reasons took the few men of great talent, such as Caro, Witt and others, back to their native country where they could earn greater salaries and get larger "tantièmes" as a result of the far greater German sales.

It is interesting to speculate what might have happened if Perkin and Nicholson had been interested enough to stay and fight out the commercial war that ensued. Perhaps the history of the dyestuff industry might have been different? Who knows? Leadership counts for much in this industry.

But one thing is clear. If, after the Franco-Prussian War *laissez-faire* had not been the policy of the State, a very different position would have resulted in the country. If the State had provided :—

Duty-free spirit on terms comparable to those enjoyed abroad :

Protection for inventions, and

Prohibition of import of dyes manufactured abroad :

Information concerning foreign products :

Above all, an assurance of a benevolent interest in the industry : do you think that Perkin and Nicholson would have left ?

Yet these are precisely the measures which the State took after the Great War. If Perkin and Nicholson had remained or if any of the other able men in the industry had had these advantages, what policy would they have adopted ?

Would the policy have been to use these facilities for the purpose of securing in the limited home market the highest possible prices to the neglect of the great markets of the world ? I do not for one moment believe it and I go further. I state with complete confidence that if, in the fifteen years preceding the war, during which I was associated with the British dyestuff industry, the Dyestuff Act had been in being the British companies carrying on business here in 1914 would have been extremely powerful institutions.

We never obtained—nor could obtain—one fraction more than the world's prices for our commodities. We always accepted competition prices where we did business. Had we had, as the British industry has to-day, the first refusal for all orders in the home market we should have been immensely strengthened in competing with the Germans abroad. Our costs would have been lower on account of the greatly increased turnover.

To-day the companies now amalgamated in the British Dyestuffs Corporation are weaker than before the war, less dangerous competitors, and a source of great anxiety to all concerned with our great industry.

For this reason, no doubt, the Board of the British Dyestuffs Corporation have, as you know, proposed an Agreement with the I.G. Last April at the annual meeting the chairman stated that the Board will resign if they are not encouraged to complete the agreement, as outlined. The colour consumers, the customers of the company, through the chairman of their association, have definitely stated that they disapprove of the agreement, that they will prevent it if they can, and will welcome an entire reorganisation of the management. Further, the agreement, the headings of which have become known, is opposed by every one of the organised bodies in Great Britain representing pure and applied chemistry, including the Association of British Chemical Manufacturers.

Thus it appears that the policy of the Board and the constitution of the Board is disapproved by the whole of the chemical world, and by their customers, the colour-using interests.

Out of much that is obscure this much is certain. The agreement has not been approved. The situation contemplated by the chairman and his colleagues has arisen. The Board have not been encouraged to complete the arrangements with the I.G., in which they put their faith, and they will, no doubt, tender their resignations.

Let me remind you, however, that both the Board and the agreement were supported at the annual meeting in April of this year by several speakers, men of high standing in the City of London, who represent substantial financial interests in the company.

The public flotation of the British Dyestuffs Corporation in 1919 was, you will perhaps remember, not a success. A large proportion of the shares remained, and apparently still remains, with the underwriters. I view with concern this divergence of views between colour users and those representing the underwriters. We all want a British dyestuff industry, and this must include the British Dyestuffs Corporation with factories employed making good dyes, selling them at reasonable prices, and earning a reasonable return on the capital invested; a company able to supply the home market with satisfaction to its customers, and strong enough to battle for a share in the world's markets. Such a company will satisfy all classes of shareholders, and satisfy the purpose for which Parliament enacted the Dyestuff Act. But you can only get such a company with the active assistance and support of the colour users. In the circumstances an impartial, dispassionate comment on the divergent views can only be helpful, and may be of interest to you. I am a strong supporter of the British dyestuffs industry, and of the British Dyestuffs Corporation, of which I am, I think, the largest individual shareholder. I regard the success of both as vital to the security of British trade in peace and in war.

The argument of what may be called the underwriters is that colour consumers are grasping, and desire to buy dyes below the economic cost of production. Thereby the shareholders are deprived of their natural right to dividends, a matter of more consequence to non-consuming shareholders than to the customer shareholders. After all, the shareholders who are consumers derive the benefit of low-priced dyes, and can look with more equanimity at the absence of dividends than those whose interest in the company is purely financial.

Frankly, I do not think that this can be upheld. I have more sympathy with the consumers' standpoint. Bearing the burden of the Dyestuff Act, they consider that every effort should be made by the most competent persons obtainable to meet the demands of their trade. They are aware of the diminished production of the British Dyestuffs Corporation, their diminished and diminishing share of the British market. They may, with justice, attribute high prices to high overhead charges consequent upon idle plants.

The Dyestuffs Act in their view—and they support the Dyestuff Act, and are prepared to carry it out fairly—cannot be used legitimately to bolster up high prices for dyes; the Act should and can be used very differently, to the great advantage of both consumers and the dye manufacturers alike.

Here, at any rate, lies an apparent though not a real diversity of interests. A shareholder in any business need not be unduly alarmed at the temporary absence of dividends, provided that the value of his shares is substantially conserved. If in addition to the absence of dividends the shareholder is faced with a diminishing asset, he is in a dangerous position. An examination of this point in this specific case leads one at once to consider the situation created by the amalgamation of British Dyes, Ltd., and Levinstein, Ltd., in 1919. In the course of this examination I may be critical. There is a time for criticism, for instructed criticism. To withhold criticism to-day may be as unwise as it may be fatal to resist criticism.

This fusion was brought about by Lord Ashfield, then President of the Board of Trade, now a Government Director of the British Dyestuffs Corporation. In 1918 you had in my firm a dyestuff manufacturing company employing 3000 hands, analogous to but smaller than the large German factories. The analogy lay in these three points:—(1) The business was managed by those who had created or had grown up in it. (2) It was a company with three large factories, large assets, but with a small nominal capital. (3) It had a contented and permanent, not a nomadic, staff, and a harmonious Board.

We never did sell our business, but we consented to put what we considered to be our duty before our inclination or our profit, and we exchanged our holding in Levinstein, Ltd., for, in round figures, some £800,000 shares in the British Dyestuffs Corporation. These shares are now worth less than a quarter of their nominal value.

Now consider the following figures: The British Dyestuffs Corporation have recently recovered about £1,000,000 in E.P.D. from profits earned by Levinstein, Ltd., before the amalgamation. Further, they are entitled to receive, or have already received, from the Du Pont Company the sum of £250,000 in cash, on account of the American rights for the Levinstein processes acquired by the Du Pont Company. The British Dyestuffs Corporation thus obtained their factories, outstandings, stocks, processes, royalties due and goodwill for a little over three-quarter million in shares, and have regained therefrom about £1,250,000 in cash, and the present market value of what is left is about £180,000. I would commend to your consideration the answer to this question. If this particular dyestuff business has in the last two or three years furnished about £1,250,000 of hard cash into the coffers of the British Dyestuffs Corporation out of past profits and in royalties for their processes, why is the market value of their property to-day only £180,000, a tiny fraction of the cost of the factories, large, modern, up-to-date and complete. The great factories and laboratories carefully designed in all ways are there intact. I will venture on the answer.

Simply because the value depends on the earning capacity. The value of a great chemical business depends little on the intrinsic value of the plant and machinery, even though it covers 50-60 acres, but on the earning capacity. This dyestuff works has lost the earning capacity it formerly possessed when in private ownership.

While these factories are stagnant, in spite of the protection of the Dyestuffs Act, their trade is passing into other hands, those of people who know the aniline-dye industry. Others in this country are busy working and enlarging their plant to take over a part of the business formerly held by Levinstein, Ltd.

There appears, therefore, to me to be no doubt that you have an asset which has diminished to a startling extent. You must remember that in

addition to the factories at Blackley and the Claus Plant at Clayton, this figure of £180,000 also includes the value of the Indigo Works at Ellesmere Port. This plant was designed, erected and owned prior to the war by the Germans. It has now double the pre-war capacity, possesses the complete monopoly for the manufacture of indigo in this country, and is amply large enough to supply the whole British demand.

If this picture does not fit in with the complacent words of the chairman at the annual meeting of the British Dyestuffs Corporation it is not my fault. It appears to harmonise with and to explain the anxiety of the Government directors and the Board to get through an agreement—I might almost say any agreement—with the Germans. It tends to justify the severity of the terms demanded by the Germans. We may surmise that it influenced the decision of the Board to retire if they are not encouraged to complete the German agreement.

On the whole, giving due weight to the disadvantages of such a course, these figures do suggest to me that no body of shareholders has cause seriously to resist the declared intention of the directors. That is a point of view I would respectfully urge on all interested in this great question.

In saying this I am sure nobody would desire to be discourteous, or to fail to recognise the great trouble which the directors have devoted to an undertaking which all of them must have found a burden presenting problems entirely foreign to their previous experience. The times are too serious and too difficult for those who care about this industry or have large interests in it to be content with what has occurred. I would recall to you the wise, and as it appears, prophetic words of the Rt. Hon. Sir A. Mond, when speaking in the House of Commons on February 2, 1915: "I speak with a certain amount of experience when I say that it is not sufficient merely to have people who, however able they may be on the commercial side, are entirely ignorant of technical matters, to control a chemical business. Unless you have people on your Board who are themselves capable of appreciating every important invention and discovery in chemical engineering which your chemical engineering staff brings to you, you are very likely to get into the position into which many companies get when the so-called practical men discard all new ideas as being only fads or as being too expensive. If you want to compete with Germany in this industry you must not follow that policy."

I hope that I have not wearied you with this account and with these figures. They are of interest, because the success of the British industry is so important to this Society; and because the successful administration of the Dyestuffs Act is only possible with a successful British Dyestuffs Industry.

The extraordinary analogy between the position of the Dyestuff Industry after the present war and after the Franco-Prussian War has no doubt occurred to many of you.

If the ability to develop this industry were here from 1856 to 1870 why not now when our chemical schools have so marvellously grown! Yet we are told to-day that this country is inherently incapable of competing in this industry which was created and developed here.

Let me close this address by quoting Lord Moulton's words when delivering an address on "The Manufacture of Aniline Dyes in England" in the Manchester Town Hall on December 8, 1914: "Let me deal for a moment with the difficulties that face one. The first is that there is a lack of the necessary technical skill. I have a great difficulty in returning a polite answer to that. To my mind it is nonsensical."

That, too, expresses my mind precisely.

THE INSTITUTION OF CHEMICAL ENGINEERS

At a meeting of the Council of the Institution, held on October 8, 1924, the following gentlemen were elected :—

Members.—Arthur Matthew O'Brien, William Temple Gardner, Sydney Joshua Tungay, Herbert Thomas Fradley. *Associate-Members.*—Arthur Joseph Underwood, William Perceval Paddison. *Graduates.*—Lawrence Gordon Cowen, Henry Oates Richardson, Frederick Estill. *Students.*—Richard Graeme Heggie, Maurice Schumlian.

Arrangements were discussed for entertaining the members of the American Institute of Chemical Engineers who would hold a joint annual meeting with the Institution of Chemical Engineers in England in July next year. The programme proposed is as follows: Sunday, July 5, 1925—Arrive at Liverpool. Monday to Wednesday, July 6 to 8—Chester. Thursday and Friday, July 9 and 10—The Lakes. Saturday, July 11—Glasgow. Sunday and Monday, July 12 and 13—Edinburgh. Tuesday and Wednesday, July 14 and 15—Leeds: Annual Meeting of the Society of Chemical Industry (if on this date). The visitors are to leave on July 18 for America. It is proposed that the tour be made by cars and an organising committee has been formed to arrange details.

MINING AND METALLURGY IN CANADA

A rich deposit of realgar is reported from the Comox district, Vancouver Island, B.C. Analyses of average samples show 57 per cent. arsenic.

The magnetic iron ore found near Pangis, on the line of the Algoma Central Railway, contains 60 per cent. iron. About twenty claims have been located and stripping has begun.

The Granby Consolidated Mining and Smelting Co. has blocked out about 10,000,000 tons on Copper Mountain, Princeton district, B.C. On the opposite side of the mountain the Princeton Mining and Development Co. is engaged in operations. The ore runs from 6 per cent. copper and 2 oz. silver to 20 per cent. copper, 65 oz. silver, and 0·09 oz. gold per ton.

FORTHCOMING EVENTS

Oct. 20. Institute of Chemistry, *Huddersfield Section.* Annual General Meeting." "Chemists' Contracts—Duties and Privileges," by G. S. W. Marlow.

Oct. 21. University of London, King's College, Strand, W.C. 2, at 5.30 p.m. "Recent Developments in High-Speed Internal Combustion Engines," by H. R. Ricardo. Also on November 4.

Oct. 21. Institute of Chemistry, *Leeds Area Section,* The University, Leeds. "Chemists' Service Agreements. Duties and Privileges," by G. S. W. Marlow.

Oct. 21. Joint Meeting of Institute of Chemistry and Society of Chemical Industry, *Edinburgh and East of Scotland Sections,* in the Hall of the Pharmaceutical Society, 36, York Place, Edinburgh, at 8 p.m. Address by W. J. U. Woolcock, C.B.E. Dinner at 6 p.m. in the North British Station Hotel, Edinburgh. Members of the Section and of the Institute of Chemistry are invited to be present. Tickets 8s. 6d. each.

Oct. 21. Institution of Electrical Engineers, The College, Loughborough, at 6.45 p.m. "Realisation of Heat Units in Steam and Electric Power Plant," by F. W. Nicholls.

Oct. 21. Imperial College Chemical Society, Royal College of Science, South Kensington, S.W. 7, at 5 p.m. "The Development of Physical Chemistry," by Prof. J. C. Philip, F.R.S.

Oct. 22. Society of Chemical Industry, *Glasgow Section,* Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, at 7 p.m. "Process Records ond their Bearing on Plant Efficiency," by J. Adam Watson.

Oct. 22. Royal Microscopical Society, at 20, Hanover Square, W. 1, at 7.0 p.m. "Elementary Principles of Microscopical Illumination," by J. E. Barnard. "Super-saturated Solid Sulutions," by Dr. R. H. Greaves. "New Photomicrographic Apparatus," by H. Wrighton.

Oct. 22. The Faraday Society, in the Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1, at 5 p.m. Discussion on "The Physical Chemistry of Igneous Rock Formation," with an introduction by Dr. J. S. Flett. Papers are expected from Prof. C. H. Desch, Dr. J. W. Evans, Prof. J. W. Gregory, A. F. Hallimond, Prof. P. Niggli, Dr. A. Richardson, Dr. A. Scott, Mr. G. W. Tyrrell, and Prof. W. E. S. Turner.

Oct. 22. Institute of Chemistry, *Manchester Section,* Annual General Meeting, The Textile Institute, St. Mary's Parsonage, Manchester, at 7 p.m. "Service Agreements—Duties and Privileges," by G. S. W. Marlow.

Oct. 23. The Society of Chemical Industry, *Chemical Engineeri[illegible] Group,* The Kelvin Room, Engine[illegible] Club, 39, Coventry Street, W. 1, at 5 p.m. (1) "Crystallization," by H. Griffiths. (2) [illegible] Development and Formation of Cryst[illegible] by Prof. T. V. Barker. An Informal Dinn[illegible] follow at 7 p.m., and the Discussion on the two papers will be contiuued at 8 p.m.

[illegible]3. Society of Dyers and Colourists, *West Riding Section.* "The Research Situation—a Criterion of National Stability," by Dr. H. H. Hodgson.

CHEMICAL MEETINGS

The list of chemical meetings published on the opposite page, long as it is, is very incomplete. It includes only the public meetings; there are in addition the council meetings, the committee meetings and sub-committee meetings of the chemical societies mentioned in the list, and also the meetings of the A.B.C.M., the Federal Council and such bodies as the Petroleum Technologists, the Oil and Colour Chemists, the B.A.C. and many other organisations, and the very numerous sections and societies, some of considerable importance, which meet in the provinces. Most of the meetings included in the list are meetings at which papers are read and many of these papers are published. So far as London meetings are concerned, there is but little overlapping and little clashing of dates. Nevertheless, several of the papers read before sectional meetings of the Society of Chemical Industry may be of interest to other London sections, and it is probably worth while to combine some of these meetings. As to the provinces, joint meetings of two or three societies have been tried and have been found successful as well as pleasant. Suggestions have been made in the past, and will be again made, for close co-operation between provincial sections for joint meetings. The publication of the important papers in pure and applied chemistry is becoming a difficult problem, and our correspondence columns bear witness to this. The problem is particularly difficult in pure chemistry, for it is impossible to state now which new compounds will be of importance fifty years hence. As the population of the world increases, the number of scientific workers will increase, and also the number of readers; the cost of printing and paper is also certain to increase. Our readers could render a very useful service to the chemical community if they would think over the essential features of our chemical meetings and our chemical publications, and give the world the benefit of their views.

What is to be done, for instance, with Prof. Urbain, who brings before the French Academy two papers, the one on "*L'Energétique des réactions chimiques,*" and the other on "*Le tombeau d'Aristoxène. Essai sur la musique*"?

The compilation of the list of meetings we should note is mainly due to the care and industry of Mr. G. S. W. Marlow.

It is not clear why all the meetings are held; certainly the social side is an important factor. Many of the papers read are either so technical or so difficult that only a small proportion of the audience can enjoy them. Such papers could usually be taken as read. If a paper is worth publishing, as a rule it is worth while to distribute advance proofs. Some chemists think that a 20 per cent. reduction in volume of most chemical publications would be both possible and desirable, and that no facts of importance would be thereby neglected.

CHEMISTRY

LONDON PROGRAMME FOR SESSION 1924–5

Of Ordinary Meetings of Chemical Interest

Times and places of Meetings with topics for discussion will be notified by the respective Societies

1924

Wed.	Oct.	1	Society of Public Analysts
Wed.	„	15	Institute of Chemistry (L.S.)
Thur.	„	16	Chemical Society
Sat.	„	18	Biochemical Society
Mon.	„	20	Chemical Industry Club
Wed.	„	22	Faraday Society
Thur.	„	23	Chemical Engineering Group
Mon.	„	27	Annual Meeting, Chemical Industry Club
Mon.	Nov.	3	Society of Chemical Industry (L.S.)
Wed.	„	5	Society of Public Analysts
Thur.	„	6	Chemical Society
Mon.	„	10	Biochemical Society
Wed.	„	12	Institution of Chemical Engineers
Thur.	„	13	Chemical Engineering Group
Fri.	„	14	"Chemical Industry" Dinner
Mon.	„	17	Faraday Society
Mon.	„	17	Chemical Industry Club
Wed.	„	19	Institute of Chemistry (L.S.)
Thur.	„	20	Chemical Society
Mon.	Dec.	1	Society of Chemical Industry (L.S.
Wed.	„	3	Society of Public Analysts
Thur.	„	4	Chemical Society
Mon.	„	8	Biochemical Society
Tues.	„	9	Faraday Society
Wed.	„	10	Institution of Chemical Engineers.
Mon.	„	15	Chemical Industry Club
Wed.	„	17	Institute of Chemistry (L.S.)
Thur.	„	18	Chemical Society

(L.S.)—London Section.

Hon. Secretaries of Societies are requested to intimate changes of date, titles of papers, and other information about Meetings to the Editor as soon as possible.

1925

Mon.	Jan.	5	Society of Chemical Industry (L.S.)
Thur.	„	15	Chemical Society
Fri.	„	16	Chemical Engineering Group
Mon.	„	19	Chemical Industry Club
Wed.	„	21	Institute of Chemistry (L.S.)
Mon.	Feb.	2	Society of Chemical Industry (L.S.)
Wed.	„	4	Society of Public Analysts
Thur.	„	5	Chemical Society
Mon.	„	9	Biochemical Society
Wed.	„	11	Institution of Chemical Engineers
Mon.	„	16	Chemical Industry Club
Wed.	„	18	Institute of Chemistry (L.S.)
Thur.	„	19	Chemical Society
Thur.	„	26	Chemical Society
Mon.	Mar.	2	Annual Meeting, Institute of Chemistry
Mon.	„	2	Society of Chemical Industry (L.S.)
Wed.	„	4	Society of Public Analysts
Thur.	„	5	Chemical Society
Mon.	„	9	Biochemical Society
Wed.	„	11	Institution of Chemical Engineers
Mon.	„	16	Chemical Industry Club
Wed.	„	18	Institute of Chemistry (L.S.)
Thur.	„	19	Chemical Society
Thur.	„	26	Annual Meeting and Dinner, Chemical Society
Wed.	April	1	Society of Public Analysts
Thur.	„	2	Chemical Society
Mon.	„	6	Society of Chemical Industry (L.S.)
Mon.	„	20	Chemical Industry Club
Wed.	„	22	Institute of Chemistry (L.S.)
Mon.	May	4	Society of Chemical Industry (L.S.)
Wed.	„	6	Society of Public Analysts
Thur.	„	7	Chemical Society
Mon.	„	18	Chemical Industry Club
Thur.	„	21	Chemical Society
Mon.	June	1	Society of Chemical Industry (L.S.)
Thur.	„	4	Chemical Society
Thur.	„	18	Chemical Society

SOCIETY OF CHEMICAL INDUSTRY

MEETING OF COUNCIL

The monthly meeting of Council was held on October 10, 1924, the President (Mr. W. J. U. Woolcock, C.B.E.) in the Chair. The President extended a cordial welcome to the new members of Council who were present.

Intimation was made of the death of Mr. W. R. Bird, recently elected Chairman of the South Wales Section, and it was reported that Mr. George H. Clegg, of Cardiff, had been appointed his successor.

A discussion took place on the falling off in applicants for membership and methods for obtaining new members were decided upon. As a means of attracting such it was agreed that no Entrance Fee shall be paid by members elected during 1925.

A letter from the Swedish Federation of Chemical Industries was read (see *Chemistry and Industry*, August 22, 1924), suggesting the adoption of the name "Methanol" as a substitute for "Methyl Alcohol," owing to the poisonous properties of the substance and possible confusion of it with Ethyl Alcohol. The suggestion was adopted on behalf of the Society.

The President and Sir Wm. Pope were nominated delegates to attend the celebration of the Coming of Age of the University of Leeds, and the Jubilee of the Yorkshire College in December.

On the invitation of the Dutch Chemical Society, the President was nominated to represent the Society at the Jubilee of the Foundation of Stereo-Chemistry laid by van't Hoff and Le Bel to be held in Amsterdam on October 25.

Mr. E. V. Evans was nominated delegate to the Smoke Abatement Conference in Manchester in November.

Permission was given to the Sydney Section to admit Associates on the same footing as already agreed to in Home and Canadian Sections.

Reports of various Committees were submitted, and 14 new members were elected:—Home, 8; Overseas, 6.

The arrangements for the Joint Dinner of the Society and the Chemical Industry Club in November were reported.

The following Committees were re-elected:—

House Committee: The President, Hon. Treasurer, Hon. Foreign Secretary, Mr. J. L. Baker, Dr. Wm. Cullen, and Prof. J. W. Hinchley.

Representatives on the Bureau of Chemical Abstracts: Dr. E. F. Armstrong, Mr. J. L. Baker, Mr. E. V. Evans, and Sir Wm. J. Pope.

Publications (*Transactions*) *Committee*: Mr. J. L. Baker, Mr. W. H. Coleman, Prof. J. W. Hinchley, Dr. W. R. Hodgkinson, Mr. E. Grant Hooper, Mr. W. F. Reid, and Mr. W. G. Wagner.

The next meeting of Council will be held on Friday, November 14, 1924, at 2.30 p.m.

SUSPENSION OF ENTRANCE FEE

As an inducement [illegible] chemists to become members, the Council has r[illegible] that no entrance fee shall be [illegible] members [illegible] the Society in 1925.

A form of application for membership will b found at the end of this section, and it is hope that it may be used to introduce a new member fo next year.

NOTTINGHAM SECTION

At the meeting held on October 8, Mr. W. J. U Woolcock, C.B.E., delivered an address on "Publicit in Chemical Industry," which was illustrated by th exhibition of two kinematograph films, "Coal and its Products" and "Heavy Chemicals," which wer much appreciated by the audience. A summar of Mr. Woolcock's address is given below:—

The growth in the practice of publicity in thi country has been so gradual that we have hardl noticed it. Only when we look back over a numbe of years do we realise what an enormous develop ment has taken place and how it has affected ever phase of our daily life. Every man, every firm, ever Association or Society, lives on his or its reputatio The Society loses its members, if it loses its reputatio for doing good work. The firm loses business as soo as its customers think it of poor repute. The ma makes no progress in his work unless he has th reputation for doing it well. Publicity is the agenc which makes reputation. Hence its importance i every industry, and in particular in chemical industry

I like to think of the days when there were n newspaper advertisements and no shop windows When the merchant and the tradesman were entirel dependent on the word-of-mouth recommendatio of their customers, and where their personal reputa tions were made by the publicity which came fron street corner or tavern conversations.

Then came the daring fellow who removed th discreet perforated zinc window blind which hid hi goods from the vulgar gaze, and boldly placed hi goods in the shop window. He was inevitabl considered a low person, but he possessed the essenti factor to success in publicity, that is, enthusiasm In the joint enterprise in which you and I are engage of building our Society we have to remember thre things:—

(1) The Society's existence depends on its reputa tion.

(2) Unless we give publicity to its work we canno build up its reputation.

(3) Enthusiasm for the work of the Society an enthusiasm in giving it publicity is essenti to our success.

But let us return to the enthusiast who started th shop-window publicity. I imagine as soon as hi example was followed, he thought of the possibilit of an advertisement in a newspaper, and I have wit me some reproductions of old copies of the *Tim* which were printed at Wembley, and which giv some idea of the restrained tone of the advertisement

Later in development came the displayed adve tisement with a carefully written-up article in th text of the paper. About the same time the use c the correspondence columns developed. At one tim the letters to the editor expressed the feelings of th readers of the paper. Righteous indignation agai

the Government—any Government—protests against oppression in all its forms, suggestions for the better conduct of every department of public life. In fact nothing but genuine expressions of feelings which could not be kept under. The advertiser to some extent gauged the popularity of a paper by the amount in its correspondence columns. This led to the stimulation of these columns, sometimes I fear by letters written by friends of the staff. Then came the beginning of publicity as we know it to-day; the realisation that "publicity" was "reputation," and that no cause could hope to obtain adherents, no industry could ultimately prosper unless in the eyes of the public it had reputation. This required a much more specialised treatment. The letter to the editor and the plain advertisement fell into disrepute and in their places came the use of "News" items. Let me illustrate what I mean by a wholly fictitious case. Suppose a branch of the industry is devoted to the manufacture of what I will call methauin products, and the production has reached a stage where the proprietors either want more capital or they want protection against foreign competition, or to increase their sales. We shall find all sorts of little paragraphs appearing as to the firm producing it. A wedding in the family of the proprietor will be recorded. A dinner of the directors and staff or an outing of the workpeople is written up—always with the name of the product well to the fore. An accident outside the works can always be utilised as "News." In other words a steady flow of news keeps the product before the general public. The art of poster publicity is now developed to an extraordinary and sometimes beautiful extent. I show one of the posters connected with the Exhibition. This brings me to the publicity of an industry in contradistinction to that of a firm. We have now realised that much can be done for individual firms in an industry by developing the public reputation of the industry itself.

A few years ago if you had casually touched a man on the shoulder and said one word—"chemicals" to him, and then asked him what was the first word that came into his mind, he would have said "Germany." It has been my ambition to change that, and so arrange the publicity of the industry that the reputation of the industry should be in everybody's mind. To this end there have been wireless talks, which, as you know, cannot be used for advertising any particular article or firm but can tell the people something about an industry. Then we had two films which will be shown you in a minute. These films were not designed for such an audience as this but for the public, and they are being shown in cinematograph theatres all over the country.

I now turn to the last method I shall mention of building up the reputation of an industry, that of exhibitions, and I shall refer to three types. In the first type I instance an exhibition for the lay mind. When the Safeguarding of Industries Bill was before the House of Commons, I found that a large number of my colleagues had but little knowledge of the substances which were dealt with in the Schedule of the Act. We, therefore, arranged an exhibition of fine chemicals, and their every-day applications. The exhibition was not open to the public, but we allowed the Press to visit it. Its scope of usefulness was limited, but it achieved exactly what we aimed at.

The second type of exhibition is to be found in the British Industries Fair. It is a purely trade exhibition, designed to attract buyers of chemicals. This does not necessitate a very attractive display, nor is it necessary to interpret the technical features.

The British Empire Exhibition, however, furnishes an excellent example of the third type of exhibition at which, although exhibitors hope to receive business inquiries or even to make sales, they realise that in the main they are spending their money on publicity. It is interesting to note how much good publicity is made by all small items. A fact, for example, that the Chemical Hall at Wembley occupies 40,000 sq. ft. and not 37,000 sq. ft. has been an advantage. It is the largest of the sections in the Palace of Industry, and because of being slightly larger than several other sections is always mentioned first. The fact that it is entered by a gate that is the called the "Alchemist Gate" is a trifle which has brought a good deal of publicity.

That the section has been prolific in good stories has also had its effect. One concerning an innocent German, who insisted on keeping his hat in one hand during the time he was allowed to hold a bottle of Perkin's Mauvein in the other has provided excellent copy. An accident at one of the stalls not only provided more copy but gave us a coat of blue paint on the roof and added to the comfort of the section during the short spell of warm weather which we had early in the year. On Sunday, when the sun's rays were breaking through the glass roof of the Chemical Hall, a large glass-covered dish, which was reputed to contain two million tuberculous bacilli burst with the heat. A mere hint to the Press representatives as to the possible effect of this accident was sufficient to secure a coat of blue paint which nothing else was able to do. I might add that the glass dish was only supposed to contain the germs.

The Chemical Section at Wembley, as I have stated, was designed to attract the notice of the public, and some millions of people have been through the Chemical Hall. The Scientific Section had a more limited appeal. Before a number of the public could be attracted to this part of the Chemical Hall there had to be some desire on the part of the visitor to know something about science, but it was a revelation to the organisers of the section how interested very large numbers of the general public were in everything connected with Science. Having satisfied that interest, it was quite easy to dispose of about 10,000 pamphlets following the different branches of science and written in popular language. The total cost of the Chemical Hall was rather over £100,000, roughly about 0·05 per cent. of the amount invested in chemical industry in this country.

One could say without fear of contradiction that the general public to-day is proud of its British Chemical Industry, and has begun to know and appreciate something of the work of its scientific chemists. I want to enlist the assistance of the branches of the Society in making still more widely known the work of its members.

CORRESPONDENCE

THE EARLY HISTORY OF ANTIMONY

Sir,—In his interesting article on "The Early History of Antimony," Dr. Hyman gives the date of "Basil Valentine's" book, "The Triumphal Chariot of Antimony," as 1624. It is perhaps not well known that the book first appeared in German in 1604, with the title: "Triumph Wagen Antimonii, Fratris Basilii Valentini, Benedicter Ordens, . . . publiciret und am Tag geben durch Joahann Thölden, Hessum, mit einer Vorrede Doctoris Joachimi Tanckij, Prof. in Univ. Leipz., Leipzig, Apels, 1604. (64 pp.) The Latin translation by Kerkringius appeared in 1671, and the illustration in the article is from this edition. The part played by Tanckius in the preparation of the book has not, so far as I know, been elucidated. It is generally regarded as a forgery by Thölde, the "editor"—if editors can be said to forge anything!

I may mention incidentally that James's "Medical Dictionary," a work filling three enormous volumes, contains many interesting notices on the history of chemistry.—I am, Sir, etc.,

J. R. Partington

East London College
October 10, 1924

CHEMICAL PUBLICATIONS

Sir,—It is only after severe mental travail that I have overcome a certain timidity in venturing to approach the fane of your stateliness.

I am not an ornithologist, and may be mistaken in supposing that the wren will fight to defend her young; but if she does so, it will be conceded that the heart of the wren militant must be wrung by conflicting emotions. Those emotions, Sir, are but as an ineffable calm when compared with my present feelings. Despite my timid nature, I feel impelled to resist an attack, although, unlike the wren, I am not actuated by the parental instinct.

The attack to which I refer takes the form of a bolt launched from a locality not 100 miles from Yorkshire, followed by a second bolt from the same locality aimed at the same target. A single shaft might have been condoned as accidental; the loosing of the second definitely establishes hostile intent, and has reduced me to a state of mind which I, being a chemist and therefore unable to write my own (or any other) language, am impotent to describe.

Although the bow has thus been drawn in such a remote locality, it has by no means been drawn at a venture. The target, Sir, is no less than a distinguished and useful society, a society devoted to the pursuit of pure science, as distinguished from science tainted with utilitarianism. That a society of this character should be dear to all chemists may be taken as axiomatic. Only stateliness such as yours, Sir, can bear with equanimity the news that it is from the hands of chemists that the hostile arrows have been sped. One is, at first, tempted to designate such treachery as "savage jealousy," but there is a double *entendre* which may explain their motives. While the society [illegible] am sure, dear to all chemists, to some chemists, Sir (and to this category belong our archers), the society is too dear. The world will, fortunately for its peace of mind, never know to what an extent my affection and esteem for a venerable society were wounded when, from a blue that in its serenity rivalled your own stateliness, those fell bolts descended. To you, as to a firm rock, I now look in this time when all my conceptions have been so rudely shaken. What I took for contented appreciation (I allude to the literary status of the society's publications) seems to have been ill-disguised tolerance. The eagerness with which the pages of those publications were scanned turns out to have been the impatient zest of the treasure hunter, which gives place to recriminations if the expected treasure is not forthcoming. Little treasure has, it would appear, been carried in the pages which have reached Yorkshire.

One criterion of works of literary merit is that they can—nay, must—be read and re-read. Literary pearls must often be dived for, and it is, I believe, R. L. Stevenson who emphasises that more joy lies in the quest than in the actual discovery. The *Journal* of the society in question, if a timid man may venture to assess a journal of such eminence, is a work of literary merit. Rarely, if ever, does the writer manage to skim the full cream of that journal in a single effort. To skim cream from some sections he has made repeated attempts, in not a few cases (tell it not in Gath) signally failing. It may be timidity which deters me from concluding—because I have failed in those cases to extract cream—that cream is absent. A conclusion of this nature, however, might possibly be drawn in a certain county which you might succeed in naming.

I have hitherto derived much innocent pleasure from my never-ending quest for cream, and Stevenson's words have consoled my all too frequent failures. In fact, I have lived for the quest. At intervals I receive my consignments of chemically prepared milk, the joys of skimming which are scarcely beginning to pall when the next delivery arrives. The following are examples of contributions which have given me the pure pleasure of the quest (to the entire exclusion, be it added, of the baser pleasure of discovery):—

(*a*) 4-Nitro-2-sulphophenyldehydrothio - *p* - toluidine sulphonic acid.

(*b*) Catalytic Racemisation of the Diastereoisomeric l - Menthyl Phenylbromoacetates.

(*c*) Action of Chlorine on 5-Chloro-1 : 1-dimethyl-Δ^4-cyclohexen-3-one.

It may seem invidious to single out these *inter pares*, but I feel that the thrills these items afforded me were not experienced by our archers.

Less timid minds than mine, Sir, have quailed at the idea of setting a money value on æsthetic pleasure. Such minds are now to be found in Yorkshire. The conclusion reached by these minds is that an upper limit can be defined to the possible values of the pleasures which I have so greatly enjoyed. That upper limit is not greater than £3 sterling per annum.

It has been said that a Jew chasing a Scottish debtor illustrates perpetual motion. I am neither Jew nor Scot, yet to me also £3 is (or are) £3. I

would perish rather than forego the pleasure I have been deriving as the result of spending that sum annually in a certain way, were it not for the fact that I was born, Sir, in Yorkshire. The modesty characteristic of that country dissuades me from claiming the *nom-de-plume* "Eboracum," which I feel sure would carry weight in certain quarters, but I feel also that in those quarters no need will be felt for the moral support of that admirer of your stateliness, Sir, who begs to sign himself,—Yours, etc.,

London J. W. Farmery
October 12

PERSONAL AND OTHER ITEMS

Mr. J. D. Mounsey has been elected Master of the Feltmakers' Company, Mr. P. H. Hirley of the Founders' Company, Mr. J. Lusty of the Loriners' Company, Mr. B. P. Thomas of the Glaziers' Company, and Mr. W. W. Leuchars Prime Warden of the Dyers' Company.

Messrs. W. B. Cooke and S. L. B. Etherton have been appointed to research assistantships in mining and fuel, respectively, in the University of Sheffield.

The German Institute for the Fermentation Industry recently celebrated the fiftieth anniversary of its foundation.

Sir W. Jones, chairman of the research committee of the British Refractories Association, is at present on a visit to the United States.

A special course of lectures in the Manchester College of Technology is to be held on "The Chemistry and Technology of Painters' Oils, Colours and Varnishes." The course, which begins on October 22, is held on Wednesdays from 7.30 to 8.30.

Sir Max and Lady Muspratt have returned to Liverpool from Canada.

The President of the Board of Education has appointed a Departmental Committee to consider what changes, if any, are required in the constitution of the University of London.

Mr. W. L. Helm, vice-chairman of John Knight, London, Ltd., has been appointed a managing director of Lever Brothers, Ltd.

Mr. J. B. M. Herbert has been appointed assistant lecturer in chemistry in the University of Manchester, in place of Mr. E. L. Hirst, who becomes lecturer in chemistry at Armstrong College, Newcastle-on-Tyne.

Sir William Alexander, chairman of the British Dyestuffs Corporation, has left Southampton by the R.M.S. *Mauretania* for New York.

On October 1, Sir William Bragg opened the new college of pure science in the University of Durham, afterwards receiving the honorary degree of D.C.L.

We regret to announce that Prof. G. D. Liveing is suffering from a fractured hip owing to being knocked down by a bicycle in Regent Street, Cambridge. Prof. Liveing is going on well, considering his 97 years.

Dr. R. Escales, founder of the "Zeitschrift für das gesamte Schiess- und Sprengstoffwesen," and of "Kunststoffe," a journal devoted to the technology of artificial textiles, died in September aged 61.

Canadian Nickel Industry

The British American Nickel Co. is stated to have gone into liquidation. The Murray mine and smelter, near Sudbury, Ont., and the refinery at Deschenes, Quebec, near Ottawa, have closed down. The company employed 700 men at Sudbury, and about 500 at the Deschenes plant. The British Government has a financial interest in the company. The failure is attributed to the inability of the Norwegian interests to render financial assistance.

Smoke Abatement Exhibition

The Smoke Abatement Exhibition to be held in Manchester in November next will include large gas and electrical displays, and will be representative of firms interested in the abatement of both industrial and domestic smoke. It is expected that a very large number of delegates from the municipalities and various institutions will be present at the Conference held in connexion with the Exhibition, when papers will be read on the production of smokeless fuel by the low-temperature carbonisation of coal, the use of town and producer gas in industry, mechanical stokers, domestic appliances, pulverised-fuel firing, oil firing, and the effects of smoke on health, building materials, and other subjects. A special feature will be the "Ideal Boiler House," which is being designed to illustrate how fuel economy and smoke abatement can be achieved by attention to the method of firing and the setting of a boiler. Information can be obtained from Mr. C. Elliott, B.Sc., A.M.Inst. C.E., Hon. Secretary, the Smoke Abatement League of Great Britain, 33, Blackfriars Street, Manchester.

Labour Problem in Mining

In his presidential address at the annual meeting of the Institution of Mining Engineers held at the British Empire Exhibition, Dr. J. S. Haldane, discussing the labour problem in mining, said that the real cause of labour unrest was rebellion against what was regarded as inhuman relations. The danger arose from the idea that the employed were only units in an economic machine manipulated without real sympathy for or understanding of the worker. As collieries became larger, so the need increased for a greater realisation of the conception of comradeship and men of real human sympathy were required on the executive staff. Neither high wages nor welfare schemes would satisfy those employed in mining but only discerning and sympathetic treatment, a sense of comradeship in a common enterprise.

Cement Manufacture in the Empire

The manifold uses of cement and especially its employment for the manufacture of concrete, now so largely used to replace brick and stone, render it of no little importance that all countries should be able to obtain cement for local use at a reasonable cost. In many overseas countries, particularly those remote from the present centres of production the use of cement is greatly restricted owing to the heavy cost of shipment and the consequent high

price of imported supplies. Portland cement is already being made in large quantities in several countries of the Empire, such as Canada, the Union of South Africa, Australia, New Zealand, and India, whilst operations on a smaller scale are being carried on in the Sudan, Rhodesia and Malaya. It seems probable that the raw products required for cement manufacture exist in nearly all parts of the Empire, but hitherto little information has been available regarding the possibilities of establishing a cement industry in most of the Crown Colonies and Protectorates. Considerable attention has been devoted to this question in recent years by the Imperial Institute, where a fully equipped cement-testing laboratory has been installed, and raw materials have been investigated from several localities, including Nigeria, Nyassaland, Kenya, India, Ceylon, Fiji, Jamaica, and Newfoundland. The current number of the *Bulletin* of the Imperial Institute contains an article discussing this important problem, particularly in relation to the possibilities of making cement in West Africa, Nigeria, Sierra Leone and Western Togoland. The article should be read by those interested in the manufacture of cement within the British Empire.

New British Chemical Standard Steel

Messrs. Ridsdale and Co. announce the issue of British Chemical Standard Carbon Steel "E" (B.O.H.) having the following standardised figures: Carbon, 0·114 per cent., and manganese, 0·492 per cent. This material has been specially prepared to meet the need for a widely recognised carbon (colorimetric) standard above 0·10 per cent., which is near to the maximum usually desired in tinplate manufacture. It has the additional convenience of being a low manganese standard, so that those who prefer to determine the carbon (colour) and manganese from the same proportion of sample may do so. As is usual, the analysis has been conducted by a number of independent analysts, works' chemists, and others (including the United States Bureau of Standards, Washington) representing different interests.

Bottles of standard turnings may be obtained from Headquarters, 3, Wilson Street, Middlesbrough, at a fee estimated to be sufficient to cover the cost of preparation. Three sizes are now provided viz., 500 gram, 100 gram, and 50 gram. A certificate giving the names of the analysts co-operating, the types of methods used (including numerous notes) and a detailed list of the individual analyses will be supplied with each bottle.

Diamond Jubilee Celebration of the L. M. & S. Railway Chemical Laboratory, Crewe

The sixtieth anniversary of the establishment of the L.M. & S. Railway Chemical Laboratory at Crewe (the first Railway Chemical Laboratory in the country) was celebrated by the staff (past and present) at a dinner held at Crewe on October 10. Captain Beames, M.I.C.E., the principal guest, and Dr. Lewis Dale, who was in the Chair, spoke of the [illegible] of the old L. & N.W. Railway in recog-[illegible] as 1864 the importance of the application of chemical science to industry.

REVIEW

Coal Carbonization. By H. C. Porter, M.S., Ph.D. American Chemical Society, Monograph Series. Pp. 442. New York: The Chemical Catalog Co., Inc., 1924. Price $6.

Although the carbonisation of coal is a branch of chemical technology that attracts an ever-increasing interest and inspires a rapidly growing literature, the author need make no apology for the book under review. By his early association with the experimental station of the U.S. Bureau of Mines, and later experience, he is well qualified to deal comprehensively with the subject, giving due weight to the scientific aspects as well as the industrial technique.

He opens with an introductory survey discussing the *raison d'être* of carbonisation in its various modifications, the advantages and the limitations which economic considerations set to the carbonisation of fuel. The different systems are compared. The scope of carbonisation processes is limited by the profitable disposal of all the products, and for this reason he thinks the towns' gas industry is "destined to become the largest exponent of coal carbonisation" because the metallurgical coke market has not the same prospects for expansion.

Two chapters are devoted to the chemistry of coal carbonisation, including the special treatment of the nitrogen and sulphur compounds. Then several chapters on coke-oven practice follow, starting from the preparation of coal for the oven and including the purification of gas and the recovery of by-products. This constitutes the main part of the book. It must be remembered that the author writes primarily of the American, which differs materially from European practice. None the less, this is, for British coke-oven men, one of the most valuable and interesting parts of the book. Although by-product coking was initiated in Europe, there is no doubt that of recent years the industry has developed more rapidly both in range and technique in America. In the nature of things, coke-oven experiments are expensive, and economic conditions are such that America is better able to embark on bold and costly innovations in large-scale practice. That is all the more reason why this book may be commended to British coke-oven workers, for modern American practice is here brought to a focus as nowhere else.

There is a long chapter on carbonisation for towns' gas, which covers ground where America has less to teach, and indeed has followed rather than led. The author is well acquainted with modern practice, but in dealing with steaming does not seem to have made the best use of available material. The report on experiments on the steaming of vertical retorts, initiated by the Institution of Gas Engineers, is not even mentioned.

The subject of low-temperature carbonisation, which in the author's opinion "has not attained or given assurance of attaining in the future such commercial success as to warrant assignment to a principal rôle," is dealt with in a chapter containing descriptions of a number of processes which have come before the public. Here considerable space is devoted to the ingenious Piron and Caracristi process

now attracting so much interest, but though estimates of cost are given, it is not made clear how far commercial success has been attained.

Prof. S. W. Parr has written an admirable introduction to the book which might fittingly have been reproduced as a review. The reviewer has no hesitation in recommending students and practitioners of coal carbonisation to seek in the perusal of this book both pleasure and profit.

H. J. HODSMAN

PARLIAMENTARY NEWS

HOUSE OF COMMONS

The Proposed German Dyestuffs Agreement

In a written reply to Mr. Graham White, who asked about the proposed agreement between the Interessen-Gemeinschaft and the British Dyestuffs Corporation, Mr. Sidney Webb stated that the Board of the British Dyestuffs Corporation had been informed that the Government would feel compelled to exercise their power of veto with respect to an agreement with the Interessen-Gemeinschaft on the lines suggested.—(Oct. 8.)

COMPANY NEWS

BRITISH GLUES AND CHEMICALS, LTD.

Presiding over the annual meeting, the chairman, Mr. T. Walton, said that during the past year, although raw materials had increased in cost, the company had slightly increased its output, and had by energetic salesmanship sold its increased production, so that stocks were now down, both in value and in weight. The steady expansion of the company's foreign markets was particularly encouraging. The company had, during the year, introduced to the market two new cattle foods, which had been well received by the agricultural community. Research work was going forward, the intention being to increase efficiency in manufacture and to find new uses for the company's products.

GLENBOIG UNION FIRECLAY CO., LTD.

The net profit of the company for the past year, including £10,155 brought forward, was £23,410. A dividend is recommended of 15 per cent. for the year, less tax, payable on October 27, carrying forward £5973. A sum of £10,872 was expended on repairs and renewals, and was paid out of revenue. The capital expenditure during the year was £1532.

BRITISH CYANIDES CO., LTD.

The report for the year ended April 30 last shows a loss of £24,991. From £14,847 brought forward from last year, there has to be deducted the interim dividend on the preference shares paid on December 15 1923, leaving £13,423 to be set against the loss made during the period under review and leaving a balance of loss to be carried forward of £11,568. The sum of £43,696 has been charged against reserve account, being the cost of the shares in the British Potash Co., Ltd., in liquidation, which are now of no value. The position and prospects of the company have greatly improved during the past few months.

BROKEN HILL PROPRIETARY CO., LTD.

The year ending May 31, 1924, is the first financia period since the establishment of the Steel Works a Newcastle that continuity of operations in all depart ments has obtained. The output from th Newcastle Works in 1924 was as follows, figure for 1923 being given in parentheses:—Pig iron 306,258 tons (62,334 t.); Steel ingots, 284,669 t (52,810 t.); coke, 305,084 t. (66,790 t.); sulphat of ammonia, 4545 t. (1071 t.); tar, 3,574,341 gals (706,148 gals.). In 1924, during 6½ months working 36,392 t. of ore was produced; 34,862 t. of crude or and tailings was treated, and 2158 t. of lead concer trates was produced. In the slimes flotation plar (Bradford Process), during 1924, 117,336 t. of slime were treated, and 12,011 t. of lead concentrate and 25,464 t. of zinc concentrates were produced The net profit for the period under review amounte to £279,339 2s. 2d., after providing £299,12 for all depreciation. The company has obtaine re-assessments of income tax for past years, and wa able to reduce the provisional amount held in reserv in Sundry Creditors' Account for this purpos The sum of £100,000 has been restored to Reserv Fund which now stands at the old figure of £1,500,00 and liquid assets total £1,030,684 7s. 7d. Productio during the year amounted to 305,084 t. coke, 3,574,34 galls tar and 4545 t. ammonium sulphate. Th plant for the manufacture of benzol, toluol an solvent naphtha has worked satisfactorily, 773,95 galls. motor spirit and 52,918 gall. solvent naphth being produced. A subsidiary company styled th B.H.P. By-Products Co. Pty., Ltd., was forme to acquire the tar distillation plant of Messr De Meric, Ltd. This new company had a successfu year and absorbed the whole of the output of ta from the coke ovens. Another new compan styled the B.H.P. Collieries Pty., Ltd., was forme during the year to develop coal-bearing land whic had been secured in the Maitland district, and commencement has been made with this work.

CANADIAN EXPLOSIVES, LTD.

The dividend of 1¾ per cent. for the quarter ende September 30 on the Seven per cent. cumulativ preferred shares is payable on October 15, to share holders on record September 30.

LAUTARO NITRATE CO., LTD.

A third interim dividend of 5 per cent. for th year 1924 has been declared, payable on October 2 to shareholders registered at the closing of th books on October 20, and to holders of share warra to bearer coupon No. 57. No dividends were pai for the previous four years, but in 1923 capitalised bonus of three new shares for eve seven held was distributed. The company recentl acquired the Lastenia Nitrate Company.

BRYANT AND MAY, LTD.

A dividend of 7 per cent. less tax, for the hal year ended September 30, 1924, has been declare on the preference shares, and an interim divide of 4 per cent. free of tax on ordinary and partnershi shares, payable November 1.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder..	£47 per ton.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali.. ..	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder..	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate	£38 per ton d/d. Normal business.
Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5½d. per lb.
Potass. Chlorate.. ..	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake..	£3 10s. per ton d/d.
Soda Caustic, solid ..	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton, carr. paid.
Sod. Bichromate.. ..	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
[illegible]	3d. per lb.
[illegible] 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
[illegible] conc. 60/65	About £14 10s. per ton d/d.
[illegible]t. ..	£9 per ton d/d.
[illegible] Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	6½d.—1s. 2d. per lb., according to quality.
Crimson	1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide ..	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide ..	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride ..	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green..	1s. 3d. per lb.
Indiarubber Substitutes White and Dark ..	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite ..	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P. ..	£47 10s.—£52 10s. per ton, according to quantity.
Sulphur Chloride ..	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep ..	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£12 per ton.
Grey	£16 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 15s.—£9 5s. per ton, according to grade and locality.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 10d. per gall. 60% O.P.
Solvent	5s. 3d. per gall. 40% O.P.
Wood Tar	£4 5s. per ton.
Brown Sugar of Lead ..	£43 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6¼d.—6½d. per lb. Quiet.
Crude 60's	1s. 7d.—1s. 9d. per gall, according to district. Market flat.
Acid Cresylic, 97/99 ..	2s.—2s. 1d. per gall. Demand fair.
Pale 95%	1s. 9d.—2s. 1d. per gall. Better enquiry.
Dark	1s. 9d.—2s. per gall. Fairly steady.
Anthracene Paste 40% ..	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6½d.—6¾d. per gall. Small demand
Unstrained	6d.—6½d. per gall.
Benzole—	
Crude 65's	7½d.—9d. per gall. ex works in tank wagons.
Standard Motor ..	1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.

Benzole—	
Pure	1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5d.—1s. 5½d. per gall. Small demand for home consumption.
Pure	1s. 8d.—1s. 9d. per gall. Small demand for home consumption.
Xylol coml.	1s. 9d. per gall. Prices reduced.
Pure	2s. 3d. per gall. Prices reduced.
Creosote—	
Cresylic 20/24% ..	8½d. per gall. Little demand.
Middle Oil .. .. / Heavy Oil .. .. / Standard Specification	5d.—6½d. per gall., according to quality and district. Fair business passing. Small demand from America.
Naphtha—	
Solvent 90/160 ..	11d.—1s. per gall. Demand good.
Solvent 90/190 ..	11d.—1s. per gall. Fair inquiry.
Naphthalene Crude—	
Cheaper in Yorkshire than Lancashire. Demand rather better.	
Drained Creosote Salts	£4—£6. Quiet.
Whizzed or hot pressed	£6—£9 per ton.
Naphthalene—	
Crystals and Flaked ..	£12—£15 per ton, according to district.
Pitch, medium soft ..	40s.—45s. per ton f.a.s. Market very flat.
Pyridine—90/160 ..	18s. 6d.—19s. per gall. Steady demand.
Heavy	12s. per gall. Market dull.

INTERMEDIATES AND DYES

Business in dyestuffs has again been better this week, and users seem to have more confidence.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 7d. per lb.
Acid H.	3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic ..	2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. ..	1s. 1d. per lb. Improved demand.
Acid Sulphanilic ..	9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	8d. per lb. naked at works.
Aniline Salts	8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. per lb. 100% basis d/d.
Benzyl Chloride 95% ..	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C. ..	4½d. per lb. Rather quiet.
m-Cresol 98/100% ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid ..	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene	9d.—10d. per lb. naked at works.
Dinitrochlorbenzol ..	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
Monochlorbenzol	£63 per ton.
β-Naphthol	1s. per lb. d/d.
α-Naphthylamine ..	1s. 4d. per lb. d/d.
β-Naphthylamine ..	4s. per lb. d/d.
m-Nitraniline	4s. 3d. per lb. d/d.
p-Nitraniline	2s. 3d. per lb. d/d.
Nitrobenzene	5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol ..	2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene ..	10½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine ..	3s. 11d. per lb. d/d.
p-Phenylene Diamine ..	10s. 2d. per lb. 100% basis d/d.
R. Salt	2s. 5d. per lb. 100% basis d/d.
Sodium Naphthionate ..	2s. 3d. per lb. 100% basis d/d.
o-Toluidine	10d. per lb.
p-Toluidine	2s. 10d. per lb. naked at works.
m-Toluylene Diamine ..	4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P. ..	£47 per ton. Firmer.
Acid, Acetyl Salicylic ..	3s. 1d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P. ..	3s. per lb.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 3½d.—1s. 4½d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst. ..	6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	1s. 6d.—1s. 8d. per lb., according to quantity.
Acid, Tannic B.P. ..	2s. 10d. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	2s. per lb. for quantity. More enquiry.
Amidopyrin	16s. 6d. per lb. for spot stocks.
Ammon. Benzoate ..	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate ..	12s. 6d. per oz. for English make.
Barbitone	14s. 3d. per lb. Cheaper.
Bismuth Carbonate ..	10s. 6d.—12s. 6d. per lb.
" Citrate	10s. 3d.—12s. 3d. "
" Salicylate ..	9s.—11s. "
" Subnitrate ..	8s. 8d.—10s. 8d. "
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Market firm.
Ammonium	1s. 6d.—1s. 9d. per lb. According to quantity.
Potassium	1s. 4d.—1s. 7d. per lb. According to quantity.
Sodium	1s. 5d.—1s. 8d. per lb. According to quantity.
Calcium Lactate ..	1s. 6d.—1s. 9d. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate	4s. per lb. Market easier after recent firmness.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Formaldehyde	£49 per ton.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	7s. per lb.
Glycerophosphates—	
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50% ..	3s. 6d. per lb.
Sodium, 50%	2s. 6d. "
Guaiacol Carbonate ..	10s. per lb.
Hexamine	3s. 1d.—3s. 3d. per lb.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor ..	English make offered, 120s. per oz

Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£25 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst, B.P.	55s. per lb. Price shows signs of recovery.
Synthetic	26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials	Market very quiet.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	1s. 10d.—2s. per lb. Seasonal increase in demand.
Methyl Sulphonal	24s. per lb. Slightly weaker.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 8d. per lb. for B.P. quality.
Paraldehyde	1s. 4d.—1s. 6d. per lb. in free bottles and cases. Supplies plentiful.
Phenacetin	5s. 9d. per lb.
Phenazone	7s. per lb.
Phenolphthalein	5s. 6d.—6s. per lb.
Potass. Bitartrate—	
99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	[illegible] per lb., 1-cwt. kegs included. f.o.r. London.
Potass. Permanganate	7½d. per lb. spot. Forward prices higher.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d.—4s. per lb.
Sod. Benzoate, B.P.	2s. 6d. per lb.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—	
Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Fair demand. Powder 2s.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 5d. per lb. Flake 2s. 6d. per lb.
Sod. Su[illegible]—	
Pure [illegible]	10d.—1s. 2d. per lb.
Sod. S[illegible]ate, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	15s. 6d. per lb. Little demand.
Thymol	17s. per lb. Slightly cheaper.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.
Aubepine	15s. 3d. ,,
Amyl Acetate	2s. 6d. ,,
Amyl Butyrate	6s. 9d. ,,
Amyl Salicylate	3s. 3d. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,
Benzyl Alcohol free from Chlorine	2s. 9d. ,,
Benzaldehyde free from Chlorine	3s. 6d. ,,
Benzyl Benzoate	3s. 6d. ,,
Cinnamic Aldehyde—	
Natural	18s. 9d. ,,
Coumarin	19s. 6d. ,,
Citronellol	17s. ,,
Citral	8s. ,,
Ethyl Cinnamate	12s. 6d. ,,
Ethyl Phthalate	3s. 3d. ,,
Eugenol	10s. ,,
Geraniol (Palmarosa)	33s. 6d. ,,
Geraniol	11s.—18s. 6d. per lb.
Heliotropine	6s. 9d. ,,
Iso Eugenol	15s. 9d. ,,
Linalol ex Bois de Rose	26s. ,,
Linalyl Acetate	26s. ,,
Methyl Anthranilate	9s. 6d. ,,
Methyl Benzoate	5s. ,,
Musk Ambrette	50s. ,,
Musk Xylol	13s. 6d. ,,
Nerolin	4s. 9d. ,,
Phenyl Ethyl Acetate	15s. ,,
Phenyl Ethyl Alcohol	16s. ,,
Rhodinol	60s. ,,
Safrol	1s. 10d. ,,
Terpineol	2s. 4d. ,,
Vanillin	25s. ,,

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 8d. per lb.
Bergamot Oil	16s. 6d. per lb.
Bourbon Geranium Oil	35s. per lb.
Camphor Oil	65s. per cwt.
Cananga Oil Java	10s. per lb.
Cinnamon Oil, Leaf	6½d. per oz.
Cassia Oil, 80/85%	9s. 9d. per lb.
Citronella Oil—	
Java 85/90%	5s. 9d. per lb.
Ceylon	3s. 3d. per lb.
Clove Oil	7s. 6d. per lb.
Eucalyptus Oil 70/75%	2s. 3d. per lb.
Lavender Oil—	
French 38/40% Esters	28s. 6d. per lb.
Lemon Oil	3s. per lb.
Lemongrass Oil	4s. 6d. per lb.
Orange Oil, Sweet	11s. per lb.
Otto of Rose Oil—	
Bulgarian	40s. per oz.
Anatolian	18s. per oz.
Palma Rosa Oil	16s. 6d. per lb.
Peppermint Oil—	
English	65s. per lb.
Wayne County	30s. per lb.
Japanese	Market practically bare.
Petitgrain Oil	9s. 3d. per lb.
Sandal Wood Oil—	
Mysore	26s. 7d. per lb.
Australian	18s. 6d. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Dec. 7th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Oct. 23rd.

I.—Applications

Bollmann. Heat-exchanging and distilling apparatus. 23,036. Sep. 30.

Cloudsley, and Lever Bros. Centrifugal separation of liquids etc. 23,081. Sep. 30.

Ellis (Ehle). Furnaces. 23,504. Oct. 4.

Fairweather (Spolka Lidowiecka Handlowo-Przemyslowa Sp. z.o.o.). Grinding and pulverising materials. 22,881. Sep. 29.

French. Furnaces. 23,172. Oct. 1.

Gardner. Apparatus for minute disintegration of substances. 22,975. Sep. 29.

Gerats. Determining critical temperatures. 23,213. Oct. 1.

Higgins. Processes involving exchange reactions. 23,183. Oct. 1.

Hooton, and Johnson and Co. Filters. 23,128. Sep. 30.

Irwin, and Johnson and Co. Filters. 23,129. Sep. 30.

Judelson. Driers. 23,496, 23,497. Oct. 4.

Morris. Pulverising or emulsifying apparatus etc. 22,947. Sep. 29.

Nyrop. Separation of particles from gases or liquids. 23,415. Oct. 3.

I.—Complete Specifications Accepted

5063 (1924). Herbst and Herbst. Mixing, kneading, and beating machine. (222,380.)

5932 (1924). Joseph. Filters for air and other gases. (222,385.)

8477 (1923). Sauer. Manufacture of adsorbent materials. (222,159.)

16,157 (1923). Peale, Peale, and Peale. Separating materials of different specific gravities. (222,185, 222,186.)

20,880 (1923). Fitzpatrick. Drying and coating porous materials for use as adsorbents and catalysts. (222,279.)

22,639 (1923). Duclaux. Membranes for ultra-filtration and dialysis. (203,713.)

464 (1924). Marks (Soc. Anon. des Produits à Flenu). Apparatus for sorting granular materials of different specific gravities. (222,361.)

6077 (1924). Pellegrino. Drying-ovens. (222,386.)

19,596 (1924). Sauer. Manufacture of adsorbent materials. (222,423.)

II.—Applications

Bertels. 23,374. *See* X.

Brown and Winser. Retorts for dry distillation of oils, tars, etc. 23,358. Oct. 3.

Ges. für Maschinelle Druckentwasserung. Preparation of raw peat to be dewatered by pressing. 23,191. Oct. 1. (Ger., 1.10.23.)

Goldstein. Treatment of hydrocarbons. 23,104. Sep. 30.

Heyl. Distillation of oil shale, coal, etc. 22,910. Sep. 29.

Hezlet. X-ray tubes. 23,208. Oct. 1.

In-Com. Gas Co., and Waldor. Fuel and means for consuming same. 22,926. Sep. 29.

Jenkins and Scott. Separating coal from shale etc. 23,293. Oct. 2.

Kidd, Pique, and Smith. 23,418. *See* XXIII.

Mitchell. External heating of vertical gas-retorts. 23,158. Oct. 1.

II.—Complete Specifications Accepted

16,956 (1923). Wood, and Minerals Separation, Ltd. Dewatering coal. (222,221.)

20,131 (1923). Imray (N. V. Silica en Ovenbouw Mij). Manufacture or treatment of coke, and manufacture of gas from coke. (222,270.)

29,008 (1923). Farbenfabriken vorm. F. Bayer und Co. *See* VII.

1193 (1924). Collin und Co. Regenerative coke ovens. (211,112.)

III.—Applications

Brown and Winser. 23,358. *See* II.

Goldstein. 23,104. *See* II.

IV.—Application

Hereward, Thomas, and Scottish Dyes, Ltd. Production of dyestuffs etc. 23,207. Oct. 1.

IV.—Complete Specification Accepted

31,990 (1923). Comp. Nat. de Mat. Colorantes et de Prod. Chimiques. *See* XX.

V.—Applications

Percival (Niederer et Cie.). Production of textile fabric with silk-like gloss. 23,201. Oct. 1.

Ross. Treatment of flax etc. 23,272. Oct. 2.

Schwalbe. Treatment of sulphite cellulose waste liquor. 23,227. Oct. 1. (Ger., 6.11.23.)

V.—Complete Specifications Accepted

7880 (1923). Tate. Converting fabrics. (221,980.)

8633 (1923). Granton. De-inking printed paper. (222,160.)

13,340 (1923). Dreyfus. Manufacture of solutions, dopes, or varnishes from cellulose derivatives. (222,168.)

17,764 (1923). Lilienfeld. Manufacture of cellulose ethers. (200,815.)

3989 (1924). Marks (Bemberg Akt.-Ges. Manufacture of artificial silk. (222,373.)

VI.—Applications

Calico Printers' Association, Ltd., and Roberts. Machines for ageing fabrics. 23,303. Oct. 2.

Calico Printers' Association, Ltd., and Roberts. Machines for wet treatment of cloth. 23,304. Oct. 2.

Standard Silk Dyeing Co. Washable dyed silk piece goods, and process of dyeing same. 23,101. Sep. 30. (U.S., 1.12.22.)

VII.—Applications

Cederberg. Manufacture of nitric acid. 23,211. Oct. 1.

Nicklin. Manufacture of ammonium sulphate and other salts. 23,161. Oct. 1.

Soc. d'Etudes Minières et Industrielles. Manufacture of nitrogen peroxide. 23,501. Oct. 4. (France, 18.9.24.)

VII.—Complete Specifications Accepted

23,567 (1923). Hartstoff-Metall Akt.-Ges. (Hametag). Producing substances from boron and carbon. (204,337.)

29,008 (1923). Farbenfabriken Vorm. F. Bayer und Co. Obtaining sulphur from gases containing hydrogen sulphide. (207,196.)

VIII.—Complete Specification Accepted

12,125 (1924). Pfalzische Chamotte-Thonwerke and Strack. Refractory bricks for blast-heaters or the like. (219,943.)

IX.—Application

Girouard. Manufacture of Portland cement. 22,945. Sep. 29.

X.—Applications

Ashcroft. Recovering tin from tin-plates etc. 23,289. Oct. 2.

Bertels and Martin. Decarbonisation of cast iron etc. 23,373. Oct. 3.

Bertels and Martin. Purification of gases for decarbonisation of cast iron etc. 23,374. Oct. 3.

Duffield. Reducing iron ore etc. from pyrites to metal etc. 23,407. Oct. 3.

Garnett and Holden. Non-corrodible alloys. 23,223. Oct. 1.

Robinson. Solder and soldering process for aluminium etc. 22,909. Sep. 29.

X.—Complete Specifications Accepted

8358 (1923). Aluminium Co. of America. Coating articles of aluminium or aluminium alloys. (212,504.)

8374 (1923). Potts (Electro Metallurgical Co.). Production of non-oxidizing non-brittle sheets of chrome iron alloys. (222,158.)

19,296 (1923). Pollak. Applying electrolytic metal coatings to porous bases. (201,567.)

XI—Application

Sachs. Anode batteries. 23,054. Sep. 30.

XI.—Complete Specification Accepted

19,296 (1923). Pollak. *See* X.

XII.—Application

Bollmann. Apparatus for removing odoriferous substances from oils and fats. 23,937. Sep. 30. (Ger., 12.6.24.)

XIV.—Applications

Bruni. Vulcanisation of rubber. 23,423. Oct. 3. (Italy, 15.2.24.)

Crick. Latex-treated materials etc. 23,179. Oct. 1.

Wiegand. Manufacture of rubber compositions. 23,003. Sep. 29.

XV.—Application

Aische and Marsh. Manufacture of size etc. 23,255. Oct. 2.

XVI.—Complete Specification Accepted

16,053 (1923). Ishitani and Kaisha. Manures. (222,181.)

XVII.—Application

Pollak. 22,952. *See* XX.

XVII.—Complete Specification Accepted

1307 (1924). Vecchis. Purifying juices and syrups in extraction of sugar from beet. (211,113.)

XVIII.—Application

Pollak. 22,952. *See* XX.

XIX.—Applications

Rees. Bleaching cereals, nuts, etc. 23,009. Sept. 30.

Stevenson. Treatment of milk. 22,934. Sep. 29.

XIX.—Complete Specification Accepted

20,047 (1923). Vogel. Manufacture of an arsenical preparation for exterminating pests. (222,268.)

25,023 (1923). Evans. Insecticide. (222,320.)

XX.—Applications

Pollak. Production of lactic acid from sugar-containing materials. 22,952. Sep. 29. (Czechoslovakia, 29.9.23.)

Riedel Akt.-Ges. Manufacture of barbituric acid derivatives. 23,112. Sep. 30. (Ger., 10.10.23.) Also 23,234. Oct. 1. (Ger., 28.6.24.)

Stephen. Manufacture of aldehydes and intermediate products. 23,136. Oct. 1.

XX.—Complete Specification Accepted

31,990 (1923). Comp. Nat. de Mat. Colorantes et de Produits Chimiques. Manufacture of perylene. (208,721.)

XXI.—Application

Godowsky and Mannes. Colour photography. 23,238. Oct. 1.

XXI.—Complete Specifications Accepted

17,138 (1923). [illegible]moto. Photographic combined developing and fixing compositions. (201,538.)

11,963 (1924). Christensen. Manufacture of multi-colour screens for colour photography. (216,853.)

XXIII.—Application

Kidd, Pique, and Smith. Determining impurities in gases. 23,416. Oct. 3.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*British India:* Ironwork, (Director-General, India Store Department, Branch No. 10, Belevdere Road, Lambeth, S.E. 1); *Cuba:* Artificial and other silk, (398); *Denmark:* Iron castings, (388); *Egypt:* Leather, (396); Leather, (B.X./1267); paint, (B.X./1271); *France:* Tinplate, copper sulphate, (389); *Italy:* Varnish and enamel paint, (390); *New Zealand:* Artificial silk, (384); *Porto Rico:* Chalmougra oil, pharmaceutical products, (399); *South Africa:* Stainless steel, (387).

Notes on Plant and Products

Pulverised Fuel.—The Vickers and International Combustion Engineering, Ltd., have contracted to supply a complete power plant utilising pulverised fuel to the York Street Flax Spinning Co., Ltd., Belfast.

Messrs. Vickers and International Combustion Engineering, Ltd., have also received a large order from Synthetic Ammonia and Nitrates, Ltd., for the boiler house for an electric power station at the Billingham-on-Tees factory. The order includes the complete equipment of the boiler house, which comprises two Thompson water-tube boilers (heating surface 9000 sq. ft., working pressure 275 lb. per sq. in.), fitted with Lopulco furnaces utilising pulverised fuel, and two Raymond roller pulverisers, each with a capacity of 6 tons of bituminous coal per hour.

Statistics in Government Publications

The Permanent Consultative Committee on Official Statistics has issued Volume II. of its annual Guide to Current Official Statistics (H.M. Stationery Office, price 1s. net, post free 1s. 4½d., pp. 306). The volume continues the detailed and systematic survey, commenced in the first issue, of the statistics contained in all current official publications. The aim of the Guide is to place the enquirer in touch with the publications containing statistics bearing on his subject, and to inform him as to the degree and mode of analysis of the statistics he will find in the volumes to which he is referred. In addition to other new features, an appendix has been added on this occasion consisting of a broad survey of publications of permanent statistical interest issued mainly since 1900.

PUBLICATIONS RECEIVED

JOURNAL OF CHEMICAL EDUCATION. Vol. I, No. 7. Pp. 137-170. Easton: Pa., The American Chemical Society, 1924.

QUALITATIVE CHEMICAL ANALYSIS OF INORGANIC AND ORGANIC SUBSTANCES. By H. W. Schimpf, Ph.G., M.D. Fourth edition, revised by A. I. Cone. Pp. ix. 201. London: Chapman and Hall, Ltd., 1924. Price 8s. 6d.

Form A.

THE

SOCIETY OF CHEMICAL INDUSTRY.

FOUNDED 1881. INCORPORATED BY ROYAL CHARTER 1907.

CENTRAL HOUSE, 46 & 47, FINSBURY SQUARE, LONDON, E.C. 2.

We, the undersigned Members of the Society of Chemical Industry, hereby propose

(Candidate's Name in full)..

as a fit and proper person to become a Member of the Society of Chemical Industry.

For Names *only* of Members recommending the Candidate. ....

....

....

And I, the said Candidate for Membership, hereby undertake that, if elected, I will be bound by the Charter and By-laws and by any Regulations made thereunder, and will further the objects of the Society.

(Signature of Candidate)..

Address to which the Candidate wishes the Society's Publications to be sent, and which is to be entered in the Society's Register. ....

....

....

Profession or Business Occupation. .... Date..

EXTRACT FROM THE BY-LAWS RELATING TO MEMBERS.

BY-LAW 5.—Every person desirous of being admitted as a Member of the Society shall be duly proposed as a Candidate for admission upon Form (A) set out in the Schedule, or such other form as the Council may from time to time prescribe. The proposal form shall be signed by two Members, to one of whom at the least the Candidate shall be known personally, and every Candidate shall make and subscribe the declaration therein contained—that, if elected, he agrees to be bound by the Charter and By-laws and by any Regulations made thereunder, and to further the objects of the Society. *Proposal of Candidate.*

BY-LAW 6.—All proposal forms of Candidates, duly signed and subscribed as hereinbefore provided, received by the General Secretary prior to an Ordinary Meeting of Council, shall be considered thereat, and the Council may, in their absolute discretion, by resolution passed by a majority of those present, elect or postpone the election of any Candidate as a Member of the Society, or may refuse to elect any Candidate whom they consider to be not a fit or proper person to be elected as aforesaid, and upon such election may also decide whether any Member so elected shall be required to pay for the year then current the whole or any part of the annual or other subscription or other fee hereafter provided, and thereupon the General Secretary shall give notice of such election and decision to the Member elected as aforesaid, and upon such notice and the payment of the said subscription or other fee, the person so elected shall, pursuant to the Charter and By-laws, become and continue to be subject to all the duties and obligations and entitled to all the rights and privileges of a Member. *Election of Members.*

BY-LAW 8.—Except as otherwise decided by the Council, every Member shall, upon notice of his election, in addition to a subscription for the current year in which he is elected, or any payment in lieu thereof, pay to the Treasurer, or other person appointed by the Council to receive Members' fees or subscriptions, an entrance fee of One Guinea, or such other amount as may for the time being be prescribed by Regulations. *Entrance Fee.*

BY-LAW 9.—Every Member shall on the First day of January in each year pay to the Treasurer, or other person as aforesaid, the sum of Two Pounds Ten Shillings, or such other sum as the Council may prescribe by Regulations, and every Member shall upon his election pay the like amount, as his subscription for the year current in which he is elected, or such part thereof as may be decided by the Council, but in lieu of any such payment a Member may compound for that and all future payments, as hereinafter provided. *Annual Subscription.*

A Member joining under the age of 25 shall be entitled to pay a subscription of £2 per annum until attaining the age of 25, or for 3 years from date of election, whichever is the longer period, but subject to the provisions that his application for Membership must be accompanied by (1) satisfactory evidence of age, and (2) a declaration that he is not joining the Society as a nominee of any firm or corporation, but solely in his own interests as an individual member.

BY-LAW 11.—Any Member whose annual subscription, payable on the First day of January, is unpaid on the First day of March next following shall, while remaining subject to the duties and obligations, not be entitled to any of the rights of a Member until such subscription shall be paid, and at any time after the First day of March, the General Secretary shall give notice to all Members whose subscriptions are so in arrear, and if any Member on the next ensuing Thirty-first day of December shall continue in arrear, such Member shall cease to be a Member, and his name shall then be removed from the Register by the General Secretary, but without prejudice to the right of the Council to recover any such arrears or to enforce any duty or obligation to which, as a Member, he may have become liable at the time of such removal, in any Court of competent jurisdiction. Notwithstanding anything in this By-law provided, the Council in the exercise of their sole discretion may, having regard to the circumstances in which the subscription of any Member shall be in arrear as aforesaid, postpone or remit the payment thereof, and continue such Member in full enjoyment of all rights of Membership as if such subscription had not at any time been or continued in arrear. *Subscriptions in arrear.*

BY-LAW 13.—Any Member may at any time determine his Membership by notice in writing to that effect, sent to the General Secretary, but such notice in order to operate as a determination shall be accompanied by payment of any subscription or fee which at the date of the notice shall have become payable by the Member, and which remains unpaid. *Resignation of Members.*

N.B.—Entrance Fee suspended for the year 1925.

This form should be completed and signed by the Applicant for membership, and should then be sent to—

THE GENERAL SECRETARY,
SOCIETY OF CHEMICAL INDUSTRY,
CENTRAL HOUSE,
FINSBURY SQUARE,
LONDON, E.C. 2

from whom all further particulars may be obtained on application.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY.

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

VOL. 43 NEW SERIES — LONDON, OCTOBER 24, 1924 — No. 43

EDITORIAL

WE published last week a list of chemical meetings to be held in London. This list and the list of chemical societies, which appears each week at the top of our first page, should drive home to us the great number of chemical societies which exist and the great expense involved in belonging to the most important of them. It is not only the annual subscription which has to be faced; there are entrance fees on joining the majority of these societies, and the cost of binding the journals at the end of the year is of the same order of magnitude as the annual subscriptions, instead of being, as formerly, a trifling number of shillings. The expense of storing the bound journals is also a housing problem of the utmost importance. The Society of Chemical Industry has recently decided to suspend its entrance fee for the year 1925, and this step will be welcomed by many chemists who feel that such a procedure is a step in the right direction. It remains to be seen whether the additional number of new members who will avail themselves of this opportunity will compensate for the loss of the entrance fees and justify the Society in continuing the policy. There is a constant struggle going on in all the societies between the necessity of making both ends meet and the desire to provide the most for each member at the lowest cost. The struggle affects this journal as it does many others; "publish more articles, more reviews, more items of news," say the majority of our readers; "save fifty pounds a week on printing if you can," say our financial autocrats. This awkward dilemma confronts us every week and every week we have complied with both demands. We have printed more pages of *Chemistry and Industry* this year than during the corresponding period of last year; the pages are about ten per cent. larger than they were; nevertheless the total cost of the *Journal* appears so far to be about four-fifths of the cost during the corresponding period of last year. This considerable economy justified the Council in making the concession to new members we have referred to. It remains for the present members to induce so many of the younger chemists to join the Society that the financial result to the Society will not be more than its resources can endure.

*   *   *

In the Journal of the Franklin Institute for October, 1924, is an interesting paper by Dr. C. B. Lipman and Mr. J. K. Taylor, both of the University of California, entitled: "Do Green Plants have the power of fixing elementary Nitrogen from the Atmosphere?" In the year 1853 a Frenchman, M. Ville, asserted that green plants fixed atmospheric nitrogen. M. Boussingault and Messrs. Lawes, Gilbert and Pugh satisfied themselves and the world at large that green plants had no such power, and for sixty or seventy years their decision has been accepted. More recently two Italians, Messrs. Mameli and Pollacci, made experiments which confirmed M. Ville's original statement. Now Dr. Lipmann and his colleague publish the details of a large number of experiments which also confirm the conclusion of M. Ville. Those who have not performed experiments on plant culture and the determination of nitrogen in plants cannot be expected to follow with adequate care and logic the details of such work and the critical examination of it and of conflicting experiments. Nitrogen may be absorbed by the plant or by bacteria attached to it; the seeds, the solutions in which they germinated, and the air are all possible sources of nitrogen; the nitrogen in the air may be elementary or may exist as ammonia or oxides of nitrogen. All these considerations appear to have been carefully studied by the authors of the paper; the experiments they made were numerous and are described in detail, and the authors themselves are convinced that some plants, for instance wheat and barley, gain nitrogen at the expense of the elementary nitrogen of the atmosphere. Peas seemed to be unable to do this; *Bromus* had a slight power of fixing nitrogen. The authors of the paper have clearly made out a *prima facie* case for such fixation; those who are able to estimate at its true value the evidence they have published will be able, or perhaps unable, to point out errors, fallacies and false deductions. The decision of this vexed

question may be both interesting and important, and we are confident that our readers would welcome a critical examination of the paper we have referred to.

* * *

Prof. Lowry presents us this week not with a dissertation on co-ordination, but with some pithy observations on the psychology of chemists. Just as the expert may detect that in a supersaturated solution there are portions which will soon crystallise, so, too, the observant will notice in Prof. Lowry's historical memoir a number of observations, which he was on the point of making, but has yet retained in a fluid state, nevertheless with a definite orientation or polarisation. The quick reception of new points of view declines with maturity. Mr. Asquith is a little dubious about such a simple scheme as the nationalisation of banks. If a man accepts eagerly a bulky and a boggy bun, he is probably still young in mind and appetite. For chemists a more subtle test is required; there is no one universal elixir which will discriminate between those who are ascending the curve and those whose tangents are already beginning to point downwards. Tests, indeed, there are; they shock the more sedate; photosynthesis, synthetic syrups (sirops as we fancy they are called in dry countries), hydrogen ion concentration, solvation, the re-entrant orbits of the nineteenth electron of strontium, these are examples of the newer phases, corresponding to the shingled hair and the syncopated tunes. But whether the new theories please or displease particular individuals is of very little consequence. The science advances; the substitution theory of Dumas, said to have originated with a smoky candle, has proved serviceable; the tetrahedral conception of the carbon atom has explained many phenomena; ions, electrons and orbits, electrovalency and all other valencies, will all take their places in the great procession proudly marching towards the truth. And, the proud man, dressed with a little brief authority, can do so little to retard progress. He may do much to open up a new avenue, as van't Hoff did. But whether he is easy or worried by new facts or new beliefs is of no moment. *Quand Sa Hautesse envoie un vaisseau en Egypte, s'embarrasse-t-elle si les souris qui sont dans le vaisseau sont à leur aise ou non ?*

The development of chemistry as a science and as an essential ingredient of modern industry and civilisation is as certain as the revolution of the planets in the solar system. Its teaching can neither be ignored nor forgotten :—

> The Moving Finger writes; and having writ
> Moves on; nor all your Piety nor Wit
> Shall lure it back to cancel half a line,
> Nor all your Tears wash out a Word of it.

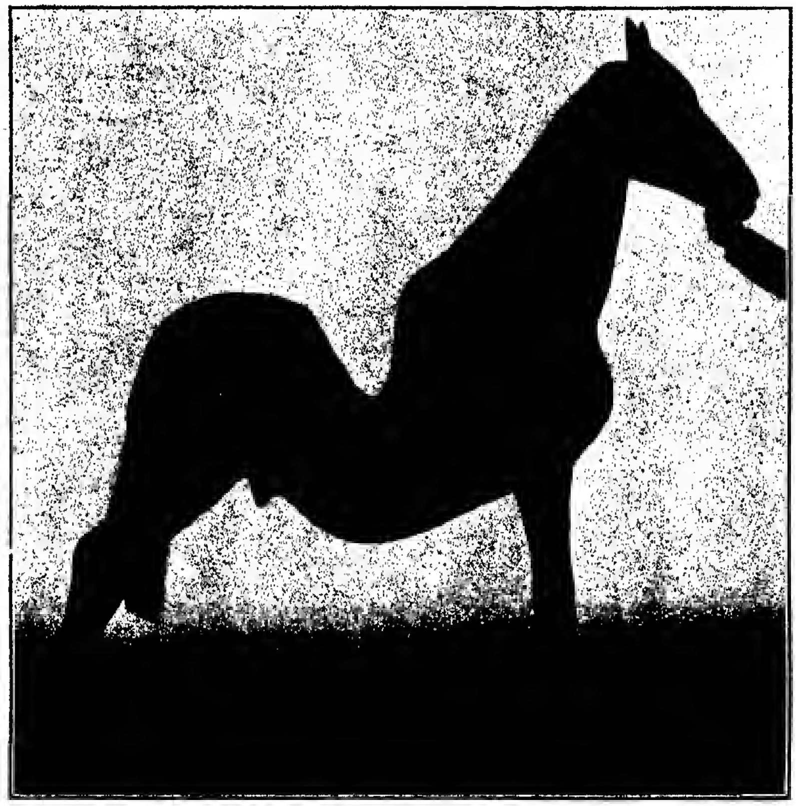
We are proud of the part which the Society of Chemical Industry takes in making known the new facts, and the new theories. When we glance over any of the past volumes we realise how immense is the service the Society has rendered, how essential it is that this be maintained and how glad are those who spend so much of their time in organising the Society, its Sections and its Engineering Group.

MEN AND MANNERS
I—THE PEGASUS OF VAN'T HOFF

1. If a student of organic chemistry were asked to name the two features which form the crowning glory of that branch of science, it is almost certain that his reply would include at least one of the following :—First, the development of structural formulæ, based upon the quadrivalency of carbon, whereby the whole of the reactions of a compound can be summarised in a single picture. Second, the tetrahedral model of the carbon atom, with the explanations that it gives of ring-formation, stereoisomerism, and the still more delicate phenomena of optical isomerism. It is therefore both interesting and instructive to recall the way in which these supremely important discoveries were received by a chemist of the old school, nourished on the "sincere milk of the word," the unadulterated "Gospel according to Berzelius." The story has to some extent fallen into oblivion, but is set forth in outline in Schorlemmer's "Rise and Development of Organic Chemistry," perhaps the most fascinating book on organic chemistry that has yet been written. Schorlemmer's picture of Kolbe attacking Kekulé, Wislicenus, van't Hoff, Fischer, and von Baeyer in turn is, however, sufficiently amusing to justify a search through Kolbe's papers for the original references, which Schorlemmer does not give.

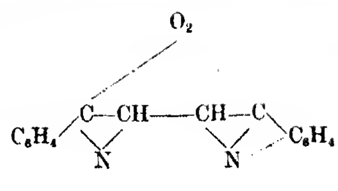
2. The attack upon Kekulé is contained in a "Criticism of Aug. Kekulé's address 'On the Scientific Aims and Achievements of Chemistry,'" (*J. für prakt. Chem.*, 1878, **125**, 139-156) on the occasion of his inauguration as Rector of the University of Bonn in October, 1877. Kolbe asserts that "During the last 15 years nobody in Germany has exerted a worse influence upon exact chemical research and on the young chemist than Kekulé. The beautiful experimental work which he published in 1858 on mercury fulminate and on glycollic acid, and in 1861—1864 on succinic, fumaric, pyruvic, and itaconic acids, justified the expectation that this still youthful chemist would enrich our science with yet more important discoveries. These expectations have been disappointed. . . . Instead of valuable chemical discoveries he has given to chemistry only two phantasies, the so-called theory of bonds and the doctrine of the benzene-ring. This was the beginning of the great decline of chemistry in Germany. . . . And not only do young inexperienced chemists follow eagerly the direction pointed out by Kekulé . . . but older chemists also have allowed themselves to be seduced into treading the same path. Our science is not permanently injured by such ephemeral abberations; more to be pitied are the young chemists educated in such schools, who learn to arrange the atoms in chains, to write elegant structural formulæ, and by working to a pattern to increase somewhat the number of ortho-, para- and meta-compounds, but have little experience, especially in the field of inorganic chemistry. Is it to be wondered at that our chemical manufacturers have now a great prejudice against the theorising but useless chemists turned out by the universities and technical schools ?"

These criticisms fill sixteen pages of text with polemical matter, the publication of which is accounted for by the fact that Kolbe was himself the editor of the journal in which they appeared. They conclude with a suggestion that Kekulé's speculations might be completed by assuming that molecules, which are fixed by bonds in three dimensions, may still possess freedom of vibration in a fourth dimension! This view has, I believe, been revived in recent years as the basis of a mechanism for the Walden inversion, but the theory is Kolbe's own. Kolbe's deliberate jest is, however, perhaps less humorous than his repetition of the perennial wail about the seducing of youth, since this alleged seduction had been used more than 2000 years ago as an excuse for an experimental research by Socrates on the narcotic properties of coniine.

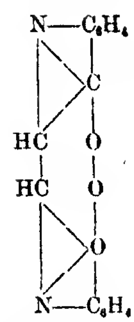


The "Pegasus of van't Hoff"

3. Kolbe's lament, that the spread of structural chemistry had brought about a revolt of chemical manufacturers against the university-trained chemist, receives added interest from the fact that he made a special attack upon von Baeyer in connexion with his investigations on the structural formula of indigo. The discovery of the structure of this compound, and the syntheses which followed almost inevitably from it, provided materials for the supreme triumph of German organic chemistry in the industrial field; but this would scarcely have been possible if the manufacturers had not adopted a more enlightened view than their academic colleague of the value of theoretical chemistry. In this particular case, Kolbe's humour consisted in writing the formula in two ways, the first being "indigo in the form of an umbrella, with cover and knob, but minus a stick" whilst the second shows indigo "in the form of a tower with a winding staircase" (*J. für prakt. Chem.*, 1883, **25**, 257).



The indigo umbrella



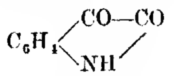
The indigo turret

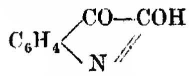
Kolbe's own views on the structure of this group of compounds are set out in a paper under the title,

"What is isatin?" (*J. für prakt. Chem.*, 1883, **27**, 491); but they are scarcely intelligible to a modern reader. Thus, he asserts that—

"Isatin=$(C_6\left\{\begin{matrix}H_4\\N\end{matrix}\right\}CO)COH$ (Stickstoff benzoyl-Formyl)"

On the other hand, Baeyer's two formulæ for isatin are supplied with descriptive titles as follows (*J. für prakt. Chem.*, 1883, **28**, 39).


Old hieroglyphics


New hieroglyphics

A separate article (*J. für prakt. Chem.*, 1882, **26**, 308) under the provocative title, "Reasons for my Judgment on Ad. Baeyer's Scientific Qualifications," is devoted to a criticism of von Baeyer's work on the phthaleins, whilst the fertile conception of the "mobility of hydrogen atoms" is adversely criticised in another article (*J. für prakt. Chem.*, 1884, **29**, p. 32) under the title, "The Present Distressful State of Chemistry."

4. The main attack on van't Hoff is contained in the second of two articles under the title, "Signs of the Times" (*J. für prakt. Chem.*, 1876, **122**, 268; 1877, **123**, 473). In the first of these articles, Kolbe had made a strenuous attack on the unnamed author of a paper on "Aromatic Compounds of Phosphorus," who had maintained very reasonably that the structural formulæ of organic chemistry formed an almost complete system, whilst the corresponding aspects of inorganic chemistry were still in a very rudimentary condition. In the second article he laments that speculative science, which had been displaced fifty years before by exact research, was now being "brought out again by sham research workers from the lumber-room in which the errors of the human mind are stored," and was trying "to smuggle itself into a society to which it did not belong, like a hussy with new clothes and freshly-powdered." As an illustration of this remarkable phenomenon he quotes the recently published paper of van't Hoff on "The Arrangement of Atoms in Space"! He suggests that any who regard his anxiety as to the progress of chemical research as exaggerated should read "if they can" this mixture of fantasy and folly. He was, however, particularly angry because van't Hoff held an appointment at the Veterinary College at Utrecht, whilst the translator of the pamphlet was an assistant at an Agricultural Institute in Heidelberg. Kolbe apparently still questioned whether any good thing could "come out of Nazareth" as represented by these two schools of applied science. He regards it as "a sign of our present poverty of and hatred of criticism" that two almost unknown chemists, occupying positions such as these, should dare to attempt a solution of the highest problems in chemistry. But he would not have deigned to take any notice of their work if Wislicenus, against whom no such devastating accusation could be made, had not "in an incomprehensible way" written an introduction to it. Moreover, instead of treating it as a joke, he had seriously recommended it as a meritorious work. By doing this, however, Wislicenus had openly withdrawn from the ranks of exact research workers, and gone over to a camp of speculative philosophers who could scarcely be distinguished from spiritualists! The same accusation was levelled against Kekulé, who, instead of "jeering at the nonsense" of van't Hoff's hypothesis of the asymmetric carbon atom, had actually included it, in his rectorial address, amongst the achievements of chemistry.

5. The passage which has gained for Kolbe the largest measure of notoriety is, however, the one in which he says that "A certain Dr. J. H. van't Hoff, who holds an appointment at the Veterinary College of Utrecht, has, it appears, no taste for exact chemical research. He has thought it easier to bestride Pegasus (probably borrowed from the Veterinary College) and to proclaim in his *La Chimie dans l'Espace* how on his bold flight to the Chemical Parnassus the atoms appeared to be arranged in space." This fantastic picture, with its irrelevant reference to van't Hoff's appointment, obviously called for some embellishment in order to do justice to the situation. By a fortunate accident, there came into the veterinary stables a horse which was wholly worthy to play the part of Pegasus. This noble animal was therefore promptly led out to be photographed, and to this day the photograph adorns the walls of the Veterinary College at Utrecht. Through the kindness of Dr. Byl, and by the courteous permission of Prof. Krediet, a copy of this photograph is reproduced as an illustration to this article, and as a souvenir of a critic who, with uncanny accuracy, succeeded every time in "putting his money on the wrong horse" and persistently failed to recognise a winner. So certain, indeed, was Kolbe's judgment that he could scarcely have paid any higher compliment to one of his contemporaries than to include his name in his "black list," with all the greatest chemists of his day from Kekulé to Fischer.

T. M. Lowry

MINING AND METALLURGY IN CANADA

An examination of the natural gas from the well at Inglewood, Peel County, Ontario, shows that it contains one per cent. helium.

The value of the mineral production of British Columbia for 1923 was \$41,304,320, as compared with \$33,153,843 in 1922. The metallic production was as follows: Gold (placer), \$420,000; gold (lode), \$3,704,994; silver, \$3,718,129; copper, \$8,323,266; lead, \$6,321,770; zinc, \$3,278,903. There was a general decline in mineral production in the northern districts, but a substantial increase in southern B.C. The gross production of coal was 2,542,987 tons, a slight decrease compared with 1922. The Fordney tariff in U.S.A. and competition of Californian oil accounts for the falling-off in demand.

The Pacific Coast mines in South Wellington district, at one time the chief producers of coal, which have been closed down for some time, will be re-opened under the control of a new group of Eastern capitalists.

INSTITUTE OF BREWING RESEARCH SCHEME

An Epistle to the Research Committee of the Institute of Brewing, the Lawes Trust Committee, the Wye College Research Committee and Agricultural Experiment Stations generally.

It is well known that a study of barley and of hops is being made on behalf of the Institute of Brewing. As an honorary brewer and a confirmed believer in beer, I naturally take an interest in the proceedings of the Institute and, therefore, have been greatly perturbed by adverse criticisms which have reached my ears of the work on barley, in particular. Those who wish to read up the subject may consult a paper on "The Barley Crop: a Study in Modern Agricultural Chemistry," by Dr. E. J. Russell, in the Journal of the Institute, Vol. XIX, new series, 1922, pp. 697—717; also two Reports by the Director of the Rothamsted Experiment Station on "Experiments carried out in 1922 and 1923" (*ibid*, Vol. XX, 624—654, Vol. XXI, 618—837). The experiments are in charge of a special sub-committee, of which the Director of Rothamsted is Chairman. Field trials have been specially made not only at Rothamsted but also at about a dozen other centres, the object, we are told, being to determine :—

1. The influence of environmental conditions (soil, season and manuring) on the yield and quality of barley;
2. The relationship of chemical composition of barley to malting and brewing value.

The same seed and the same manure is used at all the stations, so that soil and climate are the two variables affecting the results.

I will not discuss the need and value of such experiments on the yield of barley, but turn at once to the question of quality, as being of primary importance. Putting aside the fact that quality for brewing is one thing and quality for feeding another, we have first to inquire: "How is quality (for brewing) defined and determined?" The answer is blankly: "Quality is neither defined nor is it definable at present; it is a matter of mere personal judgment, depending upon experience in both maltster and brewer. Both regard what is obviously a C_1 product —a mature, well-conditioned grain—as that of highest quality. It is true, a high percentage of nitrogen is usually to be associated with immature development of the grain; given a fair maturity of growth, however, *the test of practice*, mainly that of appearance, seems to be the only recognised and public* criterion of quality.

This is the point I wish to make—in Brewing-Land "there ain't a single commandment; if a man raise a thirst, he must somehow satisfy it with a product of empiricism and art, not of science."

* I use this expression advisedly, because brewers are not all prepared to state the nature of their requirements—what constitutes quality, in their opinion. Messrs. Guinness and Co., we know, decline to make the results of their inquiries in any way public and at least one other large brewing firm assumes this attitude. Neither the farmer nor the academic student can work blindfold: the brewing industry must play the game in its entirety, if the problems of its industry are to be solved with the aid of outside scientific studies, as inquiries cannot be conducted fruitfully without a knowledge of every detail and reciprocal exchange of information.

This, I take it, is the criticism abroad of the Institute's action: it is to be feared it is valid.

The same is true of hops.

Argle: field trials, whether with barley or with hops, such as have been instituted, are of little, if any, value, so long as we are without definite criteria of quality.

Agriculturists have not the slightest need to make experiments to determine the yield without as well as with nitrogenous manure. It is long since established that an economic yield of a cereal is only possible when a sufficiency of nitrogen is presented to the plant.

We know also that the plant, like the human being, requires a complete diet—everything in due proportion, although the seed, like the infant, will drain its parent and will even flourish upon a feeble stock: so it is necessary to take into account the growth of the plant as a whole, not merely the grain. Wherever grain be grown, the condition of the soil, not merely the manurial treatment of the moment, has to be considered. Barley is generally grown in this country following a heavily manured root crop, which may or may not be folded off; if not, as a second straw crop, following wheat, after clover or a succession of green crops. In the first case there is no question of an application of nitrogen: the danger is that the land already contains an excess. In the second case, the need or otherwise of nitrogen will be determined by the strength of the land and whether it have been well manured or not for previous crops. It is inevitable that nitrogen will give a positive result in some trials, a negative in others. What general conclusion then can be drawn? The same is true of phosphates and potash: they may be wanted or not, according to the character of the soil and the previous treatment of the land. It is difficult, therefore, to see what material for the study either of yield or of quality can accrue from the observation of plots treated as described that is not already available from the Rothamsted experiments and Messrs. Beaven and Munro's study of the barleys. An altogether different type of experiment must be developed, if the problem before the grower of high-grade barley is to be elucidated—that of combining high yield with high quality.

Agriculturists have carried on tentative and crude field trials of this order long enough: the time is come to take stock of the situation and seek to develop an improved technique, one which can be termed "scientific." There is a worthy past to be considered, which merits the closest study, as affording lessons for the future; in fact, we need to retire for a time and live on the balance we have accumulated, until we have devised sure means of developing anew our attack on Nature

Turning to the brewing process, this is one of extraordinary intricacy, the grain being a plexus of variables—carbohydrates, proteins, salts, etc. It is almost a vital process; is so, indeed, in its final fermentative stage. We know that enzymes are developed during malting which are operative during mashing; these undoubtedly vary in quantity and the quality of their effect depends greatly upon the conditions to which they are subject.

Our policy is clear. The brewer must possess his soul with patience until we have ascertained something of the composition of his raw materials—and of the agents (self-contained) to which they are subject during malting and brewing; when components and agents are sorted out, their individual interactions must be studied. This is the classic method inaugurated by Emil Fischer, which has given his work its preponderating value. Starting with the foundation stone, taking care to measure and define each brick that he laid, he built up a structure of which every part was known. There is no other method.

Thirty years ago, I began to study the Rothamsted cereals. We measured everything we could: weight, density and volume of the grain, weight per thousand seeds, percentage of water, percentage of nitrogen and of ashes; then we attempted to "analyse" the grain and determine the percentage of "Starch"; but using wheat broke down hopelessly and put the work aside, hoping for better times. Before 1880, I had my suspicions of "Starch" and felt sure that several enzymes were concerned in the mashing process; the difficulty was to dissect them out; we then knew but little of such agents. The subject was constantly under discussion among us but the horizon was long obscured by clouds—my school, I am proud to say, has done not a little to lift these and now we are beginning to see daylight. Our work on enzymes has helped to make the foundations secure and hopeful methods of attack on "*Diastase*" are foreshadowed. As to "Starch," the scales are almost suddenly fallen from our eyes and we begin to see it in its true proportions, largely through the illuminating work of Prof. Ling, the head of the Midland Brewing School, perhaps the pupil of whom I am most proud. Starch, it seems, may have at least three components—*Amylose* or, as I should prefer to call it, *Amylum* (reserving the *ose* termination for reducing compounds); *Amylopectin* (or its phosphate); *Hemicellulose*. Each of these, probably, is resolved in the mash by a different enzyme. Several years ago, when my former assistant, Mr. Horton, was unable to verify the remarkable *Taka-diastase* method of determining starch elaborated by Mr. W. A. Davis, another of my pupils, it was clear that there had been some alteration with time in the character of the "Diastase"; discussing the matter together, we came to the conclusion that it was necessary to tackle the problem systematically, more or less on lines which had been successfully followed in the study of amygdalin; that the various carbohydrates in starch or producible from it should be dealt with individually and the enzymes dissected out with their aid; we had even contemplated beginning with Julian Baker's amylodextrin. The proteins must be similarly studied.

When we have accurate methods at our disposal, we shall have sufficient material in the accumulated Rothamsted samples to determine the nature of the variations due to manurial treatment and season. Then only will it be possible to go further afield and advise both farmer and brewer and consider climatic effects. It may be a long lane and one difficult to walk; still, it will have a clear and sure turning.

The same argument holds for hops. Experiments on drying probably are of value, as they serve a practical end. So much is known of the manurial treatment of the crop, however, that little can be learnt of practical value by further experiments. The trials are mainly of worth as demonstrations to growers of the special value of phosphates. As to breeding new varieties, not much can be done without clearer guiding criteria. Flavour is a matter of personal opinion. As to preservative power, Mr. Lloyd Hind's Report (*Journal of the Institute of Brewing*, Vol. XXI, p. 725) is disconcerting: "The results show," he says, "that whatever substances constituted the preservative of hops, they were not the soft resins in their entirety, neither did they form a definite proportion of the soft resins. They seem to be associated with it and roughly it might be said that high resins go with high preservative power." Clearly, as in the case of barley, further study in the brewery and the laboratory should precede exhaustive field trials. Even resistance to disease may be more a question of conditions of cultivation and growth than of any specific quality in the hop plant.

I would ask the three Committees, therefore, to take complete stock of the situation before embarking on further extensive field inquiries. I would urge the Institute, for a time, to give the Birmingham stable all the backing it needs and to be very liberal. Prof. Ling has let loose the bloodhounds of inquiry in a way that should make the pursuit of the quarry a certainty of the not too distant future. It is a strange reflexion upon the narrowness of scientific outlook, that in a city of brass—though not of "paint an' putty"—so much should have been done to probe a problem of utmost importance to the husbandry of the world and that the centres of agricultural inquiry should have shown little or no vital interest in the plant's activity. That touch of Nature which should make the laboratory kin with the fair fields has thus far been wanting: apparently, chemico-physical and biological instincts are rarely conjoined. We may well leave the soil for a time and steadily work at the plant, at which we have so long gazed but merely weighed-up. We talk big of Agricultural Chemistry but no real chemistry, no organic or natural chemistry, has thus far been put into it. We chemists, in fact, are not sufficiently mindful of our opportunities and of the call there is upon us for work of practical value. It were well for us to bear in mind the warning:—

> There is a world outside the one you know,
>   To which for curiousness 'ell can't compare.
> It is the place where wilful-missings go,
>   As we can testify for we are there.

It is nothing short of intolerable that we should have left the field of inquiry into the quality of foodstuffs generally almost untilled. The need of maintaining dyestuff works which can be used in the event of war to produce poisons is often enough instilled into us; the need of *complete* study of the nature and value of foodstuffs, never! We need now to focus our efforts upon the determination of the significant constituents. The effect of manurial treatment can then be inferred from the vast mass of material awaiting effective analysis at Rothamsted.

HENRY E. ARMSTRONG

FORTHCOMING EVENTS

Oct. 25. BIOCHEMICAL SOCIETY, School of Biochemistry, Tennis Court Road, Cambridge, at 3.30 p.m. (1) "Fractional Ultra-filtration of Serum Proteins," by A. B. Anderson. (2) "The Carbohydrates and Fat Metabolism of Yeast," by D. Hoffert and I. S. MacLean. (3) "The Isolation of Spermine and its Chemical Composition," by H. W. Dudley, and M. C. and O. Rosenheim. (4) "The Influence of Spa Waters upon Urinary Excretion," by P. C. Raiment and G. L. Peskett. (5) "On the Micro Estimation of Urea in 0·2 c.c. of Blood," by G. Thomas. (6) "The Acid-Soluble Phosphorus Compounds in Milk," by H. D. Kay. (7) "The Effect of Acidose on Calcium and Potassium in Plasma and Urine," by J. B. S. Haldane, J. Hicks, and C. Watchorn.

Oct. 25. MINING INSTITUTE OF SCOTLAND, Royal Technical College, George Street, Glasgow, at 3 p.m. "Industrial Standardisation," by Mr. C. LeMaistre.

Oct. 25. HULL ASSOCIATION OF ENGINEERS, Municipal Technical College, Park Street, Hull. "Modern Constructional Plant and its Application," by I. W. BENSON.

Oct. 28. INSTITUTION OF CIVIL ENGINEERS, Great George Street, London, S.W. 1, at 6 p.m. "The Economic Position of Great Britain," by E. Crammond.

Oct. 29. SOCIETY OF CHEMICAL INDUSTRY, *Newcastle-on-Tyne Section*, Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. "The Oppau Explosion," by Prof. W. N. Haworth.

Oct. 29 and 30. SOCIETY OF CHEMICAL INDUSTRY, Nottingham Section, University College, Nottingham, at 5 p.m. Dr. W. Lawrence Balls will open a Discussion on "Textiles" with the Faraday Society.

Oct. 20. FARADAY SOCIETY, at the Institution of Electrical Engineers, Victoria Embankment, Savoy Place, W.C., at 5.30 p.m. "Electrical Precipitation," by Sir Oliver Lodge, F.R.S.

Oct. 30. UNIVERSITY OF SHEFFIELD, DEPARTMENT OF FUEL TECHNOLOGY. A course of six lectures on "Furnace Heating" will be given by R. J. Sarjant M.Sc., at St. George's Square, Sheffield, at 5.15 p.m. on successive Thursday afternoons.

Oct. 30. TEXTILE INSTITUTE, *London Section*, 38, Bloomsbury Square, London, W.C. 1, at 7 p.m. "Artificial Silk Fabrics," by R. Boettcher.

Oct. 30. SOCIETY OF DYERS AND COLOURISTS, *Midlands Section*, University College, Nottingham. "The Dyeing of Leather," by M. C. Lamb.

Oct. 30. INSTITUTION OF MECHANICAL ENGINEERS, *Birmingham Section*, Queen's Hotel, Birmingham, at 6.30 p.m. "Co-partnership in Industry," by Major S. J. Thompson.

Oct. 30. INSTITUTION OF MECHANICAL ENGINEERS, *North Western Branch*, Annual Dinner, at the Engineers' Club, Manchester, at 7 p.m.

Oct. 31. INSTITUTION OF MECHANICAL ENGINEERS, STOREY'S GATE, LONDON, S.W. 1 Informal meeting at 7 p.m. Discussion on "Engineering Novelties at the British Empire Exhibition."

Oct. 31. INSTITUTION OF MECHANICAL ENGINEERS, The University, Leeds, at 7.30 p.m. "Heat-Loss in Gas Engines," by Prof. W. T. David, M.A.

Nov. 3. SOCIETY OF CHEMICAL INDUSTRY, *London Section*, at 8 p.m. "Experiments in Protection," by W. J. U. Woolcock, C.B.E. Members may dine at the Club before the Meeting.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

A circular letter with further particulars and a form of application for tickets has been sent out to the members.

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The price of Volume VIII (1923) to members of the Society is 7s. 6d., and to non-members 12s. 6d., post free in each case.

Fellows of the Chemical Society have the privilege of purchasing the volume at the price of 10s. post free.

A set of Volumes II to VIII inclusive can be purchased by a member of the Society at the price of £2 2s. 6d., and by a non-member at the price of £3 15s., post free in each case.

MEMBERS ELECTED, October 10, 1924

Carsley, Samuel H., 31, Macgregor Street, Montreal, P.Q., Canada. Instructor in Chemistry. (Queen's University).

Cash, Louis S., 36, Sinclair Street, Wollstonecraft, Sydney, New South Wales, Australia. Works Chemist.

Gibson, Alfred L., Department of Chemistry, Ontario Agricultural College, Guelph, Ont., Canada. Professor.

Hopkins, Stanley, Messrs. Ruths Steam Accumulator Co., Ltd., 45, Kingsway, London, W.C. 2. Manager.

Howell, Herbert T., Trichy Road, Coimbatore, South India. Chemist and Works Manager.

Ingledew, Arthur E., c/o Eastern Coal Co., Ltd., Bhowra Colliery, P.O. Box 102, Jamadoba P.O., Manbhum, India. Analytical Chemist.

Ingold, Christopher K., F.R.S., The University, Leeds. Professor of Organic Chemistry.

Mann, Thomas, c/o Messrs. Hellon and Mann, 40, Lowther Street, Whitehaven. Analytical Chemist.

Preen, Frank H. E., c/o Dr. Thuna, 436, Queen Street West, Toronto, Ontario, Canada. Consulting Chemist.

Staton, Rowland, The Brown-Firth Research Laboratories, Princess Street, Sheffield. Metallurgical Assistant.

Topley, John W. M., 84, Coombe Road, New Malden, Surrey. Engineer.

Tucker, Percy A., Birmingham Central Laboratories, 59, Cambridge Street, Birmingham. Metallurgical Chemist.

Wedgwood, Philip, 11, Chalsey Road, Brockley, London, S.E. 4. Gas Chemist.

Wood, Cecil Wm., National Oil Refineries, Ltd., Skewen, Glam., South Wales. Chemist.

BRISTOL SECTION

The opening meeting of the Session was held in the University Chemical Department, Mr. M. W. Jones presiding over an excellent attendance.

As the meeting was held jointly with the Bristol and South-Western Counties section of the Institute of Chemistry, the ceremony of admission for three Associates of the Institute was carried out by Mr. C. J. Waterfall.

Dr. M. Nierenstein then read a paper on the "Present Position of the Catechin Chemistry." Catechin is an astringent principle found in cutch, a substance used in the East for dyeing and tanning, and occasionally in medicine. The lecturer described the preparation of various forms of crystalline catechin, and showed the constitution of those that had been investigated. The research work had been carried out in the biochemical laboratory of the University, with the assistance of Miss Hazleton and Dr. Hooper.

Amongst those who took part in the discussion were Dr. Rixon, Dr. Mann, and Mr. Jones. Dr. Mann, who is Director of Agriculture to the Government of Bombay, provided the material used in the investigations. Speaking of the uses of cutch in India, he described the use of cutch, mixed with pan leaves and betel nut, as a masticatory esteemed by the natives as a stimulant and aid to digestion.

CHEMICAL ENGINEERING GROUP

At the meeting of the Chemical Engineering Group, held on October 23, in the Engineers' Club, two papers were read.

A paper was presented by Mr. T. V. Barker, entitled "The Development and Formation of Crystals," which gave a general account of the results accruing from the purely scientific study of crystals, without touching upon the industrial aspect of the subject. Some of the points dealt with were crystal form and symmetry, the lattice structure of a crystal, polymorphism and isomorphism, crystal mixtures, physical properties of crystals, the chemistry of the crystalline condition and the enigma of crystal form. Many diagrams were given to illustrate the various points raised, which were of particular interest, as the author restricted the discussion to topics not adequately described elsewhere.

In a paper entitled "Mechanical Crystallisation," Mr. Hugh Griffiths said very few of the researches on the dynamics of crystallisation were of interest to the chemical engineer. For this reason, crystallisation was too often regarded as a "craft," not a "science," in industry. In many chemical works the moment a crystallising process came for consideration, the stationary vessel was installed without question, because it was very cheap. It was not, however, cheap to operate, and in addition, frequently the saving in capital cost was more than counterbalanced by the enormous stock of material which had to be carried in process. Mr. Griffiths first discussed the properties of crystallising solutions, and finally dealt with (1) plants for uncontrolled crystallisation, and (2) plants for controlled crystallisation.

THE PRIESTLEY LECTURE AT BIRMINGHAM

Prof. G. T. Morgan, F.R.S., head of the Chemistry Department at the University of Birmingham, delivered the annual Priestley Lecture on October 17, at the Midland Institute, Birmingham. Reviewing Priestley's work as a chemical investigator Prof. Morgan said his earliest study began with "fixed air" or carbon dioxide. In consequence of being near a brewery, Priestley was led to experiment on the fixed air arising from the fermentation vats by studying its effects on burning candles, on living animals, and in water. He noted that water saturated with the fixed air had a pleasant acidulous taste, and he recommended this solution as a substitute for natural aerated water, communicating his discovery to the Royal Society and to the Admiralty. In this way Priestley became the founder of the mineral-water industry. The lecturer then described the discovery of oxygen, or as Priestley called it, "dephlogisticated air." Priestley suggested the new gas might prove beneficial for certain morbid conditions of the lungs, or that, being a powerful supporter of combustion, it might be used in producing high temperatures in certain metallurgical operations such as the melting of platinum. These suggestions had since been put in practice. Prof. Morgan traced the subsequent development of oxygen up to the modern process of liquefaction of air. The quantity now distributed in Great Britain in cylinders is 300 million cb. ft. a year. One per cent. of the output is used for medical purposes, 3 per cent. for limelight, and for experimental work and research; the rest of the gas is used in industry, metal-cutting representing 59 per cent., welding, 25 per cent., and the remainder being used in producing high temperatures for special metallurgical operations.

THE SPIRIT OF SCIENCE

The inaugural meeting of the Chemistry Section of the Leicester Literary and Philosophical Society on October 15 was devoted to an address by Prof. H. E. Armstrong, F.R.S., on "The Spirit of Science," of which an abstract is appended.

Indulgence, even deep indulgence, in a scientific occupation, even the possession of great scientific ability in some particular field, does not necessarily make a man scientifically sane all over. Apparently, our brains are compartmented, and the compartments are not necessarily all interlocked.

We are creatures of evolution, and under the severe conditions of nature only those have survived who could think together, work together and wonder together. Just as a man has selected certain tools suited to his daily use, so we have been selected as types, fitted to the society in which we have lived. To-day, freedom of thought is beginning to be allowed, and every kind of freak is having his chance, the scientific worker among them. Unfortunately, just as freedom is coming on, those most fitted to be free have elected to kill out their type. Freaks are admittedly dangerous, and the scientific freak has proved himself to be capable of anything—he is fast

undermining the foundations of society and has made the whole world kin. His doings and his power must be understood, if we are to reconstitute society upon a stable basis.

The human mind has a trick of tying itself into knots and prefers to follow fashion rather than reason. It is a strange mechanism, and like the mechanisms we ourselves construct, varies greatly both in kind and in perfection. Our position is aptly summed up by the most distinguished French literary man of the day in saying :—

"I know that there is no certainty outside science, but I know also that the worth of scientific truth lies in the methods of its discovery, and that those methods are not to be arrived at by the common run of mankind."

Surely our duty is to learn all we can of the method which underlies modern progress and modern practice; to do what we can to overcome the imperfections of our understanding. I believe it to be no longer merely a question of inviting people generally to become interested in science and take up the study of scientific method. No, it is a matter of immediate urgency: not only our material safety but our peace of mind, and our whole mental outlook are at stake.

The prime mission of science being the search after truth, science and pure religion—religion divested of dogma—cannot be in conflict. The Church of the future should be the first to advocate and use scientific method in the service of morality and ethics of conduct. Science has a great social constructive work before it, to demonstrate and develop the power of human understanding and our ability to trust in ourselves.

The primary need of the day is the abandonment of jargon—that cleric and scientist alike should talk in terms that can be understood of the masses.

The spirit of science is the art of calculated, reverent inquiry into all things—which we call scientific method. At present we do but educate the worser part. Adapting a writer of the day, Education may make us ignorant, but we are born inquisitive. There is no imagination, no real purpose in our system. Surely it is for us to take arms against our sea of troubles by turning our thoughts earthwards and seeking to enjoy and know what is ours, to have and to hold till death do us part, recognising that there is infinite beauty spread out for our enjoyment, satisfied to believe that we are but the present links in an ever-moving chain, and that it is our prime duty to make each link fulfil its due purpose.

ACADÉMIE DES SCIENCES

On October 13, M. Desgrez communicated a paper by MM. Caille and Viel on the transformation of chemical complexes, the particular work referring to the displacement by mercury of antimony from solutions of iodostibinate of pyridine, piperidine, theobromine, nicotine, etc., in hydrochloric acid. Prof. D. Berthelot summarised researches by M. C. Henry on the heat given out by animals at constant temperatures, showing that it is possible to apply the theoretical formulæ established for radiation from black bodies. Prof. Urbain read a paper by MM. Marie and Lejeune on the influence of colloids on surface tension. The question of the presence of colloids in certain mineral waters was raised in a paper by MM. Henrijean and Kopaczewski. The instability of bicarbonated water has already been referred to the presence of colloids, but it can be explained either by chemical reactions or by the presence of molecular complexes. In the case of the ferruginous bicarbonated water of Spa the instability is caused by colloids, for these authors have shown, with the aid of a new method, the presence of iron in colloidal form.

INSTITUTE OF PETROLEUM TECHNOLOGY

At the opening meeting of the session, held at the House of the Royal Society of Arts, October 7, the following awards of Medals and Scholarships were announced :—

The Boverton Redwood Medal.—This Medal, which has been presented to the Institution by Mr. Alexander Duckham to commemorate the late Sir Boverton Redwood, founder and first president of the Institution, is awarded to the author of the paper of the greatest merit on any subject connected with Petroleum Technology, presented to the Institution during two consecutive sessions ; preference being given to original work. The award is not confined to members of the Institution, and can be withheld if the Council consider that no paper of sufficiently outstanding merit has been presented.

It has been decided that the award should be made retrospective to 1919, the date of Sir Boverton Redwood's death, and so for the Sessions 1919–20 and 1920–21, it has been awarded to M. Paul de Chambrier, of Pechelbronn, for his paper on the "Working of Petroleum by means of 'Shafts' and 'Galleries'," which was read before the Institution on February 15, 1921. It is hoped that, if M. Paul de Chambrier can be present, the Medal will be presented to him at the seventh annual dinner of the Institution, which is to be held at the Connaught Rooms, Great Queen Street, London, on March 17 next.

As there was no paper of outstanding merit for the Sessions 1921–22 and 1922–23, no award has been made for those sessions.

Students' Medal and Prize.—This Medal and Prize, given by the Institution, is awarded to the student member of the Institution who presents the best paper on any subject connected with petroleum technology, in any one session. The Medal and Prize has been awarded to Lieut. J. H. Blakiston, R.N.R. (late student of the oil-technology course at Birmingham University), for his paper, entitled "The Oilfields of Roumania." This is the first award of this Medal and Prize.

The Institution's Scholarships.—These scholarships are awarded annually, one each to the Royal School of Mines, Imperial College of Science and Technology, London, and to Birmingham University, to a third-year student, taking the petroleum technology course who is also a student member of the Institution. The award is made on the recommendation of his

professors, and is to assist him with his fourth-year studies. The award to the student at the Royal School of Mines has been made to Mr. Ernest Clark, and the award to Birmingham University will be announced shortly.

CHEMICAL SOCIETY

At the first ordinary scientific meeting of the new session, held on Thursday, October 16, a resolution commemorating the late Sir James Dobbie was put from the Chair by the President, Prof. W. P. Wynne, and was adopted in silence by a standing vote. Reference was made to the Address which had recently been presented to the Franklin Institute and the congratulations conveyed to the Rensselaer Polytechnic Institute, Troy, on the occasion of their centenary celebrations, to the Address which would shortly be presented to the Netherlands Chemical Society and the Netherlands Society of Chemical Industry, and to the congratulatory message which had been sent to the new Indian Chemical Society. The President then announced that Dr. N. V. Sidgwick had been appointed Chairman of the Publication Committee; that the Society's representatives on the Bureau of Chemical Abstracts had been reappointed for the ensuing year; that the arrangements with the Society of Chemical Industry and the American Chemical Society regarding the price to Fellows of their publications had been renewed; and that the entrance fee of £3 had, for the present, been suspended. A meeting of the Research Fund Committee would be held in December; applications for grants and reports connected with outstanding grants must be received by December 1. Applications from Fellows would receive priority of consideration.

The following communication was then made by Dr. R. Lessing:—

The influence of catalysts on carbonisation [with M. A. Lister Banks].

THE catalytic effect of individual mineral constituents* on the carbonisation of coal, to which attention had been drawn by Lessing in 1914, has been studied. As the ash in coal cannot be reduced below a certain minimum, sugar and cellulose, practically free from ash, were investigated in the first instance. Forty catalysts have been tried, the compounds being added at the rate of 0·01 gram molecule per 100 grams of sugar or cellulose, either in solution or dry. On carbonising the material by the platinum crucible method for the determination of volatile matter in coal (for three minutes only), remarkable differences in coke yields were found, varying from 20 per cent. to 5 per cent. of the sugar or cellulose, the untreated substance being always at or near the bottom of the list. An attempt was made to group the added compounds according to the magnitude of their [illegible] effect. The quantitative variation is equalled if not surpassed by extraordinary differences in appearance and structure and particularly the swelling propensities in the case of sugar. A preliminary study of coal was made by examining the clarain and vitrain fraction of Dalton Main Coal, the ash of which was reduced to 0·86 per cent. Similar variations were obtained in the yield of coke, retort carbon and tar.

The catalytic influence of inorganic constituents on the carbonisation of coal is therefore proved.

Dr. E. K. Rideal remarked that at least four different effects could be noted from a cursory examination of the authors' results: (*a*) the gaseous catalytic removal of the elements of water by sulphur trioxide; (*b*) the solid catalytic removal of the elements of water by incompletely anhydrous alumina; (*c*) the removal ("peptisation") of the surface film of adsorbed oxygen by alkalis; (*d*) the catalytic partial oxidation of hydrocarbons at the surface of the carbon by catalysts, *e.g.*, iron or manganese, contained therein. It was possible that the catalytic gasification $C + H_2O \rightarrow CO + H_2$ and the subsequent reaction $2CO \rightleftharpoons CO_2 + C$ might also take place.

Dr. Lessing acknowledged the ingenuity of Dr. Rideal's suggestion; he doubted, however, whether there was enough oxygen present to produce the "peptisation" effect referred to. The question of the formation of charcoal which might catalyse volatile substances had been taken into consideration, and the decomposition of hydrogen peroxide by charcoal containing iron was mentioned in the paper.

Mr. R. G. W. Norrish described:—

The photosensitive formation of water from its elements in the presence of chlorine [with E. K. Rideal].

WEIGERT showed qualitatively in 1908 that when a mixture of hydrogen, chlorine, and oxygen is illuminated water is formed. This reaction has been investigated quantitatively at atmospheric pressure in the present research. It has been found that the rate of water formation is given by the expression

$$\frac{d[H_2O]}{dt} = k_1[Cl_2]\,[O_2],$$

it being independent of the hydrogen pressures over a wide range. The reaction resembles the photocatalytic decomposition of ozone in the presence of chlorine, which according to Bodenstein and Bonhoeffer is described by the equation,

$$-\frac{d[O_3]}{dt} = k_2[Cl_2]\,[O_3]$$

It would appear that in both cases chlorine molecules become active by the absorption of visible radiation, and on collision can then transfer their energy either to activate an oxygen molecule or to decompose an ozone molecule. This purely photosensitive process of water formation is regarded as independent of the simultaneous formation of hydrogen-chloride which occurs. The anticatalytic effect of oxygen on the latter reaction is attributed to a direct intervention of oxygen in the hydrogen chlorine reaction chains with their resultant shortening and the formation of a relatively negligible quantity of water.

Prof. H. Brereton Baker suggested that the absorption of hydrogen chloride by slightly moist

phosphorus pentoxide would constitute a source of error; Prof. A. J. Allmand asked whether any measurements of the quantum efficiency of the reaction had been made, and sought information regarding the thermochemical data. Dr. E. K. Rideal did not think that the error envisaged by Prof. Baker would be very great, but admitted the possibility of its existence. He then spoke of the connexion between the experiments described and the Budde effect, referring also to Christiansen and Kramers' hot molecule theory, emphasising the part played in chemical reactions by excited molecules. Dr. T. Slater Price also joined in the discussion.

In reply, Mr. Norrish referred to experiments which had indicated that absorption of hydrogen chloride did not take place; the quantum efficiency of the reaction had not been examined.

Prof. F. L. Pyman then dealt with :—

The directive influence of substituents in the glyoxaline nucleus on substitution in the benzene nucleus of phenylglyoxalines—the nitration of 2-phenylglyoxaline and its carboxylic acids [with E. Stanley].

By the mono-nitration of 2-phenylglyoxaline and its 4-mono- and 4:5-di- carboxylic acids, followed by decarboxylation in the last two cases, the isomeric nitrophenylglyoxalines have been isolated in the following yields :—

	p	*o*	*m*
From 2-phenylglyoxaline ..	50	1·5	0·2
From 2-phenylglyoxaline-4-carboxylic acid	52	—	18
From 2-phenylglyoxaline-4:5-dicarboxylic acid	19	—	52

It is suggested that the results are connected with the fact that the first two compounds form salts with mineral acids, whereas the last does not, and on this basis they may be partly systematised with the help of the theory of induced alternate polarities.

Prof. C. K. Ingold claimed equality of consideration for the alternate polarity theory and Flürscheim's theory of variable affinity in cases where the experimental results could be explained equally satisfactorily by the latter as by the former. Mr. W. E. Garner enquired whether, by working at different concentrations, the possible effect of un-nitrated molecules on the molecules undergoing nitration had been examined. Dr. B. Flürscheim was of opinion that the theory of induced polarities could not consistently explain either Prof. Pyman's experimental results or aromatic substitution in general. The theory assumed that when oxygen and nitrogen are both present, the former is the negative key-atom; thus, in the present case, if the carboxyl oxygen was the key-atom, the anticipation of increased ortho-para orientation resulting from the introduction of carboxyl groups was not borne out by experiment. According to the speaker's own theory, an unsaturated atom directly attached to the nucleus must direct to ortho- and para-substitution. Both theories predicted identical orientation whenever such an unsaturated atom chanced to be relatively electro-negative, and diametrically opposed orientation if otherwise. Where the postulates of the two theories thus disagreed, the theory of induced polarities invariably failed, the positions taken up by substituents entering nitrosobenzene, phenylpropiolic acid and 2.4-dinitroazobenzene being mentioned as examples.

Replying first to a question put by Dr. P. C. Austin, Prof. Pyman said that the fact that the yield of the ortho-compound was very small could probably be attributed to the greater difficulty of its isolation owing to its solubility, and to its greater tendency to oxidation by the nitric acid. Although the polarity theory was not necessarily exclusive in its ability to interpret his results, he considered that mutual neutralisation of the effect of the carbon atoms would be at least as probable as the parallel effect postulated by Dr. Flürscheim in the scheme :—

$$\begin{array}{l} \mathrm{H}\,\overset{-}{\mathrm{O}}\,\overset{-}{\mathrm{O}}\,\overset{+}{\mathrm{C}}\,.\,\overset{-}{\mathrm{C}}\,. \\ \qquad\qquad\;\; \| \\ \mathrm{H}\,\underset{-}{\mathrm{O}}\,\underset{-}{\mathrm{O}}\,\underset{+}{\mathrm{C}}\,.\,\underset{-}{\mathrm{C}}\,. \end{array}$$

Owing to the lateness of the hour, the reading of the paper: Investigations on the dependence of rotatory power on chemical constitution. Part XXIV. Further experiments on the Walden inversion. J. Kenyon, H. Phillips, and H. G. Turley, was postponed until the next meeting of the Society.

MINING IN FRENCH NORTHERN AFRICA

Exports of phosphates from Tunisia in August, 1924, totalled 209,137 metric tons, distributed as follows :—France, 69,630 t., Great Britain, 34,580 t., Belgium, 18,300 t., Italy, 55,377 t., Spain, 2891 t., Portugal, 5920 t., Sweden, 4399 t., and Germany, 8040 t.

In 1923, 190,000 t. of phosphates was exported from Morocco, compared with 80,000 t. in 1922 and 8000 t. in 1921. It is estimated that before very long the railroad and the Casallanca wharves should furnish the means of exporting 450,000 t. a year from Kourigha, or 1500 t. daily. Up to the present the ground actually exploited between El Borrondj and Oned Zem measured about 80 km. in length and 50 km. in breadth, and the deposit of phosphate appears to be 25 to 50 m. in thickness.

The mineral output of Algiers in 1923 amounted to 467,384 t. of phosphates, of which 373,283 t. was won by the Cie. de Phosphates de Constantine, and 59,930 t. by the Cie. des Phosphates de M'Zaita. The output of iron pyrites was 21,000 t.; that of iron ores totalled 1,448,805 t., of which 417,917 t. was extracted by the Société de l'Orienza, 381,531 t. by the Cie. des Mines de fer Magnétique de Mokkta el Hadid, 173,753 t. by the Société des Mines de fer du Zaccar, 101,851 t. by the Société des Mines de fer de Rouina, and 47,145 t. by the Beni Filkai Mining Co., Ltd. Zinc ore won amounted to 61,108 t., and lead ore to 24,475 t. Copper, all extracted by the Cie. Minière et Metallurgique de Caronte, amounted to 2600 t. In addition 1503 t. of antimony and 3562 t. of coal were produced, and the Société Algérienne des pétroles de Thouanet, the sole producers of petroleum, produced 1337 t.

CORRESPONDENCE

THE EARLY HISTORY OF ANTIMONY

Sir,—I have read with some interest Dr. Hyman's paper in *Chemistry and Industry*, dealing with the early history of Antimony in which reference is, of course, made to Basil Valentine. I do not claim to speak with any authority on this matter, but I have always felt that such a person did, in fact, exist, and there appears to be some evidence of his having been

Frontispiece to the 1677 edition of Basil Valentine's Works

born in Mayence [illegible] the end of the fourteenth century, or [illegible] fifteenth century. I have in my [illegible] of Basil Valentine's Works [illegible] published in 1677 [illegible] Hamburg, and [illegible] interesting as the frontispiece gives what [illegible] purports to be a portrait of the [illegible]. This [illegible] which is in German, contains the Tri[illegible] [illegible] y (Triumph-Wagen des Antimonii), [illegible], fairly well known. It is rather earlier [illegible] the Amsterdam edition to which Dr. [illegible], and of which you have reproduced the frontispiece, but there are others much earlier still. I have had the frontispiece photographed and enclose a copy of the photograph as I think it may interest your readers.—I am, Sir, etc.,

A. Chaston Chapman

Sir,—Readers of the article on "The Early History of Antimony," by Dr. Hyman and the subsequent letter by Prof. Partington, may be interested to learn that a copy of the first Latin translation by Kerkringius is contained in the library of the Chemical Society. The illustration reproduced in the article is common to both editions. From a curious defect in the engraving of the date, which makes 1671 to appear as 1674, it is evident that both are from the same plate.

In addition to this volume the library contains an English edition published seventeen years prior to that referred to by Dr. Hyman. The title is, "The Triumphant Chariot of Antimony, being a Conscientious Discovery of the many Reall Transcendent Excellencies included in that Minerall, Written by Basil Valentine, a Benedictine Monke. Faithfully Englished and published for the Common Good. By I. H. Oxon. Printed for Thomas Bruster, and are to be sold at the three Bibles neere the West end of Paules Church-Yard in London. 1660." This edition is very rare, and is not mentioned in any of the bibliographies, and differs from the so-called first edition of 1661 in date and publisher.

It is of interest to note that whilst the title page of the latter edition is a single leaf, that of the 1660 is a part of the first section.—I am, Sir, etc.,

F. H. Clifford

Chemical Society
Burlington House, W. 1
October 20

Sir,—I am obliged to Prof. Partington for his valued criticism of my article of October 10. The editions referred to have escaped experienced bibliographers and are of much interest. The earlier we can trace the history of these books the nearer we will arrive at a solution of their mysteries.

I also take this opportunity of correcting an error in the same paragraph. The translation by A. E. Waite was made in 1893, not 1803.—Yours, etc.,

Glasgow, H. Hyman
October 20, 1924

PERSONAL AND OTHER ITEMS

Mr. S. G. P. Plant, B.Sc., M.A., has been appointed University lecturer in organic chemistry at Oxford.

Mr. H. Lambourne M.A., M.Sc., Senior Lecturer in Organic Chemistry at University College, Nottingham, has been appointed Head of the Chemistry Department at the Borough Polytechnic Institute, London.

The degree of Doctor of Science has been conferred by the University of Glasgow on Mr. Kishori Lal Moudgill, Professor of Chemistry in the College of Science, Trivandrum, South India.

Sir Lees Knowles has been elected Master of the Plumbers' Company.

Dr. W. C. Geer, vice-president in charge of research at the B. F. Goodrich Rubber Co., Ohio, will retire from his post next year with the intention of devoting his time to research.

Dr. A. E. Dunstan has been appointed Chief Chemist to the Anglo-Persian Oil Company, Ltd.

The Institution of Automobile Engineers has awarded its Crompton medal and its "utility prize" to Dr. Aitchison for his paper on "Light alloys for pistons and connecting-rods." The Graduate's prize has been awarded to Mr. R. N. Aveline, of the Coventry Branch, for his paper entitled "Carburation."

Dr. A. T. de Mouilpied, of the British Dyestuffs Corporation, and formerly lecturer in chemistry in the University of Liverpool, has been appointed to the Professorship of Science at the Royal Academy, Woolwich.

On October 20, Prof. H. B. Dixon, honorary professor of chemistry in the University of Manchester, delivered a lecture on "The Life and Work of Ludwig Mond," in the chemistry theatre of the University. The lecture was the first of the "Ludwig Mond lectures," founded by the late Mrs. Ludwig Mond, in memory of her husband. The lectures are to be alternately on pure and applied science.

Dr. R. O. Howell has been appointed lecturer in chemistry in University College, Dundee, in succession to Dr. J. S. W. Boyle, who has become headmaster at Prestonpans. Mr. C. A. Kerr has been appointed assistant in the same chemical department.

Mr. G. J. Robertson has received the Ph.D. degree of the University of St. Andrew's for his thesis, entitled "Investigations on Cellulose."

The following candidates have passed the Examination for the Associateship of the Institute of Chemistry of Great Britain and Ireland :—General Chemistry : Allister, C. F., Heriot-Watt College, Edinburgh ; Austin, R. G., University College, Southampton ; Bell, J. L., Heriot-Watt College, Edinburgh ; Brown, J., Heriot-Watt College, Edinburgh ; Browne, T. E. W., B.Sc., University College, Bangor ; Cochrane, C. G., B.Sc., Heriot-Watt College, Edinburgh ; Firth, H., Bradford Technical College ; Fletcher, A. E., Central Technical School, Liverpool ; Hallas, C. A., B.Sc., Northern Polytechnic Inst. and King's College, London ; Lander, Miss C. M., University College, Nottingham ; McGill, A., Heriot-Watt College, Edinburgh. Ransome, G. L., B.Sc. (Lond.), The University, Cambridge ; Rumford, F., Battersea Polytechnic ; White, W. A., Sir John Cass Technical Institute ; Williams, K. A., B.Sc. (Lond.), Chelsea Polytechnic Institute. Metallurgical Chemistry : Claudet, R. A. O., B.Sc. (Lond.), King's College, London, and Sir John Cass Technical Institute.

The following candidates have passed the Examination for the Fellowship :—Branch "A," Inorganic Chemistry : Morris, E. A., B.Sc. (Lond.). Branch "D," Agricultural Chemistry : Pyne, G. T., A.R.C.Sc.I., B.Sc. (Lond.). Branch "E," the Chemistry, including Microscopy, of Food and Drugs, and of Water : Bagnall, H. H., B.Sc. Branch "G," Chemical Engineering : Sensicle, L. H., B.Sc.

On September 16, a portrait bust in bronze of Louis Pasteur was dedicated in the American Institute of Baking at Illinois. During the ceremony Dr. S. P. L. Sorensen, director of the Carlsberg Laboratories, Copenhagen, Denmark, gave an address on "Louis Pasteur."

Mr. H. Roberts, J.P., a director of Joseph Crosfield and Sons, Ltd., who died in July, left £65,179, with net personalty, £57,394.

The late Mr. C. Haslam, formerly chairman of Joseph Crosfield and Sons, Ltd., and vice-chairman of William Gossage and Sons, Ltd., left £8975, net personalty £6726.

The late Prof. Julius Wertheimer, D.Sc., principal of the Merchant Venturers' Technical College, Bristol, left property valued at £13,693 (net personalty £12,607). A sum amounting to nearly £6000 is left to the Society of Merchant Venturers to found a scholarship at the College.

We regret to announce the death, in a landslide at Kenogami, Quebec, of Sir William Price, president of Price Brothers and Co., Ltd., one of the chief lumber firms in Canada. The firm was founded by Sir William's father, who, sent to Canada from England to procure masts during the Napoleonic blockade, settled in the country and laid the foundations of the modern business, which controls many thousand square miles of pulp and timber areas. The tragic death of Sir William Price is a great loss to the development of Canadian industry, in which he had played a prominent part.

Distillation of Oil Shale in Australia

The Australian Shale Oil Corporation, Ltd., has purchased the rights to the Bronder process of distillation for Australia and New Zealand. The Corporation holds about 3500 acres of shale concessions near Murrurundi, which are estimated to contain 9 million tons of shale, averaging 60 gallons of crude oil to the ton. Five retorts are to be erected, each with a capacity of 22½ tons, and it is estimated that 1000 tons of shale can be treated per day at a cost of 67s. a ton, including charges for mining, transport, retorting and distilling, the oil being valued at over £6 per ton. The chief feature claimed for the Bronder retort is that the charge is uniformly heated, the heat being applied, not to the retort, but to a steel column containing steel tubes and connected with the retort so that the gases from the shale, heated by passing over the tubes, again pass over the shale, which attains 800° F. Initial heating is by producer gas, but when gas is given off this is used for heating.

The Use of Preservatives in Foods

According to the *Grocer*, the report of the committee appointed to inquire into the use of preservatives and colouring matter in food has been presented to the Minister of Health and will be published shortly. It appears that prohibition is recommended of the use of preservatives in food and drink offered for sale, save in specific cases, such as sausages, jam and various beverages. The term preservative is not to apply to salt, saltpetre, sugar, vinegar, acetic acid, alcohol, spices or the agents introduced by smoke-

curing. It is concluded that if preservatives are at all necessary they should consist solely in benzoic and sulphurous acids and their salts. Boric and salicylic acids and their salts, however, are stated to be "not so undesirable as formaldehyde, its derivatives, and fluorides." Most of the articles containing boric acid are said to be sold by other makers free from boric acid. The committee consists of Sir Horace Munro (chairman), Prof. W. E. Dixon, Sir A. D. Hall, Mr. J. M. Hamill, Prof. Gowland Hopkins, Mr. G. R. Leighton, Mr. A. P. Luff, Mr. C. Porter, Mr. E. Richards, and Mr. G. Stubbs.

Notification of Industrial Diseases

In pursuance of sub-section 4 of section 73 of the Factory and Workshop Act, 1901, the Home Office has issued a draft order entitled The Factory and Workshop (Notification of Diseases) Order, 1924, applying to poisoning by carbon disulphide, poisoning by aniline and its compounds, and chronic benzene poisoning occurring in a factory or workshop. The Order is to come into force on January 1, 1925. Copies of the draft Order can be obtained from H.M. Stationery Office, price 1d.

OBITUARY

EDWARD HILTON-BROWN

The death of Mr. Edward Hilton-Brown, F.C.S. which took place with dramatic suddenness from angina pectoris, on September 11, at Toronto, during a special visit to Canada, will be greatly regretted in commercial circles in England, on the Continent and in Canada, where he was highly respected both as a business man and a scientific organiser and experimenter in new methods of manufacture.

Mr. Hilton-Brown was originally a pupil of Sir William Ramsay, who considered him a very prominent student. In the year 1890 he joined the firm W. Miller and Co., of St. Petersburg, leaving them to take up a post as director on the board of Messrs. W. Ropes and Co., oil refiners and distillers, St. Petersburg. During the period 1910-12 Mr. Hilton-Brown distilled oils in what is now known as the "tumble still" with excellent results. Horizontal separators, very closely resembling those erected by one of the most prominent oil companies in England, were used. He also investigated, perfected and then carried out on a commercial scale the hydrolysis of fatty oils and the separation of glycerol by means of naphthenic sulphonic acids at this early period, and did quite a large business in this respect with sunflower-seed oil. Another process brought to the commercial stage and used by Mr. Hilton Brown was the recovery of sulphuric acid from sludge acid. After the separation of the acid tar the acid liquor was diluted and electrolysed. The organic matter present was given off during electrolysis and a water-white concentrated acid of 95 per cent. strength eventually obtained. [illegible] Mr. Hilton-Brown endeared himself [illegible] assistants and, in fact, to everybody who [illegible] contact with him, and, thanks to his genial [illegible] and [illegible] energy, work under his supervision invariably [illegible] on smoothly and well.

REVIEWS

A Systematic Course of Qualitative Analysis. By Henry W. Schimpf, Ph.G., M.D. Fourth edition, revised by Alfred I. Cone, Phar.D., Ph.G. Pp. ix+194. London: Chapman and Hall, Ltd., 1924. Price, 8s. 6d.

This book brings together in a comparatively small space the wide range of work in qualitative analysis required by students of pharmacy, for whom it is primarily intended. The present edition differs from its forerunners in the omission of "short" methods of analysis and in the addition of chapters on ionisation, law of mass action and analysis by the dry method. According to the preface to the first edition, the book is designed for the use of students who have but a few months to spend on a course of analytical chemistry, even though that course comprises the common metals and acids, fatty acids, aromatic acids, coal-tar bases, colouring matters, carbohydrates and alkaloids. This course is made to some extent possible by the care which has been taken by the author and reviser to define the condition necessary for success in the tests described, and the methods for preparing the proper reagents. The best feature of the book lies, in fact, in their definition of experimental conditions.

The section (pp. 97) on "Identification and Separation of Inorganic Acids and Bases"—which, however, deals also with the commoner organic acids—departs very little from standard practice. The reactions and tables are clearly set out, and useful notes, much fuller in many cases than is usual in books of this class, follow the tables. The section on organic analysis (pp. 50) contains a scheme for the detection of a large number of substances of pharmaceutical interest, which appears well designed for its purpose, though of little use for general organic analysis. Even for the purpose in view, the sodium fusion test for nitrogen should have been given in addition to the soda lime test, which would not succeed with several of the substances included in the scheme. In this section, equations and formulae are given only for the simplest reactions and substances, and it is evident that students using the book are expected to acquire little beyond a mechanical system of organic analysis capable of dealing with a particular set of substances.

The section devoted to "definitions and general considerations" (pp. 27) appears to be of very little use. The definitions include several which should be well-known to students before they are permitted to commence qualitative analysis, and one—"Compounds are classified as acids, bases and salts"—which is definitely misleading. The paragraphs on the electrolytic dissociation theory, the law of mass action and the solubility product are clear and concise, but these theories are not applied to explain the methods used in practice. One would hesitate to add to the burden of students who are working through the course described in the book "in a few months"; yet the paragraphs on these theories could only become valuable by the addition of a section in which they were used to explain some of the important separations.

T. S. Moore.

THE RUBBER CONFERENCE—BRUSSELS, 1924. Pp. 218. London: Rubber Growers' Association. Price 5s.

This volume published by the Rubber Growers' Association comprises a series of papers with the discussions thereon read at the Conference held during the recent Rubber Exhibition at Brussels. The subject matter covers a wide field and is mainly concerned with the production and properties of plantation rubber. Of particular note is the paper by Mr. P. J. Burgess which reviews the present-day problems of cultivation, disease, transport and packing of rubber. Prof. Blackman deals with the physiological aspects of disease in plants, an important subject in regard to the disease commonly known as Brown Bast. Dr. Maas analyses the tapping systems in Sumatra. There are two or three papers dealing with chemical and physical research, particularly the vulcanising properties, and including the results of an examination of a new type of raw rubber obtained by spraying latex in hot air. Such rubber is of interest as it is a "whole latex" rubber, whereas the ordinary coagulation process yields rubber from which serum or whey has been removed. There are two or three statistical papers. Mr. Miller deals with the adjustment of production and consumption and Mr. Macfadyen gives abundant data in regard to the development of the industry. The following papers of scientific or technical importance are also of interest, namely, Mr. Pinching on the condition of some of the trees first planted in the East; Dr. Geer (of the B.F. Goodrich Co.) on crude rubber from the consumer's point of view; Drs. Pickles and Turner on the effect of oils on the vulcanisation of rubber; and, finally, Dr. de Vries on the role of enzymes in the coagulation of the Hevea latex.

The book is well got up and clearly printed, has a table of contents and index of authors, but no comprehensive index. The subject matter is from the pen of men well known in the industry who have specialised on the subject discussed. The book should find a place on the shelves of all interested either in crude rubber or its conversion to manufactured articles.

HENRY P. STEVENS

COMPANY NEWS

CELLULOSE HOLDING AND INVESTMENT CO., LTD.

The first dividend of this company, which was formed in 1922, has been declared of 3d. per share, or 25 per cent., tax free.

YADIL PRESS, LTD.

At an extraordinary general meeting on October 21, it was decided to wind up the company, as it "cannot, by reason of its liabilities, continue its business," and to appoint a liquidator.

FORSTERS GLASS CO., LTD.

The fifth annual general meeting was held on October 15, Mr. John Forster (chairman) presiding. Despite the fact that the year had been one of gradually increasing cost of raw materials, rising wages and reduced average price of manufactured goods, the accounts for the year to March 31, 1924, showed a profit of £13,883. This had only been attained by strenuous and efficient work and observing the strictest economy. The number of articles sold during the year was 60 per cent. greater than last year, owing to the opening up of new lines of business, and better trade was expected during the coming months. By adjustments of taxation, the debit balance of £29,292 brought forward last year had been converted into a credit balance of £5529, which, together with the profit of £13,883, made a total credit balance of £19,412, which has been dealt with as follows:—£8247 written off cost of debenture issue; £5000 for depreciation of plant and machinery; £6,165 carried forward.

ROSARIO NITRATE CO., LTD.

An interim dividend of 5 per cent. less tax has been declared.

EASTERN CHEMICAL CO., LTD.

A loss of £5855 is shown by the accounts for the year ended March 31, 1924. In view of the fact that the replacement value of the plant is considerably higher than the original cost, the directors do not consider it necessary to write off any further sum for depreciation this year. Unfavourable conditions recorded in the annual report for last year have continued, and it has not been practicable to raise the prices of the company's manufactures, but very considerable economies have been made in the cost of production, the full effect of which will be felt in the current year.

ALUMINIUM CORPORATION, LTD.

At the fourteenth ordinary general meeting, Mr. Kenneth M. Clark (the chairman), who presided, said that the issued capital stood at the same figure as last year. The first debentures had been increased, after deducting the sinking fund, by £70,370, to provide a portion of the cost of extensions. The second debenture issue was unchanged, and mortgages showed an increase of £200. Loans showed an increase of £11,000 and consisted of £130,000 guaranteed or advanced by the chairman and colleagues, and the sum of £10,000 borrowed from other sources. Sundry creditors and credit balances showed an increase of £13,601, and represented about £53,000 due to ordinary creditors, £12,000 to an associated company, and £86,000 to members of the board, the balance being made up of various reserves for taxation and other contingencies. The sum of £107,903 had been expended during the year on increasing the power and plant, the depreciation reserve on plant and machinery being increased to £34,000. Sundry debtors showed an increase of £23,000, which was in accordance with the increased turnover, whilst stocks were decreased by £32,500. The year 1923 was a less difficult one than 1922, and sales were considerably increased, though, until the end of the period, prices did not improve. The demand for the Corporation's product was maintained in all directions, and the increased

capacity of its rolling mill was fully justified, last year. The Corporation had increased the water storage capacity, and had placed orders for a second and larger pipe-line to take advantage of the increased power. The works were now operating to the full capacity of the plant installed and valuable goodwill had been established. Negotiations had been completed for a tunnel to connect the Eigiau and Cowlyd Lakes, and it was hoped to place the contract for this shortly. This tunnel would greatly help storage and enable the Corporation to balance all their lakes. A dividend of 7 per cent., less income tax, on the preference stock and shares was approved. At the close of the meeting an extraordinary general meeting was held, at which a resolution was passed to convert the existing preference shares into preference stock.

BORAX CONSOLIDATED, LTD.

A dividend of 6 per cent. per annum, less tax, has been declared on the preferred ordinary shares for the half-year ended September 30, 1924. After paying the preference dividend, the preferred ordinary rank for a non-cumulative dividend of 6 per cent., the balance going to the deferred.

BABCOCK AND WILCOX, LTD.

An interim dividend is announced of 5 per cent., tax free, on the ordinary capital of £4,297,656, being the same as was distributed in November last year, when the full dividend, including a 2 per cent. bonus, totalled 12 per cent., against 20 per cent., plus a capitalised bonus of 100 per cent. paid for 1922.

MAGADI SODA CO., LTD.

A meeting was held on October 17, to consider a scheme for the resuscitation of the company, put forward by Messrs. Brunner, Mond and Co., Ltd. Under this scheme the old company would be liquidated and a new company formed which would create and issue £500,000 first mortgage debentures, carrying interest at 6 per cent., payable half-yearly, which were to be redeemable in 1945, or earlier, at six months' notice, but not before July, 1929, at £105 for each £100. The interest on those debentures for the first two financial years of the new company was to be payable out of profits. Each debenture holder was to receive debentures in the new company for the same amount as his present holding. There were various small amendments to the scheme as originally circulated, the chief of which was the redemption price of the debentures. The scheme as modified, was carried; but it was agreed by the meeting that a request should be sent to Messrs. Brunner, Mond and Co., asking them to give more favourable consideration to the deferred shareholders.

The Directors of the Midland Bank, Ltd., announce that they have elected Lord Kylsant, G.C.M.G., to a seat at their Board.

REPORT

Special Reports on the Mineral Resources of Great Britain. Vol. XXVIII. Refractory Materials: Fireclays. Analyses and Physical Tests. By F. R. Ennos, B.A., B.Sc., A.I.C., and Alexander Scott, M.A., D.Sc. Memoirs of the Geological Survey. Pp. 84. H.M. Stationery Office, 1924. Price 3s.

This volume is supplementary to Volume XIV in this series (Refractory Materials: Fireclays. Resources and Geography. Pp. 243. 1920). The data have been principally obtained from analyses at the Geological Survey Laboratories and physical tests made under Dr. Mellor at Stoke-on-Trent, but results have been incorporated which were obtained from other analysts, whose names are given.

The first chapter deals with the general nature of fireclays, which like other clays are formed from pre-existing rocks by disruption accompanied by decomposition and hydration. They may be "residual," that is, lying where formed, or "transported," carried to a fresh bed by the action of water. In the latter case they experience during the translation some sort of grading, and it is this which gives the best clays. In Great Britain the best fireclays are found in association with coal measures and appear to have formed the seat-earth on which the coal-yielding vegetation grew.

Some typical analyses of fireclays are given. They consist essentially of hydrated silica and alumina, which may be free or combined, and which constitute "clay substance," whilst as impurities occur titania, ferric oxide, magnesia, alkalis, and traces of sulphur and organic matter. Some account is given of the mineralogical constitution of clays, a subject which has not received a great deal of attention; the nature of the clay-substance is most reliably discriminated by the behaviour of the clay on heating.

The changes which occur on heating are described, together with factors which spoil the product. The importance of grain-size is mentioned, influencing as it does the rapidity of vitrification and the porosity of the resulting mass.

Chapters II, III, and IV deal respectively with the location, analysis, and results of physical tests of a large number of British fireclays. The analyses were made by the method of W. F. Hildebrand (*Bull.* 700, U.S. Geol. Survey, 1919), except that combined water and organic matter were determined more accurately. The physical tests consisted in determinations of porosity, contraction on firing and drying, and softening point with and without load.

The relation of refractoriness to chemical composition is extremely complicated; some attempts are described, however, to correlate clays of various classes with others in the same class. Clays very seldom conform to the theoretical composition of kaolinite and the silica content may often be usefully adjusted; excess alumina generally increases refractoriness without deleteriously affecting other properties, provided precautions are taken regarding shrinkage and drying. The impurities mentioned above are generally deleterious.

Attempts have also been made to determine the effect of load on refractoriness and also to find some relation between porosity and contraction on firing. The whole Report contains a mass of material of interest to users and manufacturers of bricks and refractories.

LEGAL INTELLIGENCE

ALLEGED INFRINGEMENT OF LETTERS PATENT

Mr. Justice Tomlin, in the Chancery Division on October 16, reserved judgment in an action by Dr. Meyer Wildermann, of Fellows Road, Hampstead, for an injunction to restrain F. W. Berk and Co., Ltd., from infringing his patent (No. 26,568, of 1900) for an invention relating to "improvements in electrolytic cells for the electrolysis of alkaline salts," and for damages.

Mr. Arthur Colefax, K.C. said the plaintiff was a Rumanian, and his complaint was that large quantities of caustic potash were imported which he alleged were made by the Deutsche Wildermann Werke at Luelsdorf, near Cologne, by the use of an apparatus which infringed his invention. The defendants denied infringement and said they did not know of the plaintiff's patent, and that as he was living in Germany when the purchases were made in November and December, 1919, the action was not maintainable owing to the Treaty of Peace of January 10, 1920.

Mr. W. A. Caldwell, analytical chemist, who represented the British Government in Germany in 1919, spoke as to the similarity of the Deutsche Wildermann Werke's plant to that described in plaintiff's specification.

For the defendants Sir D. Kerby submitted that there was no evidence of infringement. The process of preparing the amalgam and making the potash and chlorine, which was the chemical process concerned in this case, was general. What plaintiff had done was to make a small improvement in a cell, but they had nothing to do with that. It would be unfortunate in the public interest, if the plaintiff were to succeed. In 1919, the Government was assisting British trade by arranging sources of supply, and it granted a license to the defendants to import potash. They had no knowledge that plaintiff's patent was used in connexion with its manufacture, and he submitted that it would be harsh to penalise a firm which was simply selling an article, because that article was made by the use of a patent of which it could not have the slightest knowledge. "If I invent a new spade and somebody digs round a fruit tree with it, then anybody who buys the fruit of that tree is an infringer of the patent of my spade." That, he said, appeared to be the result of the plaintiff's argument.

The University of Oxford has agreed to pay sums out of the Government grant for a period of three years to certain college laboratories which undertook part of the University teaching in different departments of chemistry.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	.. £45 per ton.
Powder.. ..	.. £47 per ton.
Acid Hydrochloric	.. 3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	.. £21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric ..	.. Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali..	.. £6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	.. Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	.. £7 10s. per ton, packages extra. Price advanced.
Borax, Commercial—	
Crystal.. ..	.. £25 per ton.
Powder.. ..	.. £26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	.. £5 17s. 6d. per ton d/d.
Copper Sulphate ..	.. £25 per ton.
Methylated Spirit 64 o.p.—	
Industrial ..	.. 2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised ..	.. 3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate ..	.. £38 per ton d/d. Normal business.
Nickel Ammon. Sulphate	(as above)
Potash Caustic ..	.. £30—£33 per ton.
Potass. Bichromate	.. $5\frac{3}{4}$d. per lb.
Potass. Chlorate..	.. 3d.—4d. per lb.
Salammoniac ..	.. £32 per ton d/d.
Salt Cake.. ..	.. £3 10s. per ton d/d.
Soda Caustic, solid	.. Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals ..	.. £5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	.. £24 per ton.
Sod. Bicarbonate	.. £10 10s. per ton, carr. paid.
Sod. Bichromate..	.. $4\frac{1}{4}$d. per lb.
Sod. Bisulphite Powder 60/62%.. ..	.. £17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate ..	.. 3d. per lb.
Sod. Nitrate refd. 96%	.. £13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton /dd.
Sod. Sulphide cryst.	.. £9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	.. 6½d.—1s. 2d. per lb., according to quality.
Crimson ..	.. 1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	.. £3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	.. 3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	.. £30—£33 per ton, according to quantity.
Carbon Black ..	.. 7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride	.. £60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green ..	1s. 3d. per lb.
Indiarubber Substitutes White and Dark ..	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black ..	.. £48 per ton, barrels free.
Lead Hyposulphite	.. 7½d. per lb.
Lithopone, 30% ..	.. £22 10s. per ton.
Mineral Rubber "Rubpron"	.. £16 5s. per ton f.o.r. London.
Sulphur	.. £10—£12 per ton, according to quality.
Sulphur Precip. B.P.	.. £47 10s.—£52 10s. per ton, according to quantity.
Sulphur Chloride	.. 4d. per lb., carboys extra.
Thiocarbanilide ..	.. 2s. 6d. per lb.
Vermilion, pale or deep ..	5s. 1d. per lb.
Zinc Sulphide ..	.. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

There is a general feeling that the fall in price of acetates during the last few weeks has reached its limit. The tendency is now to stiffen again.

Acetate of Lime—	
Brown	.. £11—£11 10s. per ton.
Grey	.. £15 per ton.
Liquor	.. 9d. per gall. 32° Tw.
Charcoal	.. £7 15s.—£9 5s. per ton, according to grade and locality. Demand quiet but price steady.
Iron Liquor ..	.. 1s. 7d. per gall. 32° Tw.
	1s. 2d. ,, ,, 24° Tw.
Red Liquor ..	.. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote ..	.. 2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible ..	.. 4s. 9d. per gall. 60% O.P.
Solvent	.. 5s. 6d. per gall. 40% O.P. Firmer.
Wood Tar ..	.. £4 5s. per ton. Very quiet.
Brown Sugar of Lead	.. £43 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals ..	.. 6¼d.—6½d. per lb. Quiet.
Crude 60's ..	.. 1s. 9d. per gall. Market flat.
Acid Cresylic, 97/99	.. 2s.—2s. 1d. per gall. Demand fair.
Pale 95% ..	.. 1s. 10d.—2s. per gall. Better enquiry.
Dark	.. 1s. 9d.—2s. per gall. Fairly steady.
Anthracene Paste 40%	.. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained ..	.. 6¼d.—6½d. per gall. Small demand.
Unstrained ..	.. 6d.—6¼d. per gall.
[illegible]	
[illegible] 65's ..	.. 7½d.—9d. per gall. ex works in tank wagons.
Benzole—	
Standard Motor	.. 1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Pure	.. 1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90% ..	.. 1s. 5d.—1s. 5½d. per gall. Small demand for home consumption.
Pure ..	.. 1s. 8d.—1s. 9d. per gall. Small demand for home consumption.
Xylol—Coml. ..	.. 2s. 3d. per gall.
Pure ..	.. 3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	.. 8½d. per gall. Little demand.
Middle Oil .. / Heavy Oil .. / Standard Specification	5d.—6½d. per gall., according to quality and district. Fair business passing. A little more demand for export in bulk.
Naphtha—	
Solvent 90/160	.. 1s.—1s. 3d. per gall. Demand good.
Solvent 90/190	.. 11d.—1s. per gall. Fair inquiry. Local demand good.
Naphthalene Crude—	
Cheaper in Yorkshire than Lancashire. Demand rather better.	
Drained Creosote Salts	£2 15s.—£5 10s. per ton. Very dull. No demand.
Whizzed or hot pressed	£6—£9 per ton. Demand very poor.
Naphthalene—	
Crystals and Flaked	.. £12—£15 per ton, according to district.
Pitch, medium soft	.. 40s.—45s. per ton f.a.s. Plenty of inquiry. Prospects brighter. Price too low to interest the distillers.
Pyridine—90/160	.. 19s. per gall. Steady demand.
Heavy	.. 12s.—12s. 6d. per gall. Market dull.

INTERMEDIATES AND DYES

Normal business in dyestuffs has been maintained this week, and users seem to have more confidence. Slight reductions have been made in the price of a number of intermediates.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	.. 1s. 7d. per lb.
Acid H.	.. 3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic	.. 2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	.. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic	.. 9d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil ..	.. 8d. per lb. naked at works.
Aniline Salts ..	.. 8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base ..	.. 3s. 11d. per lb. 100% basis d/d.
Benzyl Chloride 95%	.. 1s. 1d. per lb.
p-Chlorphenol ..	.. 4s. 3d. per lb. d/d.
p-Chloraniline ..	.. 3s. per lb. 100% basis.
o-Cresol 19/31° C.	.. 4½d. per lb. Rather quiet.
m-Cresol 98/100%	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline ..	.. 3s. per lb.
Dichloraniline S. Acid	.. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol ..	.. £85 per ton.
Diethylaniline ..	.. 4s. 3d. per lb. d/d., packages extra, returnable.
Dimethylaniline ..	.. 2s. 2½d. per lb. d/d. Drums extra.
G Salt ..	.. 2s. 4d. per lb. 100% basis d/d.

α-Naphthol	2s. 5d. per lb. d/d.
Dinitrobenzene	9d.—10d. per lb. naked at works.
Dinitrochlorbenzol ..	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
Monochlorbenzol.. ..	£63 per ton.
β-Naphthol	1s. per lb. d/d.
α-Naphthylamine ..	1s. 3½d. per lb. d/d.
β-Naphthylamine ..	4s. per lb. d/d.
m-Nitraniline	4s. 2½d. per lb. d/d.
p-Nitraniline	2s. 2½d. per lb. d/d.
Nitrobenzene	5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol ..	2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene ..	10½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine ..	3s. 10d. per lb. d/d.
p-Phenylene Diamine ..	10s. 2d. per lb. 100% basis d/d.
R. Salt	2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate ..	2s. 2d. per lb. 100% basis d/d.
o-Toluidine	10d. per lb.
p-Toluidine	3s. per lb. naked at works.
m-Toluylene Diamine ..	3s. 10d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS.

Acid, Acetic 80% B.P. ..	£47 per ton. Firmer.
Acid, Acetyl Salicylic ..	3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P. ..	2s. 6d. per lb. Cheaper.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric.. ..	19s.—21s. per lb.
Acid, Citric	1s. 3½d.—1s. 4½d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic	2s. 9d. per lb. for pure crystal in 2 cwt. lots.
Acid, Pyrogallic, Cryst. ..	6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	1s. 6d.—1s. 8d. per lb., according to quantity.
Acid, Tannic B.P. ..	2s. 10d. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	2s. per lb. for quantity. More enquiry.
Amidopyrin	16s. 6d. per lb. for spot stocks.
Ammon. Benzoate ..	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate ..	12s. 6d. per oz. for English make.
Barbitone..	14s. 3d. per lb.
Bismuth Carbonate ..	10s. 6d.—12s. 6d. per lb.
" Citrate.. ..	10s. 3d.—12s. 3d. "
" Salicylate ..	9s.—11s. "
" Subnitrate ..	8s. 8d.—10s. 8d. "
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Marker firm. Prices advancing.
Ammonium	1s. 6d.—1s. 9d. per lb. } According to quantity.
Potassium	1s 4d.—1s. 7d. per lb. }
Sodium	1s. 5d.—1s. 8d. per lb. }
Calcium Lactate ..	1s. 5d.—1s. 7d. per lb., according to quantity. Fair demand and steady market.
Chloral Hydrate	4s.—4s. 3d. per lb. Slightly dearer. Spot supplies short.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Formaldehyde	£48 per ton in barrels, ex wharf London.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	7s. per lb.
Glycerophosphates—	
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50% ..	3s. 6d. per lb.
Sodium, 50%	2s. 6d. "
Guaiacol Carbonate ..	10s. per lb.
Hexamine	3s. per lb. Forward prices higher.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor ..	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. "
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial ..	£36 per ton net.
Magnesium Oxide—	
Light Commercial ..	£75 per ton, less 2½%.
Heavy Commercial ..	£25 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst, B.P. ..	55s. per lb. Price shows signs of recovery.
Synthetic	26s.—35s. per lb., according to quantity. English make. Increasing demand.
Mercurials	Market very quiet.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate ..	3s. 6d.—3s. 7d. "
White precip.	4s. 7d.—4s. 8d. "
Calomel	3s. 11d.—4s. "
Methyl Salicylate ..	1s. 10d.—2s. per lb. Seasonal increase in demand.
Methyl Sulphonal ..	24s. per lb. Slightly weaker.
Metol	11s. per lb. British make.
Paraformaldehyde ..	2s. 8d. per lb. for B.P. quality.
Paraldehyde	1s. 4d.—1s. 6d. per lb. in free bottles and cases. Supplies plentiful.
Phenacetin	5s. 9d. per lb.
Phenazone	7s. per lb.
Phenolphthalein	5s. 9d. per lb.
Potass. Bitartrate— 99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite ..	7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate ..	7¾d. per lb. spot. Forward prices higher.
Quinine Sulphate ..	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 9d. per lb. for cwt. lots.
Sod. Benzoate, B.P. ..	2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite— Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.

Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.	
Sod. Nitroprusside	16s. per lb.	
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Quiet market.	
Sod. Salicylate	Fair demand. Powder 2s.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 5d. per lb. Flake 2s. 6d. per lb.	
Sod. Sulphide—		
Pure recryst.	10d.—1s. 2d. per lb.	
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.	
Sulphonal	15s. 6d. per lb.	Little demand.
Thymol	17s. 6d. per lb.	

PERFUMERY CHEMICALS

Acetophenone	12s. per lb.	Cheaper.
Aubepine	15s. 3d. ,,	
Amyl Acetate	2s. 9d. ,,	Dearer.
Amyl Butyrate	6s. 9d. ,,	
Amyl Salicylate	3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,	
Benzyl Alcohol free from Chlorine	2s. 9d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate	3s. 6d. ,,	
Cinnamic Aldehyde—		
Natural	18s. 9d. ,,	
Coumarin	19s. 6d. ,,	
Citronellol	17s. ,,	
Citral	8s. ,,	
Ethyl Cinnamate	12s. 6d. ,,	
Ethyl Phthalate	3s. 3d. ,,	
Eugenol	10s. ,,	
Geraniol (Palmarosa)	33s. 6d. ,,	
Geraniol	11s. 6d.—18s. 6d. per lb.	
Heliotropine	6s. 9d. ,,	
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose	26s. ,,	
Linalyl Acetate	26s. ,,	
Methyl Anthranilate	9s. 6d. ,,	
Methyl Benzoate	5s. ,,	
Musk Ambrette	50s. ,,	
Musk Xylol	13s. 6d. ,,	
Nerolin	4s. 9d. ,,	
Phenyl Ethyl Acetate	15s. ,,	
Phenyl Ethyl Alcohol	16s. ,,	
Rhodinol	55s. ,,	Cheaper.
Safrol	1s. 10d. ,,	
Terpineol	2s. 4d. ,,	
Vanillin	25s. 6d. ,,	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	
Anise Oil	2s. 8d. per lb.	
Bergamot Oil	16s. 6d. per lb.	
Bourbon Geranium Oil	33s. 6d. per lb.	Cheaper.
Camphor Oil	65s. per cwt.	
Cananga Oil Java	10s. per lb.	
Cinnamon Oil, Leaf	6½d. per oz.	
Cassia Oil, 80/85%	9s. 9d. per lb.	
Citronella Oil—		
Java [illegible]%	5s. 9d. per lb.	
Ceylon	3s. 6d. per lb.	Dearer.
Clove Oil	7s. 9d. per lb.	Dearer.
Eucalyptus Oil 70/75%	2s. 3d. per lb.	
Lavender Oil—		
French 38/40% Esters	28s. 6d. per lb.	
Lemon Oil	3s. 2d. per lb.	Dearer.
Lemongrass Oil	4s. 6d. per lb.	
Orange Oil, Sweet	11s. per lb.	
Otto of Rose Oil—		
Bulgarian	40s. per oz.	
Anatolian	18s. per oz.	
Palma Rosa Oil	16s. 6d. per lb.	
Peppermint Oil—		
English	65s. per lb.	
Wayne County	30s. per lb.	Higher prices anticipated.
Japanese	18s. per lb. paid.	Practically unobtainable for spot or near delivery.
Petitgrain Oil	9s. 3d. per lb.	
Sandal Wood Oil—		
Mysore	26s. 7d. per lb.	
Australian	18s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Dec. 15th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on October 30th.

I.—Applications

Freeman. Furnaces. 23,573. Oct. 6.

Harrold. Furnaces. 23,758. Oct. 8.

Hurrell. Apparatus for producing emulsions etc. 23,509. Oct. 6.

Millar. Crushing rollers. 23,805. Oct. 8.

Nyrop. Apparatus for atomising liquids. 24,078. Oct. 10.

Paterson. Apparatus for treating liquids with chemical reagents etc. 23,836. Oct. 8.

Rosencrants, and Vickers and International Combustion Engineering Co., Ltd. Furnaces. 23,572. Oct. 6.

I.—Complete Specifications Accepted

14,200 (1923). Hoevan. Mixing substances. (199,739.)

17,247 (1923). Tone. Ovens or furnaces. (200,606.)

25,093 (1923). Lilleshall Co., Ltd., and Bishop. Centrifugal filters, separators, etc. (222,676.)

15,590 (1924). Roberts. Centrifugal separator baskets. (218,321.)

II.—Applications

Crozier. Vertical retorts for distillation of shale etc. 23,689. Oct. 7.

Hérengt. Agglomerate fuel. 24,083. Oct. 11.

Hérengt. Distillation of fuel. 24,084. Oct. 11.

Laing and Nielsen. Distillation of carbonaceous materials. 24,048. Oct. 10.

Mayer (Ornstein). Manufacture of lampblack and soot. 23,739. Oct. 7.

Naamlooze Vennootschap Philips' Gloeilampenfabrieken. Precipitating chemical compounds on an incandescent body etc. 24,076. Oct. 10. (Holland, 11.10.23)

Parker and Jones. Distillation of coal etc. 23,743. Oct. 7.

Rosencrants, and Vickers and International Combustion Engineering, Ltd. Drying coal etc. 23,724. Oct. 7.

Trent. Process for producing metallurgical coke. 23,578. Oct. 6. (U.S., 6.10.23.)

Gas Light and Coke Co. and Eve. Gas scrubbers and washers. 23,717. Oct. 7.

II.—Complete Specifications Accepted

17,143 (1923). Wade (Philips' Gloeilampenfabrieken). Electrodes for electric discharge tubes. (222,561.)

17,681 (1923). Bone and Finch. *See* VII.

21,022 (1923). Christenson. *See* VII.
24,848 (1923). Kohlenveredlung Ges. Distillation of carbonaceous substances. (205,101.)
27,791 (1923). Soc. Ricard, Allenet et Cie. Fuels comprising alcohol and liquid hydrocarbon. (206,516.)
28,928 (1923). Evans (Ges. für Maschinelle Druckentwasserung). Agglomeration of coal, coke, ore, etc. (222,702.)
7483 (1924). Ramage. Low-temperature distillation. (214,222.)

III.—Application

James (Lignojen Maschinen und Apparatebau Ges.). Tar separators. 23,738. Oct. 7.

IV.—Complete Specifications Accepted

17,389 (1923). Soc. of Chemical Industry in Basle. Manufacture of sulphurised dyestuffs and intermediate products. (201,540.)
20,925 (1923). Soc. of Chemical Industry in Basle, Reber, and Froehlich. Manufacture of sulphurised dyestuffs and intermediate products. (222,624.)

V.—Applications

British Celanese, Ltd. and Ellis. Treatment of cellulose derivatives. 23,816. Oct. 8.
Ehrenthal and Scholz. Production of cottonised fibres. 23,721. Oct. 7.

V.—Complete Specification Accepted

16,963 (1923). Lilienfeld. Cellulose solutions. (217,166.)

VI.—Applications

Huebner. Finishing and ornamentation of textile materials. 23,983. Oct. 10.
Hunt, Parker, and Moscrop, Ltd. Dyeing machines. 23,990. Oct. 10.
Lord. Apparatus for treating hanks of yarn with liquids. 23,781. Oct. 8.

VI.—Complete Specifications Accepted

9192 (1923). Standard Silk Dyeing Co. Washable dye silk piece goods, and processes of dyeing same. (207,776.)
9196 (1923). Harrington. Waterproofing fabric articles. (222,292.)
17,228 (1923). Scholz. Dyeing textile fabric, paper, etc. (222,567.)
23,740 (1923). Schlumpf. Dyeing apparatus. (217,875.)
17,719 (1924). Standard Silk Dyeing Co. Washable dyed silk piece goods, and a process of dyeing same. (219,697.)
18,339 (1924). Standard Silk Dyeing Co. Dyeing silk black. (219,995.)

VII.—Applications

Cederberg. Catalytic combustion of ammonia-oxygen mixtures. 23,708. Oct. 7. (Ger., 4.12.23.)
Naamlooze Vennootschap Philips' Gloeilampenfabrieken. Manufacture of hafnium and zirconium compounds. 24,125. Oct. 11. (Holland, 15.11.23.)

VII.—Complete Specifications Accepted

17,681 (1923). Bone and Finch. Recovering ammonia from gases or vapours. (222,587.)
21,022 (1923). Christenson. Producing ammonium chloride from gases. (211,096.)
21,099 (1923). Noll. Manufacturing durable compounds containing active oxygen. (202,985.)
24,911 (1923). Angel. Making pure table salt in conjunction with electrolysis of salt solutions. (205,103).
30,874 (1923). Ewan. Manufacture of alkali metal amides. (222,718.)

VIII.—Applications

Brookes. Saggers for firing pottery. 23,875. Oct. 9.
Reynolds. Glazing of tiles etc. 24,151. Oct. 11.

IX.—Applications

Boorne and Budde. Building material etc. 24,134. Oct. 11.
Evers. Cement kilns. 23,956. Oct. 9.

X.—Applications

Brown. Extraction of metals from their ores. 23,605. Oct. 6.
Coley and Hornsey. Production of iron from iron ores. 24,000. Oct. 10.
Gerdts. Alloying metals. 23,707. Oct. 7.
Trent. 23,578. *See* II.

X.—Complete Specifications Accepted

11,759 (1923). Marks (Eureka Metallurgical Co.), Concentrating oxidised ores by flotation. (222,530.)
17,163 (1923). Jonas and Hunt. Annealing - furnaces. (222,566.)
17,417 (1923). Speck and Kennedy. Furnaces for annealing and tempering. (222,575.)
28,928 (1923). Evans (Ges. für Maschinelle Druckentwasserung). *See* II.
30,367 (1923). Heddernheimer Kupferwerk. Alloys suitable for pressed or cast bearings. (207,826.)
3670 (1924). Stehli. Apparatus for sintering and otherwise treating ores. (222,748.)
6929 and 6985 (1924). Allmanna Ingeniorsbyran H. G. Torulf. Sintering fine and pulverous ores. (220,924, 220,925.)

XI.—Application

Kalling. Electric resistance furnace. 23,593. Oct. 6.

XI.—Complete Specifications Accepted

24,911 (1923). Angel. *See* VII.
28,872 (1923). Monnot. Alkaline storage batteries. (222,701.)
2389 (1924). Tribelhorn. Filling-paste for secondary elements. (210,777.)
10,450 (1924). Ridoni, and Soc. Talco e Grafiti val Chisone. Manufacture of electrodes from natural graphites. (222,785.)

XIII.—Application

Mayor (Ornstein). 23,739. *See* II.

XIII.—Complete Specification Accepted

17,278 (1923). Lloyd, Clapp, and Campbell. Manufacture of white lead. (203,301.)

XIV.—Applications

Bezenecenet. Impregnation of material with rubber etc. 24,088. Oct. 11.
Etty and Wilby. 23,863. *See* XV.

XV.—Applications

Etty and Wilby. Production of chrome leather. 23,862. Oct. 8.
Etty and Wilby. Manufacture of rubberised hides etc. 23,863. Oct. 3.
Kaye, Lloyd, and Pickard. Production of hide and chrome leather power for tannin analysis. 23,968. Oct. 9.

XVIII.—Complete Specification Accepted

16,740 (1923). Norbury, Desborough, Thaysen, and Galloway. Treating vegetable matter by fermentation to obtain alcohol, acetone, etc. (222,549.)

XIX.—Applications

Carpmael (Bayer und Co.). Exterminating vermin. 24,065. Oct. 10.
Harold. Preparation etc. of sterilising-agents, germicides, etc. 23,748. Oct. 7.

XX.—Applications

Knoll und Co. Preparation of dihydrocodeinone from thebaine. 23,835. Oct. 8. (Ger., 7.12.23.)
Welter. Manufacture of fatty acids. 24,052. Oct. 10. (Ger., 23.10.23.)

XX.—Complete Specification Accepted

16,740 (1923). Norbury, Desborough, Thaysen, and Galloway. *See* XVIII.

XXI.—Application

Proszynski. Photographic film. 23,683. Oct. 7.

XXI.—Complete Specification Accepted

9415 (1923). Martinez. Direct - colour photography. (222,523.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department, and quoting the specific reference number :—*Argentina* : Iron and steel, cement (429) ; *Canada* : Chemicals (403) ; Rubber goods (404) ; Stainless steel sheets, talc (The Canadian Government Trade Commissioner's Office, Portland House, 73, Basinghall Street, London, E.C. 2) ; *Chile* : Tinplate, silk (430) ; *Egypt* : Iron, brass (416) ; *France* : Chemical products (411) ; *Latvia* : Copper (A.X./1371) ; *New Zealand* : Steel (406) ; *Norway* : Chemicals, oils (413) ; *South Africa* : Steel (A/1376) ; Aluminium paint (B.X./1287) ; *Spain* : Drugs, anilines, colours, chemicals (414) ; *Sweden* : Leather (415) ; *United States* : Leather (420) ; leather (425) ; *Venezuela* : Hardware (434) ; *Yugoslavia* : Tinplate (412) ; X-Ray apparatus (B.X./1276).

Notes on Plant and Products

Bells United Asbestos Co., Ltd., has issued a pamphlet (reprinted from the *Indiarubber Journal*) entitled, "The development of the asbestos industry (1871–1924)." The early uses of asbestos, and the commencement of the modern interest in asbestos are briefly dealt with, the history of the industry being reviewed up till the formation of the United Asbestos Company in 1879, by the amalgamation of the Glasgow and Italo-English Companies and the asbestos interests of Messrs. Furse Bros. Further important developments took place in 1909, when the business of Bell's Asbestos Co., Ltd., and of the United Asbestos Co., Ltd., were amalgamated under the name of "Bell's United Asbestos Co., Ltd., and the manufacturing operations of Bell's Company in Southwark Street and East Greenwich were transferred to the United Company's factory at Harefield, which was remodelled and extended to meet the new requirements. A gen[illegible]l survey of the progress which the industry ha[illegible] made during the past fifty years is also given, together with a description of the multitudinous uses of asbestos, including brake and clutch linings, and the British-Asbestos-Cement tile, a product of the Patents Act of 1907. For some years after asbestos was introduced to the engineering world (about 1871 or 1872) it was thought that where resistance to heat and steam was essential, asbestos would take the place of rubber, but experiments have proved that intelligent combination between the two articles has obtained th[illegible]est results.

The British Sul[illegible] Ammonia Federation, Ltd. announces that th[illegible] for November delivery is £14 6s. per ton, a[illegible] December delivery, £14 8s. per ton, for neutr[illegible]uality in fine friable condition, free from lumps, [illegible]sis 21·1 per cent. nitrogen, in 4-ton lots. Limited quantities of ordinary quality will be ava[illegible] in some districts, and will be sold at 23s. per t[illegible] than the above prices, basis 20·7 per cent. ni[illegible] Neutral sulphate of ammonia as describ[illegible]ve, guaranteed not to contain more than 0[illegible] cent. free acid, will be sold on the basis of 21·1 per cent. nitrogen, with no charge if over 21·1 per cent., but with a rebate of 1s. 6d. for every decrease of 0·10 per cent. of nitrogen. An allowance of 9s. 6d. per ton will be made if the content of free acid exceeds 0·025 per cent., and an allowance of 9s. 6d. will also be made, should any delivery of neutral sulphate not be in fine friable condition free from lumps. Ordinary sulphate of ammonia will be sold on the basis of 20·7 per cent. nitrogen, with no charge if over 20·7 per cent., but with an allowance of 1s. 6d. for every decrease of 0·10 per cent. of nitrogen. These qualitative deductions apply only to deliveries of two cwts. and over.

The Consett Iron Co., Ltd., is considering developments which include the duplication of the new American Fell coke works, the remodelling of the Templetown coke works, and the erection of a large by-product plant near Newcastle. The reconstruction of the steel works will be complete in January, and the Company will then employ roughly 6000 more men than in 1913.

A new artificial-silk factory is to be built for Courtaulds, Ltd., at Bushbury, Wolverhampton. It is stated that the cost will be £1,500,000.

Overseas Trade

The *Board of Trade Journal* states that the declared values of imports during the September quarter of the year were 2·5 per cent. higher than during the third quarter of 1923, and the quantities of goods imported 22·2 per cent. higher. Exports of United Kingdom goods show a small reduction in average declared values of 1·1 per cent., and an increase in quantities shipped representing in the aggregate, 10·7 per cent.

PUBLICATIONS RECEIVED

A Classified Catalogue of Works Published by Messrs. Longmans, Green and Co. Pp. xliv+196. London: Longmans, Green and Co., 1924.

The Principles of Applied Electro-Chemistry. By A. J. Allmand, M.C., D.Sc. Second edition, revised and enlarged by the author and H. J. T. Ellingham. Pp. x+727. London: E. Arnold and Co., 1924. Price 35s. net.

Distillation du Bois. By G. Dupont. Encyclopedie Leaute. Pp. xv+284. Paris: Gauthier-Villars & Cie., 1924. Price 25 fr.

The Enlarged Callendar Steam Tables (Fahrenheit Units). By H. L. Callendar, C.B.E., F.R.S. Pp. 80. London: E. Arnold and Co., 1924 Price 7s 6d.

The Corrosion of Metals. By U. R. Evans, M.A. Pp. xii+212. London: E. Arnold and Co., 1924. Price 14s.

Messrs. G. Bell and Sons, Ltd., announce the publication, in the autumn, of the following books :—"Concerning the Nature of Things," by Sir W. Bragg, and "Chats on Science," by Prof. E. E. Slosson. Books published recently by the same firm include new editions of "X-rays and Crystal Structure," by Sir W. H. Bragg and Prof. W. L. Bragg, and "Webster's New International Dictionary."

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals and the Royal Agricultural Society.

VOL. 43 NEW SERIES | LONDON, OCTOBER 31, 1924 | NO. 44

EDITORIAL

DR. LUDWIG MOND, the subject of Prof. Dixon's recent lecture, was a remarkable man. He was remarkable in very many respects; he was an excellent chemist with a scientific mind, and able to exercise a sound judgment when faced by a scientific problem. He was also an extremely determined man; when he made up his mind to do a particular thing, for instance to make a particular piece of plant work as it should, he did not allow difficulties—whether they took the form of men, of defects, of delays, or of ignorance—to stand in his way. He persevered with his task in the face of difficulties which were nearly insuperable until it was accomplished. He had remarkable luck; that sort of luck which consists in getting up at six o'clock in the morning, in spending half-a-crown when other men spend half-a-sovereign, and in minding your own business. We do not remember that he had any other sort of luck. He was as thorough as he was determined; he had an iron will and, until late in life, he had an iron constitution. And yet he had a kindly and generous nature; a love of art and all things artistic; an appreciation of good pictures, good music and good literature, and a certain simplicity characteristic of many of the kindly Germans who lived fifty years ago. We never knew him when in his prime; we suspect that during that period of his life he must have been singularly energetic and autocratic, as are most men who accomplish great things. He also had the gift of obtaining and keeping the friendship of other men who, very different from him in their nature and training, were invaluable in the enterprises in which they were associated. It is a good thing that his memory should be kept alive by such a scheme of lectures as that instituted by the late Mrs. Mond.

The report of the meeting of the Yorkshire Section of the Society of Chemical Industry is of unusual interest. An appeal was then made for more articles on present chemical trade problems. There may be a difference of opinion about some features of the *Journal*, for instance, the editorials, but there is no difference of opinion about articles on chemical trade problems. The Yorkshire Section wants more of these, so does the editorial department of *Chemistry and Industry*; so does the editorial department of the *Transactions*, so does, in fact, every reader of the *Journal*. It was said in old days of Lockyer that he sometimes forgot that he was the editor and not the creator of Nature! We beg our readers to remember that we are merely editors. We hear many items of news, fresh developments in industry, new processes, and so on, always accompanied by the condition that no information is to be made public until further notice. This hampers us very greatly in our sanctum; on the other hand, there are several thousand chemists engaged in industry, whose knowledge is adequate for the purpose, who could send us articles of the type we all desire. We are grateful for these; they form suitable subjects for the meetings of our sections. We have no cabinet full of such articles waiting for the day when we can rouse ourselves from our lethargy sufficiently to hand them to the printers. To put the matter baldly and bluntly, we want such articles. Had we more of them we could avoid spending time on writing rather garrulous paragraphs of hardly even ephemeral interest. If every section would send us even only one such article within the next two months we should have a supply which would keep us going until our columns are filled with accounts of York Minster, and a visit to the paint and varnish factories at Ripon, with incidental notes about Fountains Abbey and Brimham Rocks. Keep us supplied with really nutritive matter until we can refresh our minds on the banks of the Nidd or the Skell, watch the Yore tumbling down at Aysgarth,

or listen to the jackdaws disporting themselves over the Wharfe at Boston Spa.

* * *

We have in the past commented on the fact that chemists here do not take the same interest in public affairs that is taken by some other professions in which men engage. It is different, it seems, in America. The Chemists' Coolidge and Dawes Committee is hard at work there; the literature sent out by the committee appeals very strongly; we have read it and much like it. It is, however, so complicated a situation that it is not easy for the chemists over here to make up their analytical minds. Here there are two sides to every question, and our side is right and yours is wrong. Over there the problem is not so simple; we asked a friend from Virginia to explain to us the difference between a Republican and a Democrat: his answer was that every self-respecting man was a Democrat; on the other hand, two friends of ours from New York spoke of the Democrats in terms too forcible for repetition. Here we are busy with our own election and we could make a very shrewd prophecy as to the result. But as the result will be known before our prophecy can be published, it seems futile to have it set up in type. In the United States it seems that there are three candidates for the Presidency, and that unless the favourite comes out well at the top of the poll, another man who is not a candidate at all will obtain the post. President Coolidge has not sent us a bound volume of his recent election addresses; but for this omission we should gladly have picked out the salient points from his abundant eloquence and given them amphoteric comments. We trust that the American chemists will make their voices and pens heard; we can assure them that if they come to this country after the voting is all over a warm welcome is always ready for them at the Chemical Industry Club.

* * *

Prof. W. E. S. T[illegible]ner has done much to improve the technology of glass-making. He has organised an important school of research, has published many papers and has collected and disseminated information about all the improvements and new discoveries in the subject of glass technology. Sheffield is the focus in which all this work is concentrated, and Prof. Turner's paper which he read there a few days ago contains much valuable matter. Those of us who are not engaged in the manufacture of glass and glass vessels do not find it easy—nor does it concern us—to estimate at their true value the Westlake machine, t[illegible]Hartford Empire feeder, or the Fourcault process. [illegible]t does interest us is that such devices are bein[illegible]hed and described by a man of science who ha[illegible]ted special attention to the subject and faces [illegible]oblems with the advantages of an acute mi[illegible]bundant knowledge. Many other industri[illegible]n a similar manner applying scientific kn[illegible]s and scientific methods for their own advant[illegible]he flax and linen industry is one which is r[illegible]us by the announcement in the daily pa[illegible]the appointment of a committee to study the growing of flax in this country. A few years ago we met an old man who remembered the time when the valley of the River Lea was brightened by many fields of flax. A hundred and twenty years ago, we think, in almost every county in England, and in almost every parish in those counties flax was grown. We have ourselves seen flax grown in Essex, principally by Scotsmen, who in that county have been remarkably enterprising and successful. But the glass industry and the flax industry are not the only ones profiting by modern research. The Fuel Industry is continually reminding us of its research department, and holding out hopes that very shortly the inhabitants of Sheffield and Stoke-on-Trent will be able to see the sun on other days than Sunday. Most of the other industries are also taking due advantage of modern science, and of all such sciences chemistry as we well know is the one which most quickly can be made use of by existing industries.

* * *

Some time ago the Fuel Research Board made the welcome announcement that it had been empowered to make tests at the public expense of plants for the low-temperature carbonisation of coal. The object of these tests is to furnish accurate technical data on the quality and quantity of yields; the throughput, working temperatures and general ease of working; and other general information on the plant under test. The Board points out very wisely that no attempt is made to pronounce on the commercial possibilities of any plant that is tested. Now we have the results of the first tests carried out, the particular plant investigated being a standard unit of the Parker plant for the low-temperature carbonisation of coal at the works of Low Temperature Carbonisation, Ltd., at Barnsley. The account of the tests, which has been published by the Department of Scientific and Industrial Research, makes interesting reading. The chief conclusions are that the throughput of 50 tons a day with 32 retorts accorded with that claimed; that the products were satisfactory in quantity and quality; and that certain defects in the plant which became evident during the trial could be remedied in future designs. The coke was of suitable size, and of good quality, and the yields of tar, gas, ammonia and gas were high. Such conclusions are encouraging, especially as the yields were slightly better than those obtained with a similar coal on an intermediate scale at the Fuel Research Station. The commercial possibilities of the plant, however, can only be judged after it has been worked continuously over a long period and after considering all costs, but the Report of the Fuel Research Board provides a basis on which at least an opinion of the future of low-temperature carbonisation can be founded. Whether the Parker process is to prove of general application, whether it is to be used only for the treatment of waste coal, whether its products will be as valuable as is claimed in some quarters, questions such as these have still to be answered. One can at least claim that there is much to be said for it from a scientific standpoint, but processes have to submit to the operation of economic laws, and these provide the final test of survival.

A DYNAMIC HYPOTHESIS OF CHEMICAL COMBINATION

By PROF. GILBERT T. MORGAN, F.R.S.

Hitherto chemists have favoured a static conception of electrons as an explanation of the facts of chemical constitution and of stereochemistry. But the physical evidence regarding atomic structure demands a dynamic conception. The object of this note is to suggest a general explanation of chemical combination based on the view that valency electrons are in a state of orbital motion.

Two limiting types of chemical valency are now generally recognised :—electrovalency, from which polar combination results, and non-polar valency leading to non-ionised substances. The former type, which is regarded as being due to the complete migration of an electron from one atomic system to another, may be exemplified by the union of sodium and chlorine to form the electrolyte, sodium chloride, wherein the valency electron of sodium has become part of the planetary system of chlorine. In a non-polar combination there is no complete migration of an electron, the combining elements share their valency electrons, so that this mode of combination is appropriately symbolised by the single and multiple bonds or linkings which appear so frequently in organic chemistry. However, the simplest form of non-polar combination, the single bond, is generally regarded as an affair of two electrons, each element concerned in the single linking sharing one electron with its consort. The double bond of organic chemistry is frequently, although not invariably, considered to involve the sharing of four electrons, two from each of the combining elements.

The simplest example of non-polar combination is the hydrogen molecule in which two electrons are shared between the two hydrogen atoms. Another simple example is furnished by dry hydrogen chloride in which the hydrogen electron is shared between the hydrogen and chlorine atoms.

According to Bohr's theory, the electrons of a single atom revolve round its nucleus in circular orbits in such a manner that no energy is radiated during the complete circuit of any single orbit; that is, each electron must be moving along a surface which is effectively an equipotential surface.

In the hydrogen molecule, the simplest binuclear system, the two electrons are now under the influence of both nuclei, with the result that their paths will no longer be circular, but in order that no energy may be radiated during a single revolution, each electron must still move along a path traced on an equipotential surface. In order that this condition may be maintained the possible orbits will all be included in the group of curves associated with the name of Cassini, the equation for these curves referred to bipolar co-ordinates being identical with the relationship expressing a constant potential. In the present case of hydrogen this is

$$\frac{e}{r} + \frac{e}{r'} = V \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(1),$$

where V is the potential (a constant for each curve of the series), e the charge on each nucleus and r and r′ the distances from the nuclei of any point on the curve.

The curves obtained by taking various values of V are shown in Fig. 1, from which it will be seen that the family of curves is divided into two groups by the figure of eight curve, consisting of two lobes intersecting at O midway between the nuclei A and B. This bilobed curve, the well-known lemniscate of

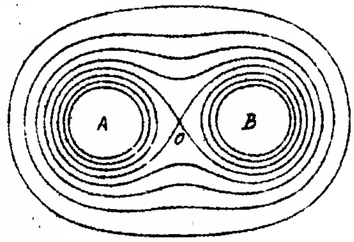


FIG. 1

Bernouilli, is a limiting curve which divides the family of Cassini curves into outer and inner series. The outer Cassini curves are continuous and encircle both nuclei. At first hour-glass in shape with a median constriction which gradually disappears as the value of the potential (V) diminishes, they approximate in the limit to elliptic and finally to circular orbits.

In non-polar combination, the path of a valency electron is an outer Cassini curve which includes both nuclei within its orbit. When two electrons are involved, as in the single bond or linking, they will move along two similar outer Cassini curves in planes inclined to one another in a manner approximating to the orbital planes of the two electrons in the helium atom.

This dynamic view of the single linking correlates the stability of saturated compounds with a similarity between their molecular structure and the atomic structure of the inert gas, helium. In methane, for instance, there is a fourfold helium arrangement of shared electrons. Round each hydrogen nucleus are revolving two electrons in outer Cassinian orbits simulating the behaviour of the stable arrangement obtaining within the helium atom. These four pairs of electrons will include the central carbon nucleus in their orbits, and the repulsion of the four positively charged hydrogen nuclei will result in a symmetrical tetrahedral arrangement which will persist in spite of the dynamic nature of the linkings.

Within the lobes of the lemniscate are the inner Cassini curves for higher values of the potential and each of these curves consists of two separated Cassinian ovals, one round each nucleus. This group of curves represents the condition of a valency electron in electrovalency; it is moving in an inner Cassinian oval round one of the nuclei. It may be remarked in passing that since any other electrons present in the two atomic systems are also under the joint influence of the two nuclei, their orbits will also be distorted from their original circular forms into

Cassinian ovals. And since this perturbation affects all the electrons in the binuclear system, it will be impossible after chemical combination has occurred to identify the electron which has either passed from one atom to the other, or which is being shared between them. This fundamental alteration in the orbits of all the electrons of the binuclear system finds a parallel in the profound and abrupt changes in physical and chemical properties which arise as a result of chemical combination. It also affords an explanation of the nascent state, of the equivalence of the four hydrogen atoms in the ammonium radical $[NH_4]$, and of the equivalence of oxygen and fluorine in Marignac's classical series, $K_2[TiF_6]$, $K_2[CbOF_5]$ and $K_2[WO_2F_4]$.

For simplicity this discussion is based on the example of two nuclei with equal charges, but the case of nuclei with different charges, although diverging from the symmetry of the Cassini curves, still preserves the fundamental principle of the movement

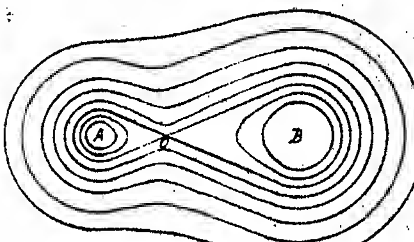


FIG. 2

of electrons along equipotential surfaces as given by the equation

$$\frac{Ne}{r} + \frac{N'e}{r'} = V \quad \ldots\ldots\ldots\ldots\ldots\ldots (2),$$

where Ne and N'e are the dissimilar charges on the two nuclei, the other terms having the same significance as in equation (1).

Fig. 2 represents the non-ionised molecule of dry hydrogen chloride; the two electrons implicated in non-polar linking rotate round both nuclei in Cassinian curves outside the modified lemniscate or figure of eight curve. When the hydrogen chloride is ionised by moisture the condition of the hydrogen electron is also shown in Fig. 2. If B is the chlorine nucleus, the hydrogen electron now revolves round this focus in an orbit which is an inner Cassinian oval comparable with those drawn within the larger lobe of the figure of eight (Fig. 2).

The foregoing figure also indicates in a similar manner the condition of the valency electron of sodium in sodium chloride. This electron is revolving in an inner Cassinian oval round the chlorine nucleus.

In more complicated examples where there are more than two nuclei, perturbations in the electronic orbits will arise owing to the mutual interactions of the va[illegible]clei, but in many instances this complication [illegible] diminished considerably by a symmetrical dis[illegible]on of these nuclei, as already indicated [illegible] of methane.

The double linking of organic chemistry corresponds with Langmuir's assumption of two co-valencies involving a sharing of four electrons between the two associated atoms. On the dynamic hypothesis now advocated this would result in the four shared electrons rotating round both nuclei in outer Cassini curves in four planes inclined approximately to each other at angles of 45°. The mutual repulsion of the electrons would, however, hinder this arrangement, and the alternative hypothesis of "mixed double bonds" advanced by Lowry (*Chem. Soc. Trans.*, 1923, **123**, 822) is, in certain instances, the more probable. In terms of the present hypothesis this alternative means that two of the four electrons rotate round only one of the nuclei in inner Cassinian ovals, whereas the other two maintain the non-polar junction by moving round both nuclei in outer Cassini curves in planes inclined to one another, as in the case of a single co-valency. This alternative agrees not only with Lowry's hypothesis of "mixed double bonds," but is also in accord with the conception of "bound ions" put forward independently by Pfeiffer in discussing the constitution of betaines (*Ber.*, 1922, **55**, 1762), and by Main Smith and myself in reference to the nature of the lakes of mordant dyes (*Chem. Soc. Trans.*, 1921, **119**, 705; 1922, **121**, 1957).

The triple linking offers similar difficulties. If three co-valencies are present, involving six shared electrons, these similarly charged particles would be moving round both nuclei along six outer Cassinian curves in planes inclined approximately at 30° to each other. The forces of repulsion thus called into play would militate considerably against the permanence of this arrangement. A more stable alternative would arise if only one pair of electrons were shared while one atom took over two electrons from the other. In this case the two shared electrons would move in outer Cassini curves round both nuclei and the two surrendered electrons would describe inner Cassinian ovals round the nucleus of the receptive atom. Such an arrangement may obtain in the acetylene molecule, and would lead to an interlacing of the electrons in the two carbon atoms which might account for the singular property possessed by the monosubstituted acetylenes, RC ⋮ CH, of yielding metallic derivatives.

As an inorganic example, the case of anhydrous chromic chloride may be cited. Insoluble and non-ionised in water, it represents a system with three non-polar linkings in which the shared electrons move in outer Cassini curves round the chromium nucleus and the chlorine nuclei. The addition of five molecular proportions of liquid ammonia first enables two of the three shared chromium electrons to be acquired by two chlorine planetary systems; two non-polar valencies become electrovalencies with two electrons derived from the chromium rotating in inner Cassinian ovals round the nuclei of two chlorine ions. The third chlorine atom is still retained in a non-polar bond until more ammonia frees it from this restraint, and the third valency electron from chromium then also describes an inner Cassinian oval round the nucleus of the third chlorine ion.

$$[CrCl_3] \rightarrow [CrCl, 5NH_3]Cl_2 \rightarrow [Cr6NH_3]Cl_3.$$

Although in the foregoing co-ordinated chromammine ions there are 21 and 24 associating nuclei respectively, these are arranged in regular order round the central chromium atom. The chromium nucleus is implicated octahedrally in six Cassinian electronic systems with six peripheral atoms consisting either of five nitrogens and one chlorine or of six nitrogens. These nitrogens are each implicated tetrahedrally in four Cassinian electronic systems, with four peripheral atoms consisting of three hydrogens and one chromium.

Although these assumed molecular arrangements are based on a conception of moving electrons, they have sufficient permanence to account for the facts of structural and steric isomerism. The persistence of these structures will result from :—

(1) The rigidity of rapid motion due to the swiftly revolving electrons in the interlocked multinuclear systems.
(2) The symmetrical distribution of the positively charged nuclei arising from their mutual repulsion.

In this way one arrives at the tetrahedral and octahedral structures which have so far been chiefly studied in stereochemistry. At the same time the dynamic conception allows to these systems the possibility of re-arrangement which is also demanded by the experimental evidence regarding racemisation, epimeric change and the Walden inversion. Under the stress of physical or chemical agents the spatial relationships of atoms in chemical compounds become modified owing to new perturbations in the orbital motions of the implicated electrons.

These electronic re-arrangements occur not only in non-polar compounds where combination is of the co-valency type, but also in the passage from the non-polar to the polar or electrolytic condition. In accordance with the dynamic hypothesis now put forward this chemical change is associated with the passage of valency electrons from outer to inner Cassinian orbits.

The fatty acids of the acetic series furnish a notable example.

$$\left[RC\begin{matrix} \diagup O \\ \diagdown OH \end{matrix} \right] \rightleftarrows \left[R.CO_2 \right]H.$$

In the pseudo-acid condition (the non-polar compound) the electron of hydroxylic hydrogen is moving in an outer Cassinian curve round both hydrogen and oxygen nuclei. In the true acid, the hydrogen electron has crossed the limiting zone of the modified lemniscate (Fig. 2), and is now moving in an inner Cassinian round an oxygen nucleus only.

Another case which illustrates the close proximity of electronic orbits to the critical lemniscate zone is seen in the behaviour of roseocobaltammine. In the chloride, three electrons from cobalt are moving in inner Cassinian curves round three chlorine ions respectively. Treatment with alkali produces an unstable triacidic base, in which these three electrons still revolve exclusively round hydroxylic oxygen, but this compound changes spontaneously into the hydroxopentamminocobaltic dihydroxide, in which only two of the three electrons persist in the inner Cassinian orbits while the third now revolves in an outer Cassinian orbit involving both cobalt and oxygen, this electron having passed from one side of the critical lemniscate zone to the other, an alteration brought about by changes in the dielectric character of the medium in which the reactive compound is placed. This medium may act catalytically, or, as is more usually the case in ionic changes, it may combine chemically with the dissociating compound.

$$\underset{\text{stable roseo salt}}{[5NH_3Co,H_2O]Cl_3} \rightarrow \underset{\text{unstable tri-acidic base}}{[5NH_3Co,H_2O](OH)_3} \rightarrow \underset{\text{stable diacidic base}}{[5NH_3Co.OH](OH)_2}$$

Many other relevant instances might be adduced but sufficient examples have been given to show how the conception of dynamic electrons in multinuclear systems may be used in explaining the facts of polar and non-polar combination, ionisation, tautomeric change and the characteristic properties of the principal types of inorganic and organic isomerism.

To those interested in the conception of dynamic electrons the following mathematical references may be useful :—

J. H. Jeans, *Electricity and Magnetism*, p. 48. G. H. Darwin, *Scientific Papers*, Vol. IV, p. 12. Pauli, *Ann. Physik.*, 1923, IV, **68**, 177. Nordheim, *Z. Physik.*, 1923, **19**, 69. Niessen, *Arch. Néerland.*, 1923, **7**, 12.

University of Birmingham
Edgbaston

METALLURGICAL AND MINING NOTES FROM CANADA

A very rich strike of silver-lead ore has been made on Galena Hill, Keno City, Yukon Territory. The samples assay 700 oz. silver to the t. and 70 per cent. of lead.

The total output of salt, in 1923, amounted to 206,985 t., valued at $1,713,516.

The production of arsenic, calculated as As_2O_3, in 1923, was 3667·1 t., valued at $883,771.

The gold produced during the past year was 1,243,341, fine oz., valued at $25,702,139.

A shipment of 1000 t. of arsenical concentrates, from the gold-dumps of Nova Scotia, has been made to England.

The production of crude petroleum in Canada in 1923 was 170,169 barrels, valued at $522,018, as compared with 179,068 barrels, valued at $611,176, in the previous year, a decline of approximately 9000 barrels.

During the year ending June 20, 1924, the Laurentide Co. Ltd. made a net profit of $2,084,524, equal to 7·2 per cent. on the capital stock (6·2 per cent. in 1923); the working capital is $6,892,142. The amount allowed for depreciation for the past year was double that of the previous year.

A vein of rich silver ore, six feet in width, has been discovered near Fort William, Ontario.

OUR EMBASSY TO AMSTERDAM

By ONLOOKER

Our Dutch colleagues have done well to keep green the memory of their distinguished countryman, van't Hoff, by openly celebrating the Jubilee of the conception upon which the modern doctrine of stereoisomerism is based, published independently by Le Bel in France and van't Hoff in Amsterdam, in the latter part of 1874. Van't Hoff, it may be remembered, was brought up on a strange diet of Burton's *Anatomy of Melancholy*, Byron, Burns and Buckle; yet his contribution was so made and so simple that it almost forthwith gave solidity to chemists' speculations as to the character of optically active compounds in particular, and it has prevailed up to the present day, a vast amount of solid work being traceable to the influence it has had. At the public meeting, held on Saturday last, October 25, in the Aula of the Amsterdam University, the foreign visitors were first welcomed by a representative of the Netherlands Chemical Society; addresses were then delivered by Profs. Cohen and Walden. Prof. Cohen's speech was an eloquent appreciation of the two men, the section devoted to Le Bel being particularly happy in its allusions. The address is to be reproduced in *Chemisch Weekblad*. Beginning with a Shakespearian quotation:—

> "And, as imagination bodies forth
> The forms of things unknown, the (chemist's) pen
> Turns them to shape and gives to airy nothing
> A local habitation and a name"—

he asked his audience to imagine themselves in Piccadilly, London, on November 30, 1893, at the Royal Society, when Lord Kelvin presented the Davy medals, jointly awarded to J. A. Le Bel and J. H. van't Hoff.

Prof. Walden appears to have prepared a complete account of the development of Stereochemistry up to the present day, but could only summarise his conclusions. The address naturally suffered in consequence, and was less suited than Prof. Cohen's to a general audience, though it will doubtless be found to be invaluable when published.

A reception preceded the meeting, and tea followed it. Unfortunately, Le Bel could not be present. The French Chemical Society was represented by Mons. Delépine, our Chemical Society by Profs. Armstrong and Lowry, whilst Mr. Woolcock Box'd and Cox'd the parts of President of the Society of Chemical Industry and that of representative of the A.B.C.M. An American wandering in Europe had been captured to appear on behalf of the American Chemical Society. Prof. Walden was the delegate of the German Chemi[illegible] Society, and also appeared for the Russian So[illegible]; it may be mentioned that he is now Profe[illegible] Rostock; he was formerly in Riga.

In the [illegible]uct was given at the *Hôtel de l'E[illegible]* [illegible] of about 35, including the E[illegible]ador. Prof. Cohen was in the [illegible] was clear that his was the active organising [illegible] behind the celebration. The menu included [illegible]propriate lubricants):—Consommé Rumford, Turbotin Fischer, Pièce de Bœuf Liebig, Poulet en Casserole Pasteur, Bombe Berthelot. To enlighten the Saintsburys, we may say that Moët and Chandon's *White Star* was served both with the Hors D'Œuvre and the Poulet—not with the Bombe. The courses were seven, but the speeches—heavier than the courses—twice that number, taken at intervals throughout the meal. All were good and full of point. The astounding proficiency of the Dutch as linguists was very noticeable, especially in the Chairman, to whom English, Dutch, French and German seem to be but one language. He is an inveterate Byronist.

The celebration undoubtedly was very successsful. A friendly party of men, understanding one another, united to give pious effect to the feeling of gratitude which all who can appreciate the great gift our science has received from the two men in whose honour we were assembled.

Mr. Woolcock, it may be said, played the part of Pooh Bah to perfection. In his presidential capacity he was the Lord High Chancellor, advising that due economy must be observed. As (private) Secretary to the Alphabet he was always prepared "to do it well." Fate, however, was too much for him. As it is believed on the Continent that all Englishmen not in the War were stricken with knighthood, a higher honour was accorded to him, and even his hotel bill was made out to *Professor* Woolcock: the terms of the bill were in no way in accordance with the title; but there it is and must remain upon him in future. He deserves it, if only because of the able way in which, during dinner, he preached the doctrine of the inseparable state of chemical science and industry. There is no doubt that our English full recognition of the significance of the occasion was appreciated. On the other hand, it is clear that such exchanges of courtesy are of great value. These meetings, however, ever serve to remind us only too forcibly of our linguistic deficiencies.

Several of the party were privileged to attend the monthly meeting of the Dutch Academy on the Saturday morning. The Academy is limited to fifty members. A simple lunch is provided at 12-1, after which the formal meeting is held.

INDUSTRIAL FILTRATION

In the recent article on Industrial Filtration the speed of the Vickeen Separator made by the British Separators, Ltd., was given as 60 r.p.m. This number refers to the type of machine of which the actual speed is 7000 r.p.m. At this speed it is capable of purifying 200 gall. per hour of transformer oil at 50° C; the output given in the article relates to a test in which the oil flow was adjusted to the figure stated. For further information on these interesting machines, reference should be made to the catalogue (B.10) describing in detail the Vickeen Separators made by British Separators, Ltd. It should also be mentioned that the Gee Centrifugal is handled by the Centrifugal Separators, Ltd., not by British Separators, Ltd.

THE TRAINING OF CHEMISTS IN BACTERIOLOGY. II

By Dr. DAVID ELLIS

In a previous article* it was shown that the chemist who is desirous of using the microscope as a supplementary aid to his general work must approach the problem with a certain amount of care. Let him not imagine that all he has to do is to procure a microscope; and that the only thing he has to learn to do is to be able to make a focussing adjustment with the lens of the microscope. The lesson must be learnt that sensation is not perception. A better illustration for my purpose could not be adduced than the well-known fact that the dog staring at the portrait of his master in oils perceives nothing more than a mixture of various coloured smells which are not good to eat. The brute mind cannot ascend to the perception of his master's likeness in oils, although it cannot be doubted that his senses are equal, if not superior, to those of the human. This is, of course, an extreme case, but in a smaller degree, the same difference is manifest between the trained and the untrained microscopist. Any teacher whose business it is to train others in the use of the microscope will endorse the statement that there is an extraordinary difference in the perceptive powers of different people when they 'keek' through the microscope. The difference, of course, is a difference in the *perceptive* powers, and a well-developed power of observation is the result of the training which has been undergone by a naturally keen mind. This power cannot be brought into being by the mere act of buying a microscope and learning how to focus, no more than a joiner is made by buying a saw.

If we then accept the fact that a training in the power of observation is necessary, we must next enquire whether it is worth while for a chemist who has so many other things to train for. This is a question which the chemist himself must decide after a consideration of the kind of work which he will be called upon later to perform. But it must surely be a poor kind of chemist that can complete his life's work without feeling the necessity of examining the products of his reactions with other than the macroscopic methods. It seems to the writer that the research chemist must be prepared at any moment to supplement the ordinary methods of examining results, by the infinitely more delicate methods which are at his disposal when he has a microscope at hand, and knows how to work it. For example, sometimes in the *Journal* of the Chemical Society a substance is vaguely described as being in the form of prisms under the microscope. All prisms are not alike, they differ in length, breadth and thickness, some are complete, others are so incomplete that their form has to be built up by the examination of many fragments. A more familiar instance is the identification of sugars by osazones and for this identification the microscope is necessary. In certain kinds of work the microscope is indispensable as, for example, when the identification of certain alkaloids is accomplished by the microscopical examination of their salts. Many other examples might be adduced showing how comparatively simple work with the microscope can make a large difference to the accuracy of the final result. It is, however, when we come to the adulteration of foodstuffs, and particularly when we deal with the examination of bacteria, yeasts and moulds, that a comparatively long training is necessary before the student can be regarded as an adept at the work. The work in these branches is essentially more an application of biology, rather than of chemistry; but in spite of this fact the work of identification can be carried on for the most part without special knowledge of biology.

The course in microscopy that is suggested for chemists is one that begins by making drawings of gross objects which are observed under the low powers of the microscope. The inevitable sting of a bee that is used by most beginners of microscopy, may be employed to train the 'prentice eye; but better would be a section of a plant stem, or a large diatom or any one of the hundreds of objects that may be bought, mounted on slides, in which a thin slice of an object that is about a millimetre in width, and which is thin enough to be transparent, is embedded in a transparent material. The novice may not know what the object is, but for the present purpose this is immaterial. So long as he is able to show by means of a drawing that he apprehends the true structure of that which he is drawing, it does not matter much whether the drawing be good or indifferent.

When this stage has been satisfactorily passed, the student may now tackle something more difficult. A good example of the second stage is supplied by the pollen grains of flowers. A better one, and one in which the material is more accessible, is the examination of the membranous cuticles of leaves. A thin transparent sheet, about a millimetre across can easily be torn from the upper layers of a leaf and examined mounted in water. This exercise has its utilitarian aspect for, in the examination of vegetable powders, the microscopical appearance of the leaf-epidermis is a great help in the work of identification. At this stage exercises should be undertaken in the preparation of hard substances like seeds, barks, and roots for examination under the microscope. When fragments are taken from different parts of an organic structure and rendered transparent by appropriate means, and when these are examined with minute care, the best of all exercises is supplied to the mind, which is thus enabled to build up satisfactory perceptions from the sensory data. A supply of vegetable powders can be obtained from any pharmacist. These may be examined in detail and drawings made from the fragments under observation. It does not matter that the chemist cannot build up the whole organic structure from the fragments; he gains experience in the sharpness of vision that results as much from the co-ordination of his perceptions as from his optic sensations.

A fresh line of work of a similar character might then be taken by an investigation of the points which distinguish the different starches; or the crystals which form when beef-fat or lard is treated with ether may be made the basis of a useful exercise. These

*Chem. & Ind, June 6, 1924

are only suggestions of possible examples in which a combination is offered of educative, and at the same time useful, exercises, all of them trending towards a point when sufficient advance will have been made to enable the student to profit by the study of micro-organisms. At first only comparatively large organisms like yeast or some of the larger moulds should be put under observation; after which, exercises should be given to show the structure of the bacteria. This should be the culminating point, and before the study of bacteria is reached a number of organisms taken from the animal as well as from the plant world should be examined. For example, let the chemist by observation put on paper his impressions of the appearance of a volvox, a desmid, an amœba or any other of the micro-organisms that are found when an organic fluid is allowed to putrefy. Then finally let the one-twelfth oil immersion lens be brought out, and the study of the forms of the different kinds of bacteria undertaken. The steps leading up to such a culmination need not all take the same direction, except that all must work upwards. The chief feature should be a gradual ascension, the route depending on the facilities at the teacher's disposal. This is surely better than standing on the beach and trying to reach the summit of the cliff at one leap, as is done in practically every case where the chemist is put to study bacteriology as a part of his course for the degree in applied chemistry.

LIFE AND WORK OF DR. LUDWIG MOND

The inaugural lecture under a scheme established in accordance with the provisions of the will of the late Mrs. Mond, in memory of her husband, the late Dr. Ludwig Mond, was delivered on October 20, by Prof. H. B. Dixon, F.R.S., at the Manchester University. The scheme provides for the delivery, in alternate years, of lectures on pure science, applied science, and some other subjects.

The Vice-Chancellor of the University (Sir Henry Miers) in calling upon Prof. Dixon to deliver his lecture, said that, owing to the beneficence of the late Mrs. Mond, they were enabled to bring distinguished scientists to lecture, not only to the students at the University, but also to the public at large. The late Dr. Ludwig Mond was representative of both pure and applied chemistry, and he was pleased to find they were honoured by the presence of Dr. Robert Mond, the eldest son of a most distinguished father.

Prof. Dixon, in delivering his lecture on the "Life and Work of Dr. Ludwig Mond," referred to the address given by Dr. Mond at the opening of the first laboratory in Great Britain designed for the special study of organic chemistry—the laboratory built in that college as a memorial to Prof. Schorlemmer. Dr. Mond said: "Our progress is measured by the increase of our knowledge, which alone enhances our power over the forces of nature and enables us to turn them to the uses of man. Any advance in pure science is very soon followed by advances in our industries. The immense development in the practical application of electricity, for instance, which we have witnessed of recent years, we owe far more to Faraday's scientific work than to all the numberless inventors who have followed up his various discoveries and turned them to practical use." Those words were spoken in that very room nearly thirty years ago by the greatest technologist of the time. Those words were in no sense a conventional tribute paid to pure science from a successful industrialist; on the contrary, they embodied the working creed of a man who knew from experience how progress in industry could alone be achieved. The life of Dr. Ludwig Mond was modelled on this belief, his industries were founded and built on scientific study, and by his generosity he repaid what he felt to be his debt to science by creating and aiding opportunities for scientific research. In Manchester, they were grateful to him for the assistance he gave in the study of organic chemistry, and of electro-chemistry. In the fulness of time, there came also the splendid gift to the nation of the "Davy-Faraday" laboratory.

Prof. Dixon then dealt with the educational period of Dr. Mond at Cassel, Marburg, and Heidelberg, his friendship with Bunsen and Solvay and his connexion with the improvement of the Le Blanc process for the manufacture of artificial soda. The early struggles of the late Sir John Brunner and Dr. Mond in the successful foundation of the great works at Winnington were fully described. An estate of 130 acres was purchased from Lord Stanley. The old hall belonging to it was restored and divided as a residence between them. In 1874, they produced their first soda. Some conception of their initial difficulties with their plant could be gleaned from Sir John Brunner's words, when he said, "Everything that could break down did break down, and everything that could burst did burst." For some time Mond slept on a platform over the engine. He was constantly strengthening and improving the apparatus, while a no less arduous labour was that of training the workmen. Following the success of the Winnington undertaking, the most inventive years of his life began. He stabilised the ammonia process, designed the Mond gas-plant for providing smokeless fuel and power, and dealt with the loss of chlorine in the Solway process, and did much other noteworthy work. The lecturer then referred to the invaluable services rendered by the firm to the nation during the war-period, than which there could be no greater monument to the genius of the late Dr. Mond. As an employer, he was known to be just, considerate and generous to his workmen.

Prof. Dixon also dealt with that period of Dr. Mond's life which was passed in Rome, and further stated that he never sought for honours, but he gratefully accepted the distinctions offered him by universities and scientific societies. He acted as foreign secretary to the Society of Chemical Industry from its foundation until he became its President, and was President of Section B of the British Association. Again, he was long a fellow of the Chemical Society, but declined to allow himself to be nominated as President upon the ground of ill-health. In 1891, he was elected a Fellow of the Royal Society, and served upon its Council, whilst the International Congress of Applied Chemistry held in London in the

summer of 1891 he was host to the foreign chemists attending the Conference. This was the last public function he attended. His fine constitution yielded to the insistent calls he made on its strength—the mind tired out the body. In the autumn he began to sink, he passed away at the age of seventy-one, and was interred in the mausoleum he had erected at Finchley.

In conclusion, Prof. Dixon said it was not his privilege to know the late Mrs. Mond until more than twenty years after her marriage, but no one could meet her then without being struck by the alertness of her intelligence, the charm of her manner, and the quick response of her sympathy.

The vote of thanks to Prof. Dixon for the lecture moved by Dr. Robert Mond.

THE MAKING OF A COMPLEAT CHYMIST *

By HENRY E. ARMSTRONG

My text is taken from the Prologue of "King nry V":—

> For 'tis your thoughts that now must deck our kings,
> Carrying them here and there; jumping o'er times,
> Turning the accomplishments of many years
> Into an hour-glass—."

nd I,

> "prologue-like, your humble patience pray,
> Gently to hear, kindly to judge (my) play."

I was present at the opening of Mason's College 1880 and heard Huxley give his address. In ong waiting for my turn, I have learnt not a little. Huxley was the noted prize-fighter of his time but am a man of peace—though I confess to resembling im in hating parsons and all their tortuous ways subordinating freedom of thought. He spoke to e public. I am invited to address a Students' ociety. I am speaking only to a section of your University. I would appeal, however, to the wide ircle of all those who are concerned with *The earch after Truth.* I see no reason why a Barrie r a Kipling should be permitted to deliver his essage to the public through, may I say, rough oung Scots and a Chemist, talking to a body of mild Midland students, should not equally speak out to all whom his thoughts may concern. In the world of to-day *Chemistry* is at least the equal of *Courage* in importance. Indeed we live and have our being wholly and solely through the constant, regulated occurrence of chemical interchanges without which courage could not be, of which, however, carce anything worth speaking of is understood, s yet, though it is becoming more and more clear o us that, *au fond,* we are but chemical mechanisms, *pace* Dean Inge and Prof. McBride. We are such stuff as dreams are made of—interpreted by the structural chemist, this means that stuff and dreams are reciprocally related: the one cannot be without the other; *Gheist* is a function, not an entity with survival value—as the Dean claims.

* An address delivered to the University of Birmingham Chemical Society, October 20, 1924.

The chemist may be no word-slinger but he may be at least the equal of the literary man and of the man of affairs in his knowledge of matters of public importance. The world has too long bowed down before mere words—it now calls for calculated action under the direction of students of affairs who are willing to use, if not experienced in the use of, scientific method—*the* method of the future, *the only method* by which we can hope to have and hold a future. I would ask you to note my use of the term Student, not Man, of affairs—the latter being too often but a man who does things without knowing why or counting the cost and, because he sometimes succeeds, is not seen through.

Huxley's topic was Science and Culture. You may read the address in his Collected Essays, Vol. III. His thesis was that, although the culture of former periods may have been purely literary, to-day it must be based, to a great extent, mainly upon Natural Science.

My subject—The Making of a Compleat Chymist—is similar to Huxley's. I have to ask to what extent the movement has been a success which he was advocating. I have some right to speak, as I took service in the Technical Educational Movement in 1879 and have been connected with the foundation of two technical colleges, the Finsbury Technical College and the Central Technical College of the City and Guilds of London Institute. May I add that I have lived long enough to have lost, if not all sense of modesty, all sense of reverence for authority: so that I can speak out perhaps with some of the courage which Barrie advocated, which unfortunately is greatly at a discount in these subservient days. It is very necessary, if we are to hold our Empire, nay, a place at all in the world, that some of us should state our convictions.

Izaak Walton's *Compleat Angler* is a noted classic, full of literary charm as well as of the technical lore of its time. No *Compleat Chymist* has yet been written but the competent writer, if ever he be found, will have endless material at his disposal and should be able to make his story thrill with interest. Go to Wondrous Wembley and ask the meaning of the various exhibits: chemistry is behind most of them—those in the Palace of Engineering would be impossible without it; indeed, the engineer is little more than a tool of the chemist, practising a few well-proved mechanical turns upon materials handed out to him through the chemical laboratory: it's like *Ubique*, in Kipling's poem, which lacks a verse for chemistry. Had the poet been cultured up to Huxley's point, he would certainly have introduced one:—

> It serves 'Orse, Field an' Garrison as motto for a crest,
> An' when you've found out all it means I'll tell you 'alf the rest.
>
> . . . .
>
> There's nothin' this side 'Eaven or 'Ell Ubique (No Chemistry) doesn't mean.

It is the science of the materials composing the universe and of their interactions, including vital phenomena; it is the science of character. Fighting is now impossible without it and it is paramount in

peace. Yet, who cares? Your mission will be to make people care and you must qualify to this end.

The chemist may not greatly love the society of the clergy or connect himself with Episcopal families and have a natural taste for a Bishop—as the good Izaak is said to have done, according to Andrew Lang. Still, he has a duty towards Bishops—if possible, to make them persons who *can see, real feeders* of their flocks, with some respect for the beauty and truths of Nature. Bishops, in my experience—I have grown up with and known a good many—are simple, apparently harmless, people; they succeed, however, in doing much harm through their sublime disregard of all modern effort to arrive at the truth and an understanding of the world—your Bishop-Designate perhaps excepted—due partly to the fact that they have been at public schools and partly to the narrow ideals of education which prevail in their profession but chiefly perhaps to their special mentality—the duality, if not plurality, of their nature. I would here challenge Dean Inge's statement (in his essay on Roman Catholic Modernism), that there cannot be two faculties in the human mind working independently of each other. It is only necessary, in Birmingham, to mention the name of my gifted friend, Sir Oliver Lodge. Has not R. L. Stevenson, too, given us Dr. Jekyll and Mr. Hyde? Did he not mean us to accept them as types?

Now, gentlemen, if one of your future functions be the reform of Bishops, you must live up to Huxley's programme of 1880. You must first learn to express yourselves clearly in terms which Bishops can understand—without putting too great a strain upon their understanding. At present, the cloth of science speaks only in terms of conundrums "which no fellow can understand." Huxley was almost the last of the clan to use clear and concise language and could express himself in incisive terms which carried conviction even to the uninstructed. I recommend you all to study his "Life and Letters" and especially his "Collected Essays." Buy these latter, if you can. The "Jargonauts" now reign and if dropped from aeroplanes upon Babel would snow Babylon under. To keep our science from suffering the fate of that city and its tower we must refine our language and at least bring it down to the level of our own understanding. Charity begins at home. I would therefore recommend, as an exercise in construing a modern language, the translation into nursery English of Part XX. of *Researches on Residual Affinity and Co-ordination*, in the current number of the *Journal of the Chemical Society*. I read there of "chelate groups" and wonder what they are: mayhap something which only a *vorpal blade* would cut, to be found in *mimsy borogoves*; my childish mind also turns to the Zoo and the *Chetah* and I ask if perhaps Chelates are its near relatives: no amount of *uffish thought* I can give to it leads me to understand the term. This is but an example of a present-day perversity which, with the best intentions, our professors are foisting upon us. As to this matter of language, you know it is often said by Bishops, "As it was in the beginning, is now," &c.; in fact, you are what you are largely in virtue of what you were made to be at school. Your language may have been refined and acquired emphasis but your outlook in language will be mainly that put upon you at school. As man is nothing without speech, it stands to reason that speech should be his first study; but speech is to be learnt through use. Our English schools have yet to give proper training in the use of speech. I shall be told it is given and is best given through classics—in translating; but this is to postpone the training to a late period and not to give it at all to most. My view is that it should be given from the nursery onwards, through the translation of everyday action into thought—through the description of things done. The instruction can then begin as soon as the child can write. I know what can be done, because I have done it and seen it done with a considerable number of young children in schools. Parenthetically, may I suggest that Lewis Carroll wrote in anticipation of the Jargonauts—to prepare children for the pernicious language of science.

Until scientific method be really taught in schools, I believe there will be no proper training in the art of expression. Experimental work is properly done only when it is properly described; in it lies infinite opportunity to develop the powers of expression. The worker has something to write about.

As to yourselves, what practice have you in the art of writing? Very little, I fear. Writing isn't chemistry, you may say. Yes, it is; the fact that complaint is so frequently made of our writing, of our inability to express ourselves clearly and concisely, is proof of the need of such training. To my knowledge, there has been a continuous quarrel, during the past fifty years, between the Chemical Society and its contributors. The man who devised the three-column system of *Experiment, Observation, Inference*, deserves utmost execration; no more grievous misservice could have been done to our science. It is impossible to overrate the value of a well-ordered, readable note-book; it is an unfailing mirror of the worker's mind.

You must learn also to read—that is an even more valuable art. Hear what Stevenson says in his *Essays in the Art of Writing*. (Chatto and Windus. 1920):—

"The gift of reading is not very common nor very generally understood. It consists, first of all, in a vast intellectual endowment—a free grace, I find I must call it—by which a man rises to understand that he is not punctually right, nor those from whom he differs absolutely wrong. He may hold dogmas; he may hold them passionately; and he may know that others hold them but coldly or hold them differently or hold them not at all. Well, if he has the gift of reading, these others will be full of meat for him. They will see the other side of propositions and the other side of virtues. He need not change his dogma for that but he may change his reading of that dogma and he must supplement and correct his deductions from it. A human truth, which is always very much a lie, hides as much of life as it displays. It is men who hold another truth or, as it seems to us, perhaps a dangerous lie, who can extend our restricted field of knowledge and rouse our drowsy consciences. Something that seems quite new or that seems insolently false and very dangerous is the test of the reader. If he tries to see what it means, what truth excuses it, he has the gift and let him read. If he is merely hurt or offended or exclaims upon his author's folly, he had better take to the daily papers; he will never be a reader.

Not all men can read all books; it is only in a chosen few hat any man will find his appointed food; and the fittest essons are the most palatable and make themselves welcome o the mind. A writer learns this early and it is his chief upport; he goes on unafraid, laying down the law; and e is sure at heart that most of what he says is demonstrably alse and much of a mingled strain and some hurtful and very ttle good for service; but he is sure besides that when his vords fall into the hands of any genuine reader, they will be veighed and winnowed and only that which suits will be ssimilated; and when they fall into the hands of one who annot intelligently read, they come there quite silent and narticulate, falling upon deaf ears and his secret is kept as if e had not written."

If you can digest this advice you will have learnt ow to read.

I have said enough about words—let me now ass to works. When Huxley spoke it was on ehalf of the Mason College—that is long since lossomed into the Birmingham University. Other wns have done likewise. Universities now abound our country. To what extent is Chemistry the tter? How many students attending our Univeries, other than Cambridge and Oxford, have any er than professional ends in view? To what nt are the Universities meeting public needs, se of the general public and of the schools— ltural as distinct from technical needs? The swer is unsatisfactory. Professor Smithells, who always a charitable critic, who had a great oppornity of judging, during the war, in connexion th the gas-mask drill, only in January this year de the statement, in his Presidential Address to e Science Masters' Association, that:—

eneration of science teaching has produced a very disapntingly small dissemination of scientific knowledge of an ilable kind among our people. In a school in which three lions of men from all classes of society were dealt with, whom a little real knowledge of elementary science meant difference between life and death, the rudiments of such owledge were not to be found in one man among a hundred. science, so far, has edified and instructed far less than reasonably to be expected from a movement that has n carried out for so long and with such vigour.

This is a serious charge against our Universities general. The teachers are of their training and y call the pace through their entrance and other minations. In our well meant attempt to prove our educational system, we have jumped m the frying pan into the fire. Formerly, we e dominated by ecclesiasticism: now we are trolled by clericism: the teacher is neither free teach what he will nor the student to learn what may; both are confined to what will pay in examinations. *Lern* and *Lehrfreiheit* are gone. e system is the greatest curse our civilisation has ed down upon itself and the chief check to our llectual advance. I am one of the few who w up before it came into existence and so am e to appraise its consequences perhaps better n those who have never known freedom. Univeres are rapidly becoming a most potent means of reotyping and sterilising thought—they are acting s intellectual trades unions, if a trade union can be intellectual. An examination system such as we are now building up through the agency of dull conformists must, in the end, destroy freedom of thought: it has so done already.

The average value of the chemist is steadily being lowered, at the present day, through the introduction into the profession of a large class of drones who may have the acquisitive power to pass an examination but are without real intellectual ability: the burden laid upon such men—unfortunately there are many women among them—is far beyond that they can carry. The position is made worse by the attempt to standardise. Man must ever seek to mould himself after one image—his tendency is to resent all expression of individuality.

To argue the case now is impossible: I can but give my considered opinion—for what it is worth.

In the year that he came here Huxley also delivered an address at the Working Men's College on *The Method of Zadig*. I advise you all to study this. To quote his son, the text of this is—

Voltaire's story of the philosopher at the Oriental court who, by taking note of trivial indications, obtains a perilous knowledge of things which his neighbours ascribe either to thievery or magic. This introduces a discourse on the identity of the methods of science and of the judgments of common life, a fact which, twenty-six years before, he had briefly stated in the words, "Science is nothing but trained and organised common sense."

Common sense may pass as a conventional term, though, of course, what is meant is an uncommon sense. Science is a failure in our schools and Universities simply because the method of Zadig remains unpractised, both in public and private. You cannot teach for set examinations to a syllabus —always a mind-limiting compromise and behind the times—and also teach Zadig.

The method behind Science, *scientific method*, used more or less unconsciously by its devotees and all pioneers, is not a systematised, acknowledged method. The Universities do not seek to teach it; small wonder, then, if the teachers who wander into the schools in no way seek to inculcate its practice.

The Universities should be schools for the masses, in the sense that they should provide competent suitable teachers—they do not. They are all of them simply professional schools, not seats of liberal education in the first place.

It is a standing reproach to the great schools at Oxford and Cambridge especially that they make no attempt to train and Zadig-ise the plain man; they care only for the Honours student who aims at being a professional of some kind. Oxford perhaps is the lesser sinner but that probably is because it attempts least—its tendency being to bury its head mainly in the sands of the past and in words; the experimental sense is scarce developed there. It is a long time since Voltaire wrote; it is a long time since Huxley preached; we say that it is a long lane that has no turning—yet 44 years is too long a period to dwell in the wilderness, for the prophet to await the chance of a collision at the cross-roads. Huxley, in fact, was wrong in saying that science was nothing but trained and organised common sense—if he intended the implication to go with this statement that the sense was in any way common and educable. The scientific faculty seems, indeed, to be very rare.

I fear Huxley's dream has not been justified; I doubt if it ever will be. The progress of scientific discovery has been marvellous—but that is the work of the few. The spread of scientific method among the people amounts to very little. The Press has less concern with us than it had in Huxley's day: only the sensational meets with notice; strangely enough we meet with most sympathy from the most conservative of our newspapers. In the art of public thinking we are much as we were generations ago. Science can help us eventually very little, unless it help us to think straight. A political impasse like the present would be impossible, politicians would not resort to merely personal invective, were we governed by the rational exercise of thought—if we were not entirely conceited as to our individual judgments and oblivious of method, ignorant of the world's working. We in no way aim at a collective treatment of our problems.

I shall best bring my meaning home to you if I say *that you don't know what an experiment is*; that your pride of knowledge is such that you are intolerant of thought. Yours is the disease of *mental inertia*: read Faraday as to this state.

Our Universities are but at an embryonic stage of their scientific development. A vast body of fact is taught but the general principles of philosophy and scientific procedure are yet to be codified and made primary subjects of study—we are not yet arrived at the stage of making the teaching of logic a first charge upon the teacher, whatever his subject.

The *Compleat Chymist* is made only when the student can leave the University and say in Tommy's words:—

Peace is declared an' I return
  To 'Ackneystadt but not the same;
Things 'ave transpired which made me learn
  The size and meanin' of the game.
I did no more than others did,
  I don't know where the change began;
I started as a average kid,
  I finished *as a thinkin' man.*

Before my gappin' mouth could speak,
  I 'eard it in my comrade's tone;
I saw it on my neighbour's cheek,
  Before I felt it flush my own.
An' last it come to me—not pride,
  Nor yet conceit but on the 'ole,
(If such a term may be applied)
  The makin's of a bloomin' soul.

It's the bloomin' soul that counts—that may come with easy provocation to the elect. I have seen it come in a youngster who took to the game of experimental inquiry and, having solved his problem alone, by means of a few properly thought-out trials, at once wrote to tell me of his success: that he *had* slain the Jabberwock:—

O frabjous day! Callooh! Callay!
  He chortled in his joy.

He had actually *discovered* oxygen by himself. That [illegible] more than twenty-five years ago—the lesson [illegible] fruit, as he has ever since been strictly methodical [illegible] his work, far beyond the average.

(*To be continued*)

FORTHCOMING EVENTS

Nov. 1. NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS. Excursion Meeting at Horden Colliery. Train leaves Newcastle Central Station at 10 a.m.

Nov. 3. SOCIETY OF CHEMICAL INDUSTRY, *London Section*, at the Chemical Society's Rooms, Burlington House, Piccadilly, 8 p.m. "Experiments in Protection," by W. J. U. Woolcock, C.B.E. Members may dine at the Chemical Industry Club before the Meeting.

Nov. 3. ROYAL INSTITUTION, Albemarle Street, Piccadilly, W., at 5 p.m. General Meeting.

Nov. 3. INSTITUTION OF ELECTRICAL ENGINEERS, The Public Library, Alexandra Road, Swansea, at 6 p.m. Discussion on "Power Factor Improvement" opened by R. G. Isaacs.

Nov. 3. UNIVERSITY OF BIRMINGHAM CHEMICAL SOCIETY, Chemical Lecture Theatre, Edgbaston, Birmingham, at 5.30 p.m. "Application of Science to the Production of Gems," by J. R. Dolphin.

Nov. 3. INSTITUTION OF THE RUBBER INDUSTRY, Engineers' Club, Coventry Street, London, W., at 8 p.m. "Gutta Percha: Preparation and General Properties," by C. W. H. Howson.

Nov. 4. INSTITUTION OF PETROLEUM TECHNOLOGISTS, the House of the Royal Society of Arts, John Street, Adelphi, W.C. 2, at 5.30 p.m. "The Oilfields of Argentina," by C. M. Hunter.

Nov. 4. MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, 36, George Street, Manchester, at 6.30 p.m. "The Phosphorescent Flame of Carbon Disulphide," by the President.

Nov. 4. INSTITUTE OF METALS, *North-East Coast Section*, Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. "Structure of Metals in its Relation to Elastic Failure" (Part II), by W. E. W. Millington.

Nov. 4. INSTITUTE OF METALS, *Birmingham Section*, Chamber of Commerce, New Street, Birmingham, at 7 p.m. "Brazing," by A. R. Page.

Nov. 4. WEST YORKSHIRE METALLURGICAL SOCIETY, The George Hotel, Huddersfield, at 7.30 p.m. Discussion on "Influence of Casting Temperature on the Physical Properties of Non-Ferrous Alloys."

Nov. 4. MANCHESTER UNIVERSITY SCIENCE FEDERATION, Chemistry Lecture Theatre, Manchester, at 5 p.m. "Some New Problems in Therapeutics," by Dr. H. H. Dale.

Nov. 4. INSTITUTION OF CIVIL ENGINEERS, Great George Street, London, S.W. 1, at 6 p.m. Address by the President, B. Mott, C.B.

Nov. 5. INSTITUTION OF CHEMICAL ENGINEERS, University College, Gower Street, London, W.C. 1, at 8 p.m. "Water Gas Process," by Dr. M. W. Travers. (This meeting is in place of the one proposed for November 12.)

Nov. 5. SOCIETY OF CHEMICAL INDUSTRY, *Nottingham Section*, University College, Nottingham, at 7.30 p.m. "The Testing of Bates in the Laboratory," by Dr. C. E. Pickard.

Nov. 5. INSTITUTION OF ELECTRICAL ENGINEERS, Savoy Place, Victoria Embankment, London, W.C. 2, at 6 p.m.

Nov. 5. INSTITUTION OF SANITARY ENGINEERS, Annual Dinner at the Holborn Restaurant, London, W.C. 1, at 7.30 p.m.

Nov. 5. SOCIETY OF PUBLIC ANALYSTS, The Chemical Society's Rooms, Burlington House, Piccadilly, W. 1, at 8 p.m. (1) "On Certain New Methods for the Estimation of Arsenic and its Occurrence in Fish and Urine," by H. E. Cox. (2) "The Estimation of Cadmium in Brass," by A. T. Etheridge. (3) "The 'Hoyberg' Method of Milk and Cream Testing," by N. C. Wright and J. Golding. (4) "An Apparatus for the Catalytic Dehydrogenation of Alcohols," by S. G. Willimott.

Nov. 6. SOCIETY OF DYERS AND COLOURISTS, *West Riding Section.* "Photography in Dyestuff Testing," by T. Thorne Baker.

Nov. 6. UNIVERSITY OF LONDON, St. Thomas's Hospital Medical School, Albert Embankment, London, S.E. 1, at 4.30 p.m. "Enzymes," by Prof. J. Mellanby.

Nov. 6. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section,* The University, Woodland Road, Bristol, at 7.30 p.m. "The Present Position of the Geber Problem," by E. J. Holmyard.

Nov. 6. INSTITUTION OF MECHANICAL ENGINEERS, *Glasgow and West of Scotland Section,* Royal Technical College, Glasgow, at 7.30 p.m. "Steels and their Selection," by Prof. J. H. Andrew.

Nov. 6. INSTITUTION OF MECHANICAL ENGINEERS, *North-Western Section,* Engineers' Club, Albert Square, Manchester, at 7 p.m. "The Missing Pressure in Gas-Engines," and "Heat Loss in Gas-Engines," by Prof. W. T. David.

Nov. 6. THE CHEMICAL SOCIETY, Burlington House, Piccadilly, W. 1, at 8 p.m. (1) "Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXIV. Further Experiments on the Walden Inversion," by J. Kenyon, H. Phillips, and H. G. Turley. (2) "Studies of Valency. Part V. The Mechanism of the Walden Inversion," by T. M. Lowry. (3) "A Spectroscopic Study of the Luminescent Oxidation of Phosphorus," by H. J. Emeléus and W. E. Downey.

Nov. 6. FINSBURY TECHNICAL COLLEGE, *Streatfeild Memorial Lecture,* in the Chemical Theatre of the College, Leonard Street, City Road, London, E.C. 2, at 4 p.m. "The Chemist and the Fermentation Industries," by J. L. Baker.

Nov. 7. INSTITUTION OF MECHANICAL ENGINEERS, *Midland Section,* Chamber of Commerce, New Street, Birmingham, at 7.30 p.m. "Pulverised Coal," by K. C. Barrell.

Nov. 7. INSTITUTION OF MECHANICAL ENGINEERS, *The Thomas Hawksley Lecture* at the Institution, Storey's Gate, St. James's Park, London, S.W. 1, at 6 p.m. "The Trend of Development of Marine Propelling Machinery," by Engineer Vice-Admiral Sir G. G. Goodwin.

Nov. 7. UNIVERSITY OF LONDON, King's College, Strand, London, at 5.30 p.m. "The Ideal Aim of Physical Science," by Prof. E. W. Hobson.

Nov. 7. INSTITUTE OF CHEMISTRY OF GREAT BRITAIN AND IRELAND, *Manchester Section,* Joint Meeting with the Manchester Sections of the Society of Chemical Industry, Society of Dyers and Colourists, and Literary and Philosophical Society, at Textile Institute, St. Mary's Parsonage, Manchester, at 7 p.m. "The Influence of Chemical Research on Medicine and Forensic Medicine," by Sir W. H. Willcox.

Nov. 7. SOCIETY OF PUBLIC ANALYSTS, Manchester Literary and Philosophical Society, 36, George Street, Manchester, at 3 p.m., to discuss the formation of a North of England Section.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

A circular letter with further particulars and a form of application for tickets has been sent out to the members.

SUSPENSION OF ENTRANCE FEE

As an inducement to chemists to become members, the Council has resolved that no entrance fee shall be paid by members joining the Society in 1925.

A form of application for membership was inserted at the end of this Section in the issue of the Journal for October 17, and it is hoped that it may be used to introduce a new member for next year.

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

VOL. IX (1924)

This volume is in course of preparation, and an order form will be sent out in due course with the application for the annual subscription for 1925.

The list of subjects dealt with and the names of the authors is as follows:—

Plant and Machinery	S. G. M. Ure.
Fuel	J. W. Cobb and H. J. Hodsman.
Gas—Destructive Distillation—Tar Products	W. B. Davidson.
Mineral Oils	S. J. M. Auld.
Colouring Matters and Dyes	E. H. Rodd.
Fibres, Textiles, Cellulose, and Paper	S. H. Higgins.
Bleaching, Dyeing, Printing, and Finishing	A. J. Hall.
Acids, Alkalis, Salts, etc.	P. Parrish.
Glass	E. A. Coad-Pryor.
Ceramics, Building Materials, and Refractories	W. J. Rees.
Iron and Steel	C. O. Bannister.
Non-Ferrous Metals	C. A. Edwards.
Electro-Chemical and Electro-Metallurgical Industries	J. N. Pring.
Oils, Fats, and Waxes	H. M. Langton.
Paints, Pigments, Varnishes, and Resins	C. A. Klein.
Indiarubber	D. F. Twiss.
Leather and Glue	D. M. McCandlish.
Soils and Fertilisers	H. J. Page.
Sugars, Starches, and Gums	L. Eynon and J. H. Lane.
Fermentation Industries	H. L. Hind.
Foods	G. W. Monier-Williams.
Sanitation and Water Purification	J. H. Johnston.
Fine Chemicals, Medicinal Substances, Essential Oils	H. King.
Photographic Materials and Processes	W. Clark.
Explosives	J. Weir.

GLASGOW SECTION

The opening meeting of the session was held on October 22, and a cordial welcome was given to Mr. D. A. MacCallum on taking the chair as the chairman of the section.

The chairman, before introducing the lecturer for the evening, appealed for the active support of the members of the Section in an effort to strengthen the membership of the Society. A paper on "Process Records and their Bearing on Plant Efficiency" was then read by Mr. J. Adam Watson, A.C.G.I., of the North British Rubber Co.

The lecturer first directed attention to the value of daily returns of the output of any manufacturing plant in order to discover the efficiency of the operations and of applying remedial measures where unprofitable working was evident. Process returns could be discussed under three headings—(1) the objects to be attained; (2) the information required; and (3) the method of using the information gained in order to attain the ends aimed at. There were many points in the working of a process upon which information was required, and these might be summarised as (1) the average efficiency of the plant as a whole; (2) the average efficiency of the individual parts of the plant in as great detail as might be desired; (3) the maximum efficiency under working conditions; (4) the possible and probable output; (5) the incidence of loss of efficiency; (6) the cost of the whole process in materials, labour and power; (7) the cost of the individual operations; (8) the variation of cost with changes in labour rates and value of materials.

In elaborating his points, Mr. Watson maintained that the over-all efficiency of a plant could be more easily obtained from daily or weekly returns than from stock sheets prepared at intervals of six or twelve months. The kind of information required to prepare the reports and estimates included records of the amount of material handled in each department, the amount of plant working, the number of hands employed and, where possible, the readings of power meters.

It would obviously be somewhat difficult to obtain these reports from foremen at first, but the system, once satisfactorily established, not only worked well but smoothly. Having obtained such returns, it was imperative to present the returns in a form that would appeal to the management. This was attained by reducing the mass of figures to a form known as the flow-sheet. The flow-sheet presented in terms of unit quantity of the final product, the quantities of material used at each stage of the process together with details of the process. The examination of regularly prepared flow-sheets revealed the interdependence of different sections; the lack of supervision at any particular stage; and enabled the management to concentrate upon the defects which may thus be rendered evident. The conversion of flow-sheets prepared in terms of material to a tabulated statement of cost was easy, and the system was elastic in application.

Many of the difficulties which arise in compiling the flow-sheet—such as allocation of power consumption—were discussed. Once such a system had been in operation for some time the advantages became obvious, and the system afforded a basis upon which instructions could be issued to the buying department; upon which suggestions may be made regarding suitable raw materials; and upon which research could be instituted.

The system adopted at H.M. Factories was used to illustrate the method of recording and the formulation of flow-sheets; and the report used by the Explosive Propellant Supply Department was quoted to show the large economy such a system made possible.

In the discussion, several speakers indicated the benefits which they had derived from the introduction of a system of process records. An interesting point was raised as to the effect of such a system of process records on the attitude of managing directors towards research work, and especially if such records were applied to the output of a works research laboratory.

Amongst other points raised in discussion were the payment of bonus according to records, the psychological effect of introducing a recording system and the attitude of Trade Unionism towards these records.

YORKSHIRE SECTION

Dr. L. L. Lloyd presided at the annual general meeting held in Leeds on October 20, when the following officers were elected:—*Chairman*, John Evans; *Vice-Chairman*, B. A. Burrell; *Hon. Local Secretary and Treasurer*, Prof. Comber, and the vacancies in the committee were filled by Dr. Forster, Prof. Ingold, Dr. L. L. Lloyd, D. McCandlish, and W. McD. Mackey. Mr. John Evans then took the chair, and a vote of thanks was passed to the past chairman and committee.

The section was favoured by an address from the President, Mr. W. J. U. Woolcock, C.B.E., on the present position and responsibilities of the Society. He said that, in view of the fact that the annual meeting was to be held in Leeds next year, he was pleased to be there and to have a frank talk with the Section. The responsibility on the Section was a heavy one, but the Society occupied a unique position and its development was of considerable importance to the community and the chemist. He initially dealt with finance which had been giving the Council a good deal of anxiety. £5000 had been taken from the accumulated funds and devoted to the development of the *Journal*—a policy which could be submitted with confidence to any member of the Society. This year the Council had looked very closely and estimated that they would finish with an expenditure of £4000 less than in the previous year—not a bad record for twelve months' work. There was in existence a House Committee having no definite place, date or duty, but which at the call of the President watched the whole of the business interests of the Society. As to the *Journal*, which was one of the principal reasons for the existence of the Society, the establishment of the Bureau of Abstracts, in conjunction with the Chemical Society, had resulted in a saving to the two Societies. The Transactions

initially depended on the Sections, and he had noted there were not many contributions from Yorkshire recently. No really suitable paper was ever refused publication. He had been told, in violent language, opinions on *Chemistry and Industry*. The Council did not start it with the idea that there was plenty of room for a new *Journal*, but it had a duty to carry to all members a certain amount of scientific information, and to do this required careful organisation. The cost of the 52 numbers for 1923 was just about 4 guineas, for 1924 the estimate was £3 10s.—for a subscription of 50s. From these figures the importance of providing a *Journal* which would carry advertisements and appeal to firms was apparent, and he stated that by establishing *Chemistry and Industry* the Council was satisfied that they were on right lines, and that firms advertising thought it better than the *Review*. The President, after referring to the racy Editorials, stated that the Market Report was so good that other papers were pleased to copy it, a tribute to the *Journal*. The correspondence columns were fairly well used and the papers which, although not suitable for the Transactions, were frequently very good. He appealed, however, for more news of the Sections to be sent to Dr. Miall.

The Council had taken the definite step of suspending for 1925, the Entrance Fee, to give sections the opportunity of getting a large influx of new members, and this was looked for especially in Yorkshire, in view of the forthcoming Annual Meeting in Leeds. Progress would depend on the work of the Sections, and the duty of organising to promote public appreciation of the value of the British Chemical Industry was one of the main methods which made progress possible. The Section had a wonderful opportunity to help, and he thought that the next Annual Meeting would be one of the best, if not the very best ever held. The date fixed provisionally was July 14, and Prof. Cobb had been appointed Conference Secretary. The President's final advice, was not to overdo the functions; let them be good, but no 8 a.m. to 2 a.m. days.

The ensuing discussion was as frank as the President's talk. Prof. Cobb, Messrs. Branson, Read and Burrell asked for further information on the decision to publish weekly, as there was a distinct impression that it was a mistake. The present form of the Abstracts was dealt with by Dr. Forster, and Messrs. Pickering and Robertson. Mr. Finn was doubtful as to the multiplication of chemical activities and referred especially to the Chemical Engineering Group, and this multiplication of Societies was referred to as one of the difficulties in securing members. The question of electing associate members as a method of interesting young chemists was raised by Dr. Parker; the circulation of *Chemistry and Industry* was asked for, and the matter was criticised; it was emphasised that articles on present chemical trade problems would appeal far more to industrialists than ones on alchemy or the early history of antimony, and funny Editorials were deprecated.

In reply to the discussion, the President stated that they had to consider many factors in publishing to keep within the postal rate, and to preserve the balance of the various parts, but the main reason for doing what they did was to carry information quickly to members in a form which would stop the decline in advertisement revenue, and the result of the 25 per cent. increase covered the extra cost in publishing weekly. It was infinitely better to have the Chemical Engineering Group inside the Society; they were exceedingly energetic and frequently brought new members. He looked forward to a decrease in the subscription when trade improved, and the Abstracts were produced by the co-operation of all chemical societies. The Bureau would develop, but certain difficulties had first to be overcome. The insufficiency of the Abstracts in Analysis he would bring before the Council.

The meeting concluded with a hearty vote of thanks to Mr. Burrell for his many years of service as Local Secretary.

EDINBURGH AND EAST OF SCOTLAND SECTION

During the Session 1924–25 all the meetings of this Section will be held jointly with the local Section of the Institute of Chemistry.

The first joint meeting was held in Edinburgh on October 21, at 8 p.m., Dr. Alexander Lauder, Chairman of the Section, presiding.

Mr. W. J. U. Woolcock, C.B.E., President of the Society of Chemical Industry, delivered an address on "Co-operation in Chemical Science." Mr. Woolcock gave an account of the activities of the various chemical bodies in organising the exhibits in the Chemical Hall at the British Empire Exhibition, and pleaded for a closer co-operation, not only between industrialists and chemists, but also between the various Societies.

Dr. J. P. Longstaff, General Secretary of the Society, described the activities of the Society and outlined the possible modes of expansion. In the interesting discussion which followed various suggestions were put forward for further co-operation between the various societies interested in chemistry.

Prior to the meeting Mr. Woolcock, Prof. G. G. Henderson, F.R.S. (President of the Institute of Chemistry), and Dr. Longstaff were the guests of the Section at a dinner in the North British Station Hotel.

OTTAWA SECTION

On October 14, the occasion of the brief visit to the Section of Dr. E. F. Armstrong, Past-president of the Society, a hurried luncheon meeting was held at the University Club, with fifteen members present. After the luncheon Dr. Armstrong clearly outlined the position of the Society in England, and emphasised the interest of the parent Society in the Canadian Sections, indicating that the Council was prepared to assist the local Sections, in every possible way, to meet their difficulties. Several of the members present offered suggestions which might tend to increase the interest in and usefulness of the Society. The Section felt honoured in this

visit of Dr. Armstrong, and it is confidently expected that it will stimulate interest in the activities of the Section. The chairman, Dr. A. E. Macintyre, expressed to Dr. Armstrong the thanks of the Section for his visit.

ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS

The Council met at the offices of the Association on October 9, 1924. There were present Mr. D. Milne Watson (in the chair), Sir Harold Boulton, Bart., Sir John Brunner, Bart., Mr. W. H. Dawson, Mr. E. V. Evans, Mr. C. A. Hill, Sir Max Muspratt, Bart., Sir William Pearce, Mr. R. G. Perry, Dr. Alfred Ree, Rt. Hon. J. W. Wilson, Mr. R. M. Bewick, Mr. E. J. Boake, Mr. N. H. Graesser, Mr. T. Miller-Jones, Mr. A. Ross Mitchell, together with the General Manager.

Trade Marks, Patents, and Designs Federation.—Dr. Ree reported that he had gone carefully through a memorandum which had been received from the Trade Marks, Patents, and Designs Federation, but did not consider the proposals of sufficient importance to call a meeting of the Patents Committee. He had, however, consulted a number of the members through the post, and their opinion was that until the project of an International Patent Law was closer to realisation the time was not ripe for these proposals. The Council adopted this view and decided to inform the Federation accordingly.

British Trade Propaganda in Scandinavia and Northern Europe.—The General Manager reported that he had had an interview with Mr. Everard Fry, who is at present in England, endeavouring to interest British firms in British trade propaganda in Scandinavia and Northern Europe. He understood that the Dutch, French, Swiss and Belgians had already made an intensive propaganda to capture the trade lost by Germany, with the result that the British proportion has declined from 27 per cent. to 16 per cent. The British trade propaganda is being carried out through the *Berlingske Tidende*, the official organ for shipping and industry. The Council instructed the General Manager to bring this to the notice of members in the Proceedings of Council, and to ask any firms interested to communicate with him.

Census of Production.—The General Manager read a letter from the Board of Trade with regard to the census of production which is to be taken for the year 1924, and asking for the observations of the Association on the draft schedule. The Council referred the matter to a committee consisting of the Chairmen of the Groups or their nominees.

Films for Ch[illegible]cal Industry.—The Council received and accepted [illegible]eral Manager's report as to the publicity w[illegible]een given to the films, "Coal and its Pr[illegible]d "Heavy Chemicals." He stated tha[illegible]s had already been shown in over 100 cl[illegible] over the Kingdom, and, in addition, he [illegible]ing frequent requests for the loan of the[illegible]m various scientific bodies and individual fir[illegible]

Federation of British Industries Grand Council.—The Council received an application from the Federation of British Industries to nominate 13 representatives to the Grand Council for Section I of Main Group 9. It was stated that Sir John Brunner and Sir Max Muspratt had already been nominated to represent the individual firms. The Council nominated last year's representatives, as follows:—Dr. E. F. Armstrong, Sir Harold Boulton, Bart., Messrs. F. H. Carr, Kenneth Chance, W. H. Dawson, E. V. Evans, C. A. Hill, D. Lloyd Howard, Dr. P. C. C. Isherwood, Messrs. T. Miller-Jones, R. G. Perry, A. Ross Mitchell and W. J. U. Woolcock.

British Empire Exhibition.—The General Manager stated that he was still unable to say definitely whether the Exhibition would be continued next year.

Committee on Industry and Trade.—The General Manager stated that he was endeavouring, through the various groups, to get the necessary evidence, and drew particular attention to Group IX Report. It was agreed that this report should form the basis of the Memorandum of the Association, and the Council instructed the General Manager to continue to collect evidence and write to the Secretary of the Committee saying that this could not be ready until the beginning of December.

Factories Bill.—The Council considered that although, in view of the present political situation, the Factories Bill was not likely to come before Parliament in its present form, similar legislation would undoubtedly be brought forward in the future. It was, therefore, decided that the matter should not be dropped, but that the General Manager should continue to get the considered views of the members.

Methanol.—The Council instructed the General Manager to take such action as was possible to bring the word "Methanol" as a substitute for "Methyl Alcohol" into common use.

INSTITUTE OF CHEMISTRY

A meeting of the Huddersfield Section was held on October 20, Dr. H. H. Hodgson in the chair, and there was an attendance of 28.

The business of the annual general meeting was first disposed of. It was unanimously decided to present five guineas from the balance in hand to the Benevolent Fund of the Institute. Dr. A. E. Everest and Dr. L. G. Paul, the two retiring members of the Committee, were re-elected for a period of three years. Certificates were presented to the following new local associates by the chairman: Messieurs. J. A. Edge, J. T. Howarth, C. F. Myers and L. [illegible] Scorah. The chairman then called upon Mr. M[illegible] the assistant secretary of the Institute of C[illegible] to give his talk on "Chemists' Contracts—[illegible] and Privileges."

Mr. Marlow opened his remarks by stating [illegible] unemployment among members of the Institut[illegible] considerably decreased in the last few months. [illegible] then outlined the essentials of a contract of ser[illegible] showing that it involved promise and acceptance, [illegible] consideration, and that it should be in writing u[illegible]

the work was to be completed in a year or less. The form of the writing was not important except that a contract with a Corporation should usually be under the seal of the Corporation. He also dealt with contracts between partners and so-called co-partnership. A clause requiring whole-time service was only binding when it was specifically stated that no time must be given to other employment. Clauses relating to trade secrets and binding clauses restraining future activities were dealt with fully. With regard to the termination of a contract Mr. Marlow showed that the question of fair notice of dismissal must depend upon the circumstances of each individual case. Other modes of termination were discussed—bankruptcy, dissolution of partnership, illness, death or default. An expired contract continued until it was definitely terminated. Contracts should be stamped within fourteen days of being made. Any restraint on future activities must be balanced by consideration, and the restraint should be reasonable.

A discussion followed in which Messrs. Tatum, Morley, Jones and Foster took part. In answer to Dr. Morley, Mr. Marlow stated that the period of restraint on future activities dated from the cessation of employment, and not from the expiry of contract. Mr. Foster suggested that a Committee of the Council of the Institute should consider contracts with binding clauses with a view to rectifying hardships. Dr. Paul, in proposing a vote of thanks to Mr. Marlow, paid a tribute to his handling of a difficult subject. [illegible] Simmons, in seconding the vote of thanks, urged [illegible]t the adaptability of the chemist would, if gener[illegible]wn among employers, considerably reduce [illegible] hardship of binding clauses restricting future activities. Dr. Everest enlarged upon the adaptability of the chemist. A properly trained chemist who kept himself reasonably up to date need not limit himself to the branch of the science in which he had been employed for a term of years. The vote was put and passed with acclamation.

BIOCHEMICAL SOCIETY

A meeting was held in the School of Biochemistry, Cambridge, on October 25, and the following papers were read:—

1. The Fractional Ultrafiltration of Plasma Proteins, by A. B. Anderson. An account of preliminary experiments in which human plasma was ultrafiltered through collodion membranes of differential permeability, the proteins in the filtrate and residual fluid being estimated quantitatively. Membranes were obtained permeable to globulin to a large extent, and impermeable or only very slightly permeable to albumin.

2. The Carbohydrate and Fat Metabolism of Yeast, by Dorothy Hoffert and Ida Smedley MacLean.

3. The Isolation of Spermine and its Chemical [illegible]position, by H. W. Dudley, M. C. Rosenheim, [illegible]O. Rosenheim. The base spermine has been [illegible]d as phosphate by a variety of methods from [illegible] (0·006 per cent.), ovary (0·014 per cent.), [illegible] (0·011 per cent.), pancreas (0·018 per cent.), [illegible]d (0·003 per cent.), thymus (0·006 per cent.), [illegible] (0·007 per cent.), and distillers' yeast (0·007 per cent). Attempts to find it in serum, blood, milk and bakers' yeast gave negative results. The free base is a crystalline, hygroscopic solid, melting between 40 and 50° C., and boiling *in vacuo* without decomposition. It is fairly volatile with steam. The most important salt of spermine is the phosphate, which is characterised by extreme insolubility in water. Analyses of this salt and of the hydrochloride (m. pt. 310°), picrate (m. pt. 250°), gold salt (m. pt. 225°), platinum salt (m. pt. 245°), and benzoyl derivative (m. pt. 155°), indicate that spermine is an isomer of cadaverine ($C_5H_{14}N_2$). Determinations of the molecular weight of the benzoyl derivative by Beckmann's and Rast's methods agree, however, with the formula, $C_{10}H_{26}N_4$ for the base.

The identity of the spermine from animal organs with that from semen has been proved by chemical and crystallographic methods.

4. The Influence of Mineral Waters upon Urinary Excretion, by G. L. Peskett and P. C. Raiment. The object of the experiments described was to find whether the ingestion of spa water had any effect upon the volume or the nitrogenous content of the urine of healthy subjects. Four subjects were taken and the results were given for two periods, in the first of which no mineral waters were given; in the second the mineral waters were taken by two of the subjects, the other two being retained as controls. The first period lasted for six days, the second for eleven. Nothing contained in the figures obtained justifies the attribution of any specific effect to the ingestion of mineral waters.

5. The Acid-Soluble Phosphorus Compounds in Milk, by H. D. Kay. It has been found that two phosphoric esters, similar in their behaviour towards heat, enzymes, acids and alkalis to the phosphoric esters found in blood corpuscles, are present in milk, one (the more readily hydrolysable) being present in important quantities. Both esters are present in cow's, goat's, and human milk. In mg. phosphorus per 100 c.c. milk, the more readily hydrolysable ester is present to the average extent of at least 4·6 mg. in cow's milk, 13·5 mg. in goat's milk, and 3·7 mg. in human milk. In the last two milks, these esters account for at least 20 per cent. of the total phosphorus of the milk. Both the more and the less easily hydrolysable ester pass readily through a collodion dialysing membrane which holds back proteins, and which allows methylene blue to diffuse slowly. The identity of these esters is under investigation.

6. The Effect of Ammonium Chloride Acidosis on the Calcium and Potassium of Human Blood Plasma and Urine, by C. S. Hicks, J. B. S. Haldane, G. A. Reay, and E. Watchorn. The ingestion during three days of 80 g. of ammonium chloride, which by conversion of the ammonia into urea liberated 55 g. of hydrochloric acid, doubled the rate of calcium excretion, and quadrupled that of potassium excretion, the latter followed by a period of retention. The serum calcium rose by 5 per cent., and later fell by the same amount; the potassium rose by 25 per cent., and then fell 20 per cent., but the parallelism between serum concentration and urinary output was incomplete.

SOCIETY OF GLASS TECHNOLOGY

The first meeting of the session was held in Sheffield on October 15, the president, Col. S. C. Halse, in the chair.

An address entitled "The Present Position of the Glass Industry in North America" was given by Prof. W. E. S. Turner, D.Sc., who observed that in America the period of trade depression had not been continuous, as was the case in the United Kingdom. In the autumn of 1922, American trade began to improve, and 1923 was a very good year. In February, 1922, trade in general began to fall off, and a very dull period still persisted. The cut-glass industry had almost entirely died out in America, but coloured glass was finding a place more and more. There was a distinct improvement in American taste for glassware. At the Steuben works of the Corning Glass Co. some very fine artistic work was being manufactured. Prof. Turner next referred to the gradual disappearance of pot furnaces in favour of tank furnaces. The latter were now being used even for the manufacture of green and blue signal lights, and for selenium ruby glass. Electric-light bulbs, except very small or very large bulbs, were now practically all made by machines fed from tank furnaces, the glass being of the soda-lime-magnesia type.

Several noteworthy advances in the glass industry were then noted. During the past few years there had been a very distinct development in the use of blowing machines or press and blow machines. Reference was made to the Westlake machine for thin-walled tumblers, the Hartford-Empire machine for electric-light bulbs, and the great development in the manufacture of light-walled tumblers.

Dealing with sheet glass, Prof. Turner remarked that the Fourcault process had not as yet achieved any considerable success in America. The cylinder process was still in active operation. An epoch-making operation was that developed at the glass works of the Ford Motor Co. This process marked an absolute departure from the use of pot furnaces, as the glass was melted in tanks, and there was continuous rolling between a pair of rollers, the sheet passing down a lehr about 440 ft. long and, subsequently, in sheets, traversed long tables in a continuous belt, where the grinding and polishing were done.

Regarding bottle machines, there was a tendency to replace the Owens machine in favour of the feeder-fed type. There were no striking advances in feeding devices, the Hartford Empire feeder being the most in favour, followed by the W. J. Miller. One novelty in operation was the use of a rotating plunger, especially when making large ware.

Prof. [illegible]ner then dealt with the problems of furnac[illegible] furnace efficiency. This was one of the fore[illegible] problems discussed by glass manufac-tur[illegible] average life of a tank furnace operated [illegible] was 11 to 13 months. A table was [illegible]wing for a number of factories the [illegible] rate of fuel consumed to glass melted. [illegible]eral fa[illegible]es could show ratios as low as 0·6. Finally, a de[illegible]ription was given of heatless lehrs.

PERSONAL AND OTHER ITEMS

The Centenary of the Physikalisch Verein at Frankfurt was celebrated on October 24. The history of the Verein is associated with well-known names such as those of R. Böttger, who carried out his work on gun cotton, and on the derivatives of anthracene, in the Institute; of Bernard Lepsius; and of Martin Freund, who carried out his researches on the alkaloids when at Frankfurt. In addition, Richard Lorenz was the first to occupy the chair of physical chemistry founded by the Verein in 1909.

The degree of D.Sc. has been conferred by the University of London on Mr. G. E. Foxwell, for his thesis entitled "The Flow of Fluids treated Dimensionally," and on Miss F. M. Hamer, for a thesis entitled "The Synthesis of an Azocyanine," and other papers.

Prof. H. B. Baker has been appointed to represent the Faculty of Science on the Senate of the University of London, in place of Dr. A. N. Whitehead, resigned.

The late Mr. J. Maddocks, a director of the Firth-Brearley Stainless Steel Syndicate, Ltd., left estate of the gross value of £63,933, with net personalty, £58,466.

Mr. P. K. Malin has succeeded Mr. E. D. Winkworth as president of the Semet Solvay Co., the Solvay Process Co., and the Atmospheric Nitrogen Co., all companies which are subsidiaries of the Allied Chemical and Dye Corporation.

Mr. J. R. Withrow has been appointed professor of chemical engineering and head of the new department of chemical engineering at Ohio State University, Ohio.

Mr. E. Barclay Hoare has been elected master of the Distillers' Company, and Mr. O. Satchell has been elected master of the Painters' Company.

Mr. J. P. Cockcroft, M.Sc., has been appointed lecturer in electrochemistry in the Faculty of Technology of the University of Manchester.

Mr. G. A. Reay (University of Aberdeen) has been elected to a research studentship in biochemistry at Emmanuel College, Cambridge.

We regret to announce the death of Mr. J. W. Spence, a member of the Society of Chemical Industry since 1883.

Mineral Production of New South Wales, 1923

The annual report of the Department of Mines for 1923 shows the record figure of £16,291,416, an increase of £2,016,646, as compared with 1922. The following are the figures of production for 1923:—Alunite, 998 tons; arsenic, 11,493 t.; asbestos, 204 t.; bismuth (metal and ore), 6 t.; chrome, 1192 t.; clays, 64,653 t.; coal, 10,487,513 t.; coke, 580,374 t.; copper (ingots, matte and ore), 1261 t.; diamonds, 175 carats; dolomite, 5059 t.; gold, 18,833 oz. fine; iron, 94,350 t.; iron oxide, 2716 t.; lime, 40,669 t.; limestone flux, 131,843 t.; magnesite, 6130 t.; manganese ore, 2556 t.; marble, 225 t.; molybdenite, 9·5 t.; platinum, 586 oz.; portland cement, 223,852 t.; silica, 18,623 t.; silver, 107,682 oz.; silver-lead ore, concentrates, etc.,

241,761 t.; oil shale, 1207 t.; tin (ingots and ore), 896 t.; wolfram, 2 t.; zinc concentrates, 426,049 t. Coal represents half the total value, silver-lead, zinc, portland cement and iron being the next most important products.

American Symposium on Corrosion

At the Baltimore meeting of the American Chemical Society, which will be held during Easter week, the Division of Industrial and Engineering Chemistry will hold a symposium on Corrosion. At the present time the tentative outline of the symposium is as follows:—(1) Submerged Corrosion of Metals: (*a*) Iron and Steel; (*b*) Non-ferrous metals. (2) Atmospheric Corrosion. (3) Corrosion of special alloys. It is hoped that the scope of the papers of this symposium will cover the problems of corrosion in the heavy chemical industry, in the special chemical industry, in the marine world, in ordnance equipment, in the oil, mining and other industries. Papers relating to any of these subjects or sub-divisions will be welcomed by the chairman of the symposium, who is Robert J. McKay. Anyone who wishes to present a paper before this symposium should communicate at once with Mr. McKay or the Secretary of the Division.

The Phenol Industry in France

The production of phenol was started in France during the war, and considerable improvements have been made in extraction. A preliminary purification of the tar oil has been found to result in an increased yield, over 88 per cent. of the crude phenols being obtainable as against 19 per cent. in previous practice. Carbon dioxide from lime kilns is also being used instead of sulphuric acid to liberate the phenol from the sodium phenate, the gas passing in counter current with the sodium phenate at 100° C. to avoid the formation of sodium bicarbonate. In investigations on the synthesis of phenols, observations on the changes taking place during the distillation of coal in horizontal retorts have given results unfavourable to the theory of Berthelot, who considers that the synthesis takes place during the distillation. In fact, if inclined chambers are substituted progressively for the horizontal retorts an increased quantity of tar is obtained per ton of coal distilled, whilst the content of phenic acid decreases. It thus appears that considering the low rate at which the temperature increases in the centre of the charge, a part at least of the mass is really distilled at a low temperature, and that thanks to the rapid extraction of the gas formed, and to the relatively low temperature of the mains, subsequent changes take place less freely than in the retorts.

The Fuel Congress at Paris

This Congress opened on October 2, under the presidency of Prof. D. Berthelot. The first paper, by M. Roszak, showed how Berthelot's method of hydrogenation had made possible the synthesis of various hydrocarbons, and thus led the way for further work. M. A. Kling discussed the production of synthetic paraffin by the Bergius process and then discussed results obtained by himself and other workers in investigating its claims. The opinion was expressed that the process is sufficiently developed for application on a large scale in France to tar, and other similar fluid products, and that it could yield large amounts of petrol, diesel oils and the like, representing no small fraction of the requirements of the country. The application of the process to coal and similar fuels seemed less advanced but it was thought that the difficulties related largely to the designing of suitable plant.

M. Mailhe, who was one of the first to deal with the problem in France, read a paper on the manufacture of motor fuels from vegetable and animal oils by means of a series of synthetic changes. In the first experiment, linseed oil was treated in the presence of electrolytic copper associated with alumina as catalyst, and the latest work was devoted to the catalytic decomposition of fatty acids. By using magnesium chloride as catalyst M. Mailhe has obtained 68 per cent. of synthetic fuel from a mixture of linoleic, linolenic and arachic acids, from which he has isolated various products ranging from petrol to heavy and thick oils, products consisting of formenic and ethylenic hydrocarbons. Industrial manufacture presents no difficulty but the economics of the process remains to be investigated. It is claimed that from a ton of oil, saponification produces 98 kg. of glycerine and 902 kg. of fatty acids, the fatty acids yielding, by the Mailhe process, 630 kg. of hydrocarbons that yield 15 per cent. of petrol, 20 to 25 per cent. of paraffin, 15 to 20 per cent. of heavy oils, 20 to 25 per cent. of thick oils, and 15 to 20 per cent. of solid oils, worth 1526 francs, or, valuing the 98 kg. of glycerine at 400 francs, a total of 1926 francs per metric ton of oil. As the cost of manufacture is not high the ton of oil must not cost more than 1500 francs, whereas at present low-grade oils are worth over 3000 francs per ton. The industrial application of the process thus seems only possible with very cheap vegetable oils. Synthetic fuel has also been obtained from beeswax and chlorophyll, this last result suggesting that in time a new branch of the cellulose industry will be established.

M. E. Goutal, describing the Andry-Bourgeois and Olivier process, stated that starting from water-gas derived from lignite coke, these authors obtained liquid and gaseous hydrocarbons. The interest of the process lies rather in the nature of the catalysts employed and the arrangement of the plant. Worked on a semi-industrial scale, the process has yielded a synthetic fuel which after hydrogenation gives a light petrol of density 0·76 and with a heat value of 11,539 calories per kg.

On October 3, M. G. Lumet spoke on the use of vegetable oils as motor fuel, and the various aspects of the problem of a national fuel in relation to agriculture were considered by various speakers. M. du Boistesselin stated that better management of French forests would increase the production of wood charcoal by 450,000 tons, an increase which would obviate the necessity for importing petrol. M. Herbillon observed that in Morocco there was an over-production of wood charcoal as the forest companies were obliged by law to carbonise all the waste from working. M. Auclair described the use

of charcoal-gas generators on lorries and pointed out that this application only had the result of raising the price of charcoal. M. Goutal suggested that wood charcoal could be replaced by wood briquettes, which, after successive carbonisation would fetch a lower price than charcoal, but being six times more dense would yield 250 calories more per kg. than the charcoal. M. R. Duchemin pointed out that industrial carbonisation necessitated the sale of by-products if charcoal were to be sold cheaper; whereas the industry already felt the competition of synthetic acetic acid. The difficulties of estimating the world resources of petroleum were discussed by M. Pineau, who thought it was premature to assign any date when the deposits would be exhausted. There was no reason to suppose that new deposits would not be discovered.

Other papers read were by M. Gramme on "Colloidal Fuel," and by M. Guiselin on the "Mechanism of the Catalytic Manufacture of Synthetic Fuels."

Smoke Abatement Conference

This Conference, to be held in the Town Hall, Manchester, from November 4–6, will open with a business meeting in the City Hall, Deansgate, Manchester. The opening of the Exhibition will take place on November 4, at 11.30 a.m., by the Rt. Hon. the Lord Mayor of Manchester, and lunch for municipal delegates at the Town Hall will commence at 1 p.m. The following papers will be read at the Conference:—"Air Pollution," by Dr. J. S. Owens; "Diagrams on Measuring Atmospheric Pollution in a Lancashire Town," by Dr. J. R. Ashworth; "Effect of Atmospheric Impurities on Buildings," by Sir F. Baines; "The Work of the Departmental Committee on Smoke Abatement," by Prof. J. B. Cohen, F.R.S.; "A Description of the Smokeless Fuel Plant for Glasgow," by R. Maclaurin; "Some New Aspects of Low Temperature Distillation," by H. Nielsen; "Coalite" (Standard Smokeless Fuel), Town Gas and Oil Supply, by the Rt. Hon. G. H. Roberts, and P. C. Pope; "Smoke Legislation in England and America," by J. W. Graham; "The Possibilities of Smoke Prevention under the P.H.A., 1875," by R. M. Rowe; "The Effect of Light on Health," by Prof. L. Hill and Dr. R. Veitch Clark; "Complete Gasification of Coal: its bearing upon Smoke Prevention and Fuel Economy," by T. R. Wollaston; "Pulverised Coal," by Dr. J. T. Dunn; "The Smoke Inspector and the Cost of Production," by H. G. Clinch; "Smoke Abatement and Boiler Room Economies in relation to the training of Boiler Firemen," by J. T. Hodgson; "Boiler Design," by W. H. Casmey; "Gas Undertakings as Fuel Providers," by Sir A. Duckham; "The Fuel of the Future," by F. W. Goodenough; "Gas Coke—In relation to Industrial and Domestic Smoke Prevention and Fuel Economy," by E. W. L. Nicol; "How Electricity can help in Smoke Abatement," by J. Frith; "The Influence of Electricity on the Domestic Smoke Problem," by J. W. Beauchamp; "The Use of Power other than that produced by Coal," by Prof. Miles Walker; concluding with a Popular Lecture by Ex-Bailie W. B. Smit[illegible] on "The Cost of a Smoky At[illegible]

REVIEW

Modern Cereal Chemistry. By D. W. Kent-Jones, B.Sc. Pp. IX+324. Liverpool: Northern Publishing Co., Ltd., 1924. Price 25s. net.

For generations millers have made good flour and bakers good bread, but their methods have been mainly empirical. Many scientists have worked at flour and bread problems, and much scientific information has been acquired, but no one had been able to state in scientific terms the ultimate cause or causes of good quality. In this connexion much attention has been given to the percentages of nitrogen, gluten, gliadin, glutenin, soluble extract, soluble phosphates, acidity measured by titration, the ratio of gliadin to glutenin, diastatic capacity and so on, but no one of these points, or all of them in combination, accounted satisfactorily for the results obtained in practice. The author, who is a keen and enthusiastic worker attached to a mill, does not appear to have evolved any new or striking conception on fundamentals, but has, in a very readable way, collated a great number of recent publications, mainly American, German, and British, and has done much work in testing and applying the new theories. He says that flour is not merely a powder to be analysed for its constitutent parts but a "coarse dispersion of a dried up hydrogel." Put shortly, the fundamental change in ideas is the recognition that flour, dough, and bread are "substances in the colloidal state." He quotes Mohs as follows:—"It is possible to get two flours having approximately the same percentage of dried albumin hydrogel (protein or gluten roughly) and having almost similar other constituents, and yet the two flours will have very different baking powers, due to the different swelling properties of the hydrogels contained." He attaches the utmost importance to hydrogen-ion concentration and writes thus:—"The importance of acidity in flour and doughs has always been realised, but somehow the old titration results of chemists did not seem to lead to any useful or definite conclusions. This was because chemists were then reporting on the quantity of acid, rather than the intensity of acid, which recent work has shown to be the thing that matters." He elaborates this point to show its importance in practice, and describes at length Bailey's electrometric method of measuring hydrogen-ion concentration. He provides a very useful indicator of how this method of measuring acidity differs from the older ones, by stating that measured by titration "low grade flours showed high percentages of acid" and high grade flours low ones, whereas "the hydrogen ion concentration is the reverse, it being high in the patent (high grade) flours and low in the lower grades." He shows that the so-called ripening of the doughs in baking, hitherto not fully defined, is due, at least mainly, to an increase in hydrogen-ion concentration. Furthermore he explains how several so called "improvers" used in milling and baking operate and justifies them by their effect on this concentration, which in turn affects the colloidal properties of flour and dough. He devotes a chapter to "Vitamins and Flour," another to "Bleaching

and Flour Improvers, and in an appendix gives a very valuable list of "Approved and Tentative Methods of Analysis" approved in August, 1922, by the American Association of Cereal Chemists. When he, a chemist, deals with flour milling technology, he makes mistakes on details. The Indian wheats we get are not "flinty," nor are they nowadays "very dirty"; cockle is not one of the chief impurities in Manitoba, Northern Spring, and Hard Winter wheats—for corn cockle as distinct from seeds, chiefly wild buck-wheat, is almost entirely absent; nor do Pacific wheats as a class yield very white flour, for Wallas, at least, yield very yellow flour. Apart from relatively unimportant errors such as these, the book is most interesting to "cereal chemists and progressive millers," for whom it was primarily written, and should be read by them. The title of the book, however, may be misleading, for beyond very slight references to rye, it deals only with one cereal, wheat and its derivatives.

A. E. Humphries

COMPANY NEWS

ELECTROLYTIC ZINC CO. OF AUSTRALASIA

With the completion of the constructional pro-mme, the capital expenditure will show a marked ine. During the year the capital expenditure £600,000. The output was 44,768 tons of trolytic zinc, in addition to which 154 tons of mium were recovered, together with residues m cadmium plant operations containing 257 tons pper. Supplies of raw material were drawn inly from Broken Hill, and a steadily increasing nage is being derived from the company's Read ebery Mines, Tasmania. The gross profit for year was £456,820, against £401,808 in 1922-23, the net profit was £341,350, against £285,406. is, added to £78,262 brought forward, made ailable £419,612, which has been appropriated as llows:—Debenture sinking fund reserve, £11,560; ation reserve, £40,000; special amortisation , £100,000; dividends Nos. 4 and 5, £169,131 st (£149,115) absorbed last year by dividends 1, 2 and 3; and balance carried forward, 21. Since the close of the period a further end (No. 6) on all preference and ordinary res, absorbing £95,346, has been paid.

RUBBER ROADWAYS, LTD.

The n annual general meeting was held on tober 22, Sir Stanley Bois, chairman, presiding. e activities of the company during the year were viewed by the chairman, who said it was gratifying record that in addition to substantial gifts of rubber ceived from producing companies for laying rubber blocks in Whitehall round the Cenotaph, two companies had given 1000 lb. and 2000 lb. of rubber, respectively, to be applied to experimental purposes. It was regrettable that the rubber blocks laid in Whitehall had to be removed after a test of eight months, the reason being that whereas similar blocks used for the roadways in Holborn and Southwark had proved satisfactory, they were not suitable for a wide thoroughfare like Whitehall where the traffic was not only heavy but very rapid. But whilst such setbacks are inevitably disappointing, each test carried out proved a source of fresh information. Two of the important advantages of rubber roads were the reduction of vibration and noise. The company has liquid assets totalling £34,652 (War Loan £17,455, cash at bank £6709), and its liabilities are apparently limited to deferred shareholders (who are to be allotted further deferred shares in satisfaction) and £2141 on open account.

CELLULOSE HOLDINGS AND INVESTMENT CO.

The net profit in the year to June 30 last amounted to £14,830 (against £4360 in 1922-23). A sum of £534 brought forward is added. The balance of new issue expenses (£851) has been written off, leaving £14,514 to be dealt with. The proposed dividend of 3d. per share, or 25 per cent., free of tax (against nil), will absorb £13,256, and £1257 is to be carried forward. In the revenue account the item "dividend" interest and "Royalty" amounts to £83,972, whilst the last accounts showed "interest and royalty" at £36,987.

LEEDS FIRECLAY CO., LTD.

The net profit for the year ended June 30 was £30,827, after providing for debenture interest, compared with £38,197 for the previous year. A dividend of 5 per cent. is proposed, carrying forward £9704.

CHINA CLAY PRODUCERS, LTD.

An association, with the object of furthering the interests of china-clay producers, has been formed and registered as a company limited by guarantee without share capital, each of the 100 members being liable for £10 in the event of winding-up. No member of the China Clay Producers, Ltd., will be qualified to hold office as a director who is the owner of any business producing British china clay and has not entered into a producer's agreement, or who holds a controlling interest in any company, or is a member of any firm producing British china clay which is not a member of the company.

BRITISH CYANIDES CO., LTD.

At the annual meeting, held on October 15, Mr. Kenneth M. Chance dealt with the causes which resulted in the Company making a loss of £24,991 during the year ended April 30, 1924, the chief reason being the sudden fall in the market value of cyanogen products. When the question of quality was regarded by consumers as being of first-rate importance, the Company was the pioneer in the manufacture of a high-grade sodium cyanide, which was then universally used in the gold-mining industry; but now an American company produced a low-grade cyanide which was sold at a price far below that of the high-grade cyanide, and, with the aid of a tariff of 33 per cent., the American company had captured practically the whole of that trade. The

British Cyanides Co., therefore, had to find a new outlet for the raw material obtained from the gas-works, and had practically to build up a new business, with the result that a great deal of research work had been done and rapid developments had taken place in the process of fixing atmospheric nitrogen, which yielded a chemical which could be used in the vulcanisation of rubber. The new plant for this had been extraordinarily inexpensive to erect, and if it proved successful would overcome all difficulties in connexion with financing the capital outlay required for converting the whole of the Company's sulpho-cyanide into this new chemical. Referring to the liquidation of the British Potash Co., Ltd., Mr. Chance said that he was convinced that the chemical trade in this country would remain incomplete until a potash industry was formed and developed on lines approved by the leading chemical manufacturers of this country and the British Government.

ERINOID, LTD.

The net profits for the year ended August 31 amounted to £27,171 (£17,125 in 1922-23), and £6417 were brought forward. It is proposed to pay a dividend of 7 per cent., less tax (against 4 per cent., less tax), to transfer £10,000 to general reserve (against £5000), and to transfer £4000 to reserve for income tax, leaving £6497 to be carried forward. An agreement has been entered into with the Casein Co. of America to form a company to manufacture Erinoid in the United States. The company will take over the goodwill and connexion of Erinoid, Ltd., in the United States in exchange for an allotment of fully-paid shares representing one-third of the common stock of the new company.

VAL DE TRAVERS ASPHALT CO., LTD.

An intermin dividend for the half-year ended June 30 of 6d. per share, or 2½ per cent., has been declared on shares Nos. 1 to 196,000, payable on November 3.

REPORT

REPORT ON THE ECONOMIC CONDITIONS IN FRANCE. Revised to June, 1924. By J. R. CAHILL, Commercial Counsellor, Paris. Department of Overseas Trade. Pp. 224. H.M. Stationery Office, 1924. Price 6s.

The economic revival which occurred early in 1922 shows no sign of failing (*cf. Chem. and Ind.*, 1923, 700). The reconstruction of devastated areas is practically complete and industries are fully active here an[illegible] other parts; the chief difficulty is a short[illegible] labour, which is being partially met by im[illegible]. The industrial capacity of the country [illegible]ly superior to what it was before the [illegible]ards both natural resources and also m[illegible]ing power. Efforts have been made to im[illegible]ublic finances, and taxation is now nearly thre[illegible]es as heavy as in 1919.

Th[illegible]aluc of imports into France in 1923 was 32,615 mill. fr., and of exports 30,431 mill. fr., each about 50 per cent. greater than in 1923, though the actual bulk increased only by about 8 per cent. in each case. There has been a considerable change since the war in the character of French trade. The recovery of Alsace and Lorraine has rendered unnecessary much of the importation previously made from Germany, such as ores, potash, and textiles. Chemical, metallurgical, and engineering industries have made such progress that imports in these branches are steadily declining, and in several other industries home-produced articles are extending their markets. The woollen trade has been much favoured in its exports by the depreciation of the franc. Great Britain and Belgium continue to be the most important customers of France, each taking exports valued at 4400 mill. fr. Of the imports Great Britain supplied 16·1 per cent. and the United States 15·5 per cent. In both these cases expansion of trade was hampered by fluctuations in the value of the franc.

The coal industry has enjoyed a period of prosperity since the beginning of 1922; output rose from 31·94 mill. t. in 1922 to 38·54 mill. t. in 1923. This is expected to show a further increase and may reach 55 to 60 mill. t. in a few years, so that there will be a big decrease in imports; these reached 30·66 mill. t. last year, of which 18·5 mill. t. came from Great Britain. The danger of stoppage of German supplies had the effect of increasing considerably the home production of metallurgical coke which amounted to 2·3 mill. t. Iron ore production recovered in the middle of the year from the effect of uncertain supplies of coke and still continues satisfactory; 95,000 t. was exported from Lorraine and 230,000 t. from Normandy. The production of iron and steel rose considerably in 1923 to 5·4 and 5·1 mill. t. respectively. The aluminium industry has been very busy during the past two years and is building up a considerable export trade. Before home demands for reconstruction purposes cut down exports, France was one of the principal world's suppliers of cement; with these demands now practically satisfied, and a production in 1923 of 5·9 mill. t., the country will no doubt again enter her old markets. Dyestuff and other chemical industries have made great progress, and home-produced dyestuffs are now thoroughly established. Among heavy chemical exports the chief is potassium chloride. All branches of textiles, except linen and lace, had a prosperous year. The increased demand for artificial silk has led to a great extension of the industry, which now produces at the rate of 3200 t. per annum.

MINERAL OUTPUT IN WESTERN AUSTRALIA, 1923

In Western Australia the value of the mineral output in 1923 was £2,657,950, being £143,676 less than for the previous year. The output was as follows:—Asbestos, 115 cwt.; clay, 34 tons; coal, 420,714 t.; copper ore, 3394 t.; copper ingot, matte, etc., 1057 t.; gold, 504,511 fine oz.; iron ore, 2 t.; lead and silver lead, 3172 t.; lead (pig), 20 t.; magnesite, 22 t.; silver, 109,005 f. oz.; tantalite, 5 t.; and tin, 131 t.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder..	£47 per ton.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
mmonia Alkali.. ..	£6 15s. per ton, f.o.r. Special terms for contracts.
leaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
isulphite of Lime ..	£7 10s. per ton, packages extra.
orax, Commercial—	
Crystal..	£25 per ton.
Powder..	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
alcium Chloride ..	£5 17s. 6d. per ton d/d.
opper Sulphate	£25 per ton.
ethylated Spirit 64 o.p.—	
Industrial	2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised	3s. 8d.—4s. per gallon, according to quantity.
ickel Sulphate .. .. / ickel Ammon. Sulphate	£38 per ton d/d. Normal business.
ash Caustic	£30—£33 per ton.
ss. Bichromate ..	5⅞d. per lb.
s. Chlorate.. ..	3d.— ' ' per lb.
lammoniac	£32 per ton d/d.
t Cake.. ..	£3 10s. per ton d/d.
oda Caustic, solid ..	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
oda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton, carr. paid.
Sod. Bichromate.. ..	4¼d. per lb.
Sod. Bisulphite Powder 60/62%..	£17—£18 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton /dd.
Sod. Sulphide cryst. ..	£9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	6¼d.—1s. 2d. per lb., according to quality.
Crimson	1s. 4d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide ..	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide ..	£30—£33 per ton, according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf.
Carbon Tetrachloride ..	£60—£65 per ton, according to quantity, drums extra.
Chromium Oxide, green..	1s. 3d. per lb.
Indiarubber Substitutes White and Dark ..	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free.
Lead Hyposulphite ..	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P. ..	£47 10s.—£52 10s. per ton, according to quantity.
Sulphur Chloride ..	4d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep ..	5s. 1d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

There is a general feeling that the fall in price of acetates during the last few weeks has reached its limit. The tendency is now to stiffen again.

Acetate of Lime—	
Brown	£11—£11 10s. per ton.
Grey	£15 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 15s.—£9 5s. per ton, according to grade and locality. Demand quiet but price steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. ,, ,, 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 9d. per gall. 60% O.P.
Solvent..	5s. 6d. per gall. 40% O.P. Firmer.
Wood Tar	£4 5s. per ton. Very quiet.
Brown Sugar of Lead ..	£43 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6¼d. per lb. Quiet.
Crude 60's	1s. 8d.—1s. 10d. per gall. Market flat.
Acid Cresylic, 97/99 ..	2s.—2s. 1d. per gall. Demand steady.
Pale 95%	1s. 9d.—2s. per gall. Better enquiry.
Dark	1s. 8d.—1s. 10d. per gall. Fairly steady.
Anthracene Paste 40% ..	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	6½d.—7½d. per gall. Small demand
Unstrained	6d.—6½d. per gall.

Benzole—

Crude 65's	7½d.—9d. per gall. ex works in tank wagons.
Standard Motor	1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Pure	1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5d.—1s. 5½d. per gall. Small demand for home consumption.
Pure	1s. 7d.—1s. 9d. per gall. Small demand for home consumption.
Xylol—Coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.

Creosote—

Cresylic 20/24%	8d.—8½d. per gall. Little demand.
Middle Oil / Heavy Oil / Standard Specification	5¼d.—6¼d. per gall., according to quality and district. Fair business passing. A little more demand for export in bulk.

Naphtha—

Solvent 90/160	1s.—1s. 3d. per gall. Demand good.
Solvent 90/190	11d—1s. per gall. Fair inquiry. Local demand good.

Naphthalene Crude—

Cheaper in Yorkshire than Lancashire. Demand rather better.

Drained Creosote Salts £3—£5 per ton. Demand slightly better.

Whizzed or hot pressed £6—£9 per ton. Demand very poor.

Naphthalene—

Crystals and Flaked	£12—£15 per ton, according to district.
Pitch, medium soft	42s. 6d.—60s. per ton according to district. Plenty of inquiry. Prospects brighter.
Pyridine—90/160	19s. per gall. Steady demand.
Heavy	12s.—12s. 6d. per gall. Market dull.

INTERMEDIATES AND DYES

Business in dyestuffs has been very well maintained this week. Slight reductions have been made in the price of a number of intermediates.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb.
Acid H.	3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1d. per lb. Improved demand.
Acid Sulphanilic	9d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	8d. per lb. naked at works.
Aniline Salts	8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	3s. 11d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4d.—4½d. per lb. Rather quiet.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichl[illegible]ine S. Acid	2s. 6d. per lb. 100% basis.
p-D[illegible]benzol	£85 per ton.
D[illegible]niline	4s. 3d. per lb. d/d., packages extra, returnable.
[illegible]ethylaniline	2s. 2½d. per lb. d/d. Drums extra.
[illegible]	2s. 4d. per lb. 100% basis d/d.
α-Naphthol	2s. 5d. per lb. d/d.
Dinitrobenzene	9d.—10d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
Monochlorbenzol	£63 per ton.
β-Naphthol	1s. per lb. d/d.
α-Naphthylamine	1s. 3½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	4s. 2½d. per lb. d/d.
p-Nitraniline	2s. 2½d. per lb. d/d.
Nitrobenzene	5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol	2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene	10½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	3s. 10d. per lb. d/d.
p-Phenylene Diamine	10s. 2d. per lb. 100% basis d/d.
R. Salt	2s. 4d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 2d. per lb. 100% basis d/d.
o-Toluidine	10d. per lb.
p-Toluidine	3s. per lb. naked at works.
m-Toluylene Diamine	3s. 10d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£47 per ton. Firmer.
Acid, Acetyl Salicylic	3s. 1d.—3s. 3d. per lb., according to quantity. Sales steady. Price firm.
Acid, Benzoic B.P.	2s. 6d. per lb. Cheaper.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 3½d.—1s. 4d. per lb., less 5% for ton lots. Market still weak.
Acid, Gallic	2s. 9d. per lb. for pure crystal in 2 cwt. lots.
Acid, Pyrogallic, Cryst.	6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm.
Acid Salicylic	1s. 6d.—1s. 8d. per lb., according to quantity. Slightly firmer.
Acid, Tannic B.P.	2s. 10d. per lb. Market quiet.
Acid, Tartaric	1s. per lb., less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	2s. per lb. for quantity. More enquiry.
Amidopyrin	15s. per lb.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	14s. 3d. per lb.
Benzonaphthol	5s. 3d. per lb. spot.
Bismuth Carbonate	10s. 6d.—12s. 6d. per lb.
„ Citrate	10s. 3d.—12s. 3d. „
„ Salicylate	9s.—11s. „
„ Subnitrate	8s. 8d.—10s. 8d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Market exceedingly firm and prices advancing. Raw materials dearer.
Ammonium	1s. 8d.—1s. 11d. per lb. } According to quantity.
Potassium	1s. 6d.—1s. 9d. per lb. } According to quantity.
Sodium	1s. 7d.—1s. 10d. per lb. } According to quantity.
Calcium Lactate	1s. 6d.—1s. 8d. per lb., according to quantity. Fair demand and steady market.

Chloral Hydrate	4s.—4s. 3d. per lb. Slightly dearer. Spot supplies short.
Chloroform	2s. 6d. per lb. for cwt. lots. Price advanced by 6d. per lb.
Formaldehyde	£46—£49 per ton in barrels, ex wharf London.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	7s. per lb.
Glycerophosphates—	
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. „
Guaiacol Carbonate	10s. per lb.
Hexamine	3s. per lb. Forward prices higher.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor.	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. „
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
...nesium Carbonate—	
...ht Commercial	£36 per ton net.
...esium Oxide—	
...ht Commercial	£75 per ton, less 2½%.
...avy Commercial	£25 per ton, less 2½%.
...vy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
...ol—	
...B.R. recryst, B.P.	60s. per lb. Market much firmer.
...nthetic	26s.—35s. per lb., according to quantity. English make. Increasing demand.
...urials	Market very quiet.
...d oxide	5s. 3d.—5s. 4d. per lb.
...rrosive sublimate	3s. 6d.—3s. 7d. „
...hite precip.	4s. 7d.—4s. 8d. „
...lomel	3s. 11d.—4s. „
...hyl Salicylate	1s. 10d.—2s. per lb. Seasonal increase in demand.
...hyl Sulphonal	24s. per lb. Slightly weaker.
...l	11s. per lb. British make.
...formaldehyde	2s. 8d. per lb. for B.P. quality.
...aldehyde	1s. 4d.—1s. 6d. per lb. in free bottles and cases. Supplies plentiful.
...nacetin	5s. 9d. per lb.
...nazone	6s. 9d. per lb. Slightly lower. Supply exceeds demand.
...olphthalein	5s. 9d. per lb.
...s. Bitartrate—	
.../100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots.
...ass. Citrate	1s. 10d.—2s. 2d. per lb.
...tass. Ferricyanide	1s. 9d. per lb. Quiet.
...otass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
...tass. Metabisulphite	7½d. per lb., 1-cwt. kegs included. F.o.r. London.
...ass. Permanganate	7½d. per lb. spot. Forward prices higher.
...uinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 3d.—5s. 6d. per lb.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 9d. per lb. for cwt. lots.
Silver Proteinate	9s. per lb. for satisfactory product, light in colour.
Sod. Benzoate, B.P.	2s. 6d. per lb. Supplies of good quality now available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Fair demand. Powder 2s.—2s. 3d. per lb. Crystal at 2s. 2d.—2s. 5d. per lb. Flake 2s. 6d. per lb.
Sod. Sulphide—Pure recryst.	10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s. per ton, minimum 5-ton lots, increasing according to quantity, 1-cwt. kegs included.
Sulphonal	15s. 6d. per lb. Little demand.
Thymol	16s. per lb.

PERFUMERY CHEMICALS

Acetophenone	12s. per lb.
Aubepine	15s. 3d. „
Amyl Acetate	2s. 9d. „
Amyl Butyrate	6s. 9d. „
Amyl Salicylate	3s. 3d. „
Anethol (M.P. 21/22° C.)	4s. 6d. „
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. „
Benzyl Alcohol free from Chlorine	2s. 9d. „
Benzaldehyde free from Chlorine	3s. 6d. „
Benzyl Benzoate	3s. 6d. „
Cinnamic Aldehyde—Natural	18s. 9d. „
Coumarin	19s. 6d. „
Citronellol	17s. „
Citral	8s. „
Ethyl Cinnamate	12s. 6d. „
Ethyl Phthalate	3s. 3d. „
Eugenol	10s. „
Geraniol (Palmarosa)	33s. 6d. „
Geraniol	11s. 6d.—18s. 6d. per lb
Heliotropine	6s. 9d. „
Iso Eugenol	15s. 9d. „
Linalol ex Bois de Rose	26s. „
Linalyl Acetate	26s. „
Methyl Anthranilate	9s. 6d. „
Methyl Benzoate	5s. „
Musk Ambrette	50s. „
Musk Xylol	13s. 6d. „
Nerolin	4s. 9d. „
Phenyl Ethyl Acetate	15s. „
Phenyl Ethyl Alcohol	16s. „
Rhodinol	55s. „
Safrol	1s. 10d. „
Terpineol	2s. 4d. „
Vanillin	25s. 6d. „

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 8d. per lb.
Bergamot Oil	16s. 6d. per lb.
Bourbon Geranium Oil	33s. 6d. per lb.
Camphor Oil	65s. per cwt.

Cananga Oil Java	.. 10s. per lb.	
Cassia Oil, 80/85%	.. 10s. per lb.	Dearer.
Cinnamon Oil, Leaf	.. 6½d. per oz.	
Citronella Oil—		
Java 85/90% ..	.. 5s. 10½d. „	Dearer.
Ceylon	.. 3s. 8d. per lb.	Dearer.
Clove Oil	.. 7s. 9d. per lb.	
Eucalyptus Oil 70/75%	.. 2s. 3d. per lb.	
Lavender Oil—		
French 38/40% Esters	32s. 6d. per lb.	Dearer.
Lemon Oil ..	.. 3s. 2d. per lb.	
Lemongrass Oil ..	.. 4s. 6d. per lb.	
Orange Oil, Sweet	.. 11s. per lb.	
Otto of Rose Oil—		
Bulgarian ..	.. 40s. per oz.	
Anatolian ..	.. 18s. per oz.	
Palma Rosa Oil ..	.. 16s. 6d. per lb.	
Peppermint Oil—		
English ..	.. 70s. per lb. Dearer.	
Wayne County	.. 30s. per lb. Higher prices anticipated.	
Japanese ..	.. 18s. 6d. per lb. paid. Practically unobtainable for spot or near delivery.	
Petitgrain Oil ..	.. 9s. 3d. per lb.	
Sandal Wood Oil—		
Mysore	.. 26s. 7d. per lb.	
Australian ..	.. 18s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Dec. 22nd; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Nov. 6th.

I.—Applications

Ablett, and Shaw and Co. Grinding and/or mixing etc. machines 24,535. Oct. 16.

Armstrong (N. V. Algem. Chemische Productenhandel). Separation of vaporised organic substances from gaseous mixtures. 24,795. Oct. 18.

Coley and Hornsey. Rotary furnaces etc. 24,184. Oct. 13.

Coley and Hornsey. Sealing rotary kilns etc. 24,185. Oct. 13.

General Electric Co., Ltd. Treatment of crystalline substances. 24,384. Oct. 14. (Ger., 3.5.24.)

Heberlein. Prevention of scale etc. in boilers etc. 24,616. Oct. 16.

Imray (Raymond Bros. Impact Pulverizer Co.). Pulverizing mills. 24,607. Oct. 16.

Marks (Maschinenbau-Anstalt Humboldt). Grinding etc. apparatus. 24,274. Oct. 13.

Mongereau et Cie. Pulverising machines. 24,518. Oct. 15. (Belgium, 15.10.23.)

Rigby. Drying. 24,524. Oct. 16.

Stone. Retorts. 24,609. Oct. 16.

Wilputte. Continuous tunnel kiln. 24,181. Oct. 13.

I.—Complete Specifications Accepted

17,667 (1923). [illegible]g. Binding granular and other substances. (200,[illegible])

24,850 (1923). [illegible]ttings and Bodman. Rotary drying apparatus. (223,0[illegible]2.)

II.—Applications

Fairbrother (Jackson Research Corporation). Gasification of coal. 24,231. Oct. 13.

Fairbrother (Jackson Research Corporation). Distillation of carbonaceous material. 24,232. Oct. 13.

Marks (Carbide and Carbon Chemicals Corporation). Processes of rectifying hydrocarbon mixtures. 24,833. Oct. 18.

Weber. Manufacture of briquettes from coke smalls. 24,259. Oct. 13.

II.—Complete Specifications Accepted

17,497 (1923). Sutcliffe. Fuel. (222,931.)

18,705 (1923). Cummins. Gas-retort settings. (222,987.)

20,741 (1923). Hinchley, Greenwood, and White. Rapidly drying peat. (223,011.)

23,259 (1923). Annaratone. Preparing liquid fuels for internal-combustion engines. (217,873.)

28,699 (1923). V. L. Oil Processes, Ltd., Lucas, and Lomax. Methods of refining hydrocarbons. (223,066.)

7509 (1924). Records. Liquid fuel. (223,140.)

10,311 (1924). British Thomson-Houston Co. *See* X.

III.—Application

Marks (Carbide and Carbon Chemicals Corporation). 24,833. *See* II.

III.—Complete Specification Accepted

28,699 (1923). V. L. Oil Processes, Ltd., Lucas, and Lomax. *See* II.

IV.—Applications

Carpmael (Farbenfabr. vorm. F. Bayer & Co.). Manufacture of azo dyestuffs. 24,592. Oct. 16.

Farbenfabriken vorm. F. Bayer & Co. Manufacture of dyestuffs. 24,753. Oct. 17. (Ger., 18.10.23.)

Hefti and Schnorf. Production of acridine derivatives etc. 24,305. Oct. 14.

Morton, Harris, Jones, Wilson. Wylam and Morton Sundour Fabrics, Ltd. Dyes and dyeing. 24,608. Oct. 16.

IV.—Complete Specifications Accepted

17,822 (1923). Barnard. Manufacture of dyestuffs. (222,947.)

20,045 (1923). Eberlein. Manufacture of silicates of the basic dyestuffs. (201,940.)

V.—Complete Specifications Accepted

14,571 (1923). Lilienfeld. Manufacture of cellulose solution. (212,864.)

6125 (1924). Akt.-Ges. für Anilin Fabrikation. Washi[illegible] artificial silk. (212,911.)

13,899 (1924). Hartogs. Spinning viscose. (223,171.)

VI.—Applications

Brandwood. Dyeing etc. yarns in wound form. 24,54[illegible] Oct. 16.

Morton, Harris, Jones, Wilson, Wylam and Morto[n] Sundour Fabrics, Ltd. 24,608. *See* IV.

Soc. Alsacienne de Produits Chimiques. Dyeing of artifici[al] silk. 24,843. Oct. 18. (Fr., 3.11.23.)

VII.—Applications

Coke and Gas Ovens, Ltd., and Pearson. Neutralisin[g] free acid in sulphate of ammonia. 24,493. Oct. 15.

Coley and Hornsey. Production of magnetic oxide o[f] iron. 24,188. Oct. 13.

Evans. Recovery of ferrous sulphate from waste pickle. 24,171. Oct. 13.

Soc. d'Étude des Agglomérés. Production of pure oxide of zirconium. 24,468. Oct. 15. (Fr., 17.10.23.)

VII.—Complete Specifications Accepted

21,136 (1923). Cooksedge. Manufacture of sodium carbonate. (223,015.)

30,988 (1923). Deguide. Manufacture of barium cyanide. (223,082.)

854 (1924). Comp. Gén. des Produits Chimiques de Louvres. Manufacture of zinc sulphide. (209,757).

3763 (1924). N. V. Stikstofbindings Industrie Nederland. Manufacture of ammonia from products containing cyanides. (211,857).

VIII.—Applications

General Electric Co., Ltd. Readily fusible glasses and enamels. 24,392. Oct. 14. (Ger., 5.5.24.)

Guy. Manufacture of saggers. 24,165. Oct. 13.

Soc. d'Etude des Agglomérés. Refractory products. 24,469. Oct. 15. (Fr., 17.10.23.)

Soc. d'Etude des Agglomérés. 24,470. *See* IX.

X.—Applications

Girouard. Manufacture of Portland cement. 24,343. Oct. 14.

Mitchell. Manufacture of cement. 24,763. Oct. 18.

Soc. d'Etude des Agglomérés. Refractory cement. 24,470. Oct. 15. (Fr., 29.10.23.)

Stone. Manufacture of Portland cement. 24,610. Oct. 16.

.—Complete Specifications Accepted

17,238 (1923). Caccia. Manufacture of lime-sand concrete. 22,923.)

17,484 (1923). Douzal. Manufacture of artificial marble. 07,497.)

—Applications

Coles. Recovery of zinc from zinc residues. 24,563. t. 16.

Coley and Hornsey. Manufacture of iron from iron ores. 189, 24,190, 24,191, 24,194. Oct. 13.

oley and Hornsey. Manufacture of steel. 24,172. . 13.

oley and Hornsey. Manufacture of alloys. 24,193, 96. Oct. 13.

oley and Hornsey. Manufacture of iron. 24,195, 24,197. 14.

vans. 24,171. *See* VII.

ournié. Production of iron and steel. 24,287. Oct. 13.

Vado (U.S. Smelting, Refining and Mining Co.). Purifying onial lead alloys etc. 24,595. Oct. 16.

omplete Specifications Accepted

221 (1923). Barker (Vegetable Oil Securities Co.). ratus for making metal catalyst. (222,922.)

,311 (1924). British Thomson-Houston Co. Malleable ductile tungsten composition or alloy suitable for the facture of lighting bodies or filaments. (215,348.)

pplications

kaldy. Anodes. 24,584. Oct. 16. (U.S., 16.10.23.)

vy. Dry batteries. 24,508. Oct. 15.

Nitt. Electrolysing fused baths. 24,265. Oct. 13.

—Complete Specifications Accepted

2,383, 12,715 (1923). Soc. Anon. le Carbone. Liquid-t coating on porous bodies of electrodes of batteries or trolysing-apparatus. (198,656 and 206,471.)

.—Complete Specifications Accepted

502 (1923). Bollinghame. Emulsive and detersive agents, d the manufacture thereof. (222,602.)

17,221 (1923). Barker (Vegetable Oil Securities Co.). e X.

III.—Application

Farbenfabriken vorm. F. Bayer und Co. Manufacture of thopone. 24,754. Oct. 17. (Ger., 30.11.23.)

XIII.—Complete Specification Accepted

19,595 (1923). Naugatuck Chemical Co. *See* XX.

XIV.—Application

Fraser, Rissik, Fraser and Co., and Shaw and Co. Producing rubber etc. solutions. 24,534. Oct. 16.

XVII.—Application

Carpmael (Farbenfabr. vorm. F. Bayer und Co.). Manufacture of esters of saccharides etc. 24,835. Oct. 18.

XIX.—Application

Krempf. Treatment of protein matter. 24,511. Oct. 15.

XIX.—Complete Specifications Accepted

21,018 (1923). Sauer. Purifying and sterilising liquids and gases. (202,654.)

21,270 (1923). Siebert. Separating scale-forming salts from boiler feed-water. (204,027.)

1861 (1924). Rushen (Siemens-Schuckertwerke Ges.). Treatment of green fodder. (223,010.)

XX.—Applications

Bloxam (Haco-Ges. Akt.-Ges.). Manufacture of compounds of alkaloids. 24,377. Oct. 14.

Carpmael (Kaiser). Manufacture of formaldehyde. 24,755. Oct. 17.

Vidal. Preparation of fatty acids etc. 24,822. Oct. 18. (Fr., 19.10.23.)

XX.—Complete Specifications Accepted

19,595 (1923). Naugatuck Chemical Co. Manufacture of formaldehyde condensation products of aliphatic amines, and products obtained thereby. (207,499.)

27,613 (1923). Pollak. Manufacture of condensation products from formaldehyde and urea, thiourea, or their derivatives. (206,512.)

10,105 (1924). Lodoga Soc. Anon., and Maimeri. Preparation of diethyl sulphate from ethylene. (215,000.)

XXI.—Application

Evans. Colour photography etc. 24,682. Oct. 17.

XXI.—Complete Specifications Accepted

17,603 (1923). Polygraphische Ges. Photographic printing-processes, and plates and films therefor. (200,814.)

17,823 (1923). Albert. Colour photography. (222,948.)

XXIII.—Application

Atkinson. Means for quantitative determination of selected gases in atmospheres. 24,228. Oct. 13.

GENERAL NOTES

Official Trade Intelligence

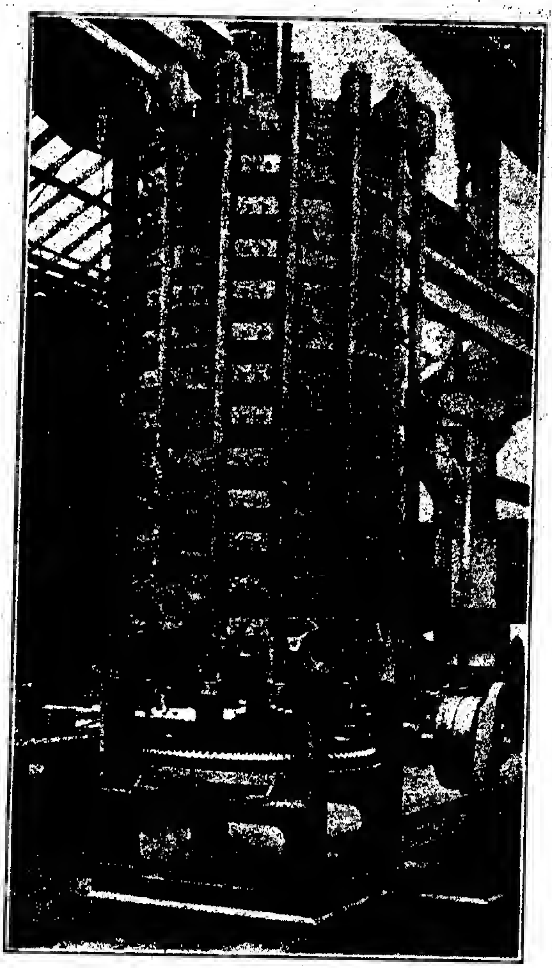
The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*British India*: Steel (Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1). *Egypt*: White metal (Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, London, S.W. 1, Ref. No. E.S.R./4331). *Italy*: Copper clad and chrome nickel wire (444). *Netherlands*: Glass (445). *Poland*: Tin, tinplate, steel (448); Chemicals, rubber (449). *South Africa*: Indiarubber (441). *Sweden*: Paper (450). *Turkey*: Leather, hides, oils (451).

Notes on Plant and Products

Messrs. Thomas Tyrer & Co. have issued the October, 1924, edition of their price-list of "Sterling" Brand Chemicals. A wide range of products is stocked, including A.R. Chemicals, volumetric solutions, and a large variety of inorganic salts both pure and commercial, and organic compounds such as benzaldehyde, ethers, and hydrogen peroxide. The list gives prices for quantities ranging from 1 lb. to 1 cwt.

An Oil Cooler of novel design is now being made by Messrs. A. F. Craig & Co., Ltd., Caledonia Engine Works, Paisley, for which several advantages are

claimed over the ordinary type of plant. The machine, which is due to Mr. J. Moore, the superintending engineer of the Burmah Oil Company's refineries, operates continuously, is extremely compact and embodies every refinement that can pass the test of practice. It consists of a vertical series of shallow circular cells (the number depending on the capacity), bolted together and supported on a frame which carries gearing and a scraping device.



THE "MOORE-BURMAH" OIL COOLER

Each cell comprises an upper and lower chamber, the upper chamber being closed above by the bottom of the next higher cell. The oil to be cooled flows through the upper chambers only, in series from top to bottom, whereas the cooling medium, brine, flows through the lower chambers in series in the reverse direction. The paraffin or other wax (the coolers being suitable for treating any mineral, animal, or vegetable oil) is deposited on the smooth inner surfaces of the cylinder, and is scraped off as it forms by well-designed, adjustable spring scrapers. If required, refrigeration can be saved by using some of the top cells as a heat interchanger (as in tubular coolers), the cold filtered oil being pumped through the brine cells in place of brine. This cooler is claimed to give a much higher unit transfer of heat than any other cooler, and a 12-cell unit has actually cooled as much as 1500 gallons of heavy oil and paraffin per hour, though it should be noted that the capacity depends so much on the nature of the oil and the content of paraffin or stearine which is to be extracted.

Glass Carboys have not sufficient strength in themselves to hold together without bursting when filled with a heavy liquid. For this reason a carboy is always provided with a hamper which, if of sound design, should follow the contour of the glass as closely as is possible. The pioneer manufacturers of carboys in this country are Messrs. R. and H. Leigh and Sons, Ltd., of Bolton, a firm which was the original patentee and inventor of the carboy hamper in 1876. The ordinary carboy makes a somewhat top-heavy package, and when used singly or in small numbers, some provision is necessary to prevent falling over. To meet this difficulty Messrs. Leigh and Sons originated the "Safety Crate" for the Railway Clearing House. This safety crate has been widely adopted and with certain adaptations, such as the "chinaman hat hoods," can be used for the transport of dangerous liquids, such as acetic anhydride. An accessory essential to the user of carboys is a carboy stand and tilter, which Messrs. Leigh and Sons supply either in stationary or portable types, in addition to the invaluable carboy barrow. Everything relating to carboys is supplied by this Bolton firm, even down to smaller gear such as carboy stoppers made of acid-resistant fire-clay.

The Eastman Chemical Co., of Rochester, N.Y., has issued a twelfth list of Eastman Organic Chemica... The list contains the names of over 1800 chemic... kept in stock, and more are continually being add... Three groups are available :—"Eastman's" chemic... of the highest purity obtainable, "Practical" che... cals of sufficient purity for laboratory work, a... "Technical" chemicals as obtained from large sc... manufacturers. In addition, many biological dy... vital stains and indicators are stocked. Data showi... the purity of the plant products are supplied ... request, and the company states that it would be gl... to hear of new organic compounds available f... purchase, or new sources of supply, and of chemica... required as it desires not only to prepare material... but to act as a medium for the mutual assistance ... organic chemists.

PUBLICATIONS RECEIVED

THE INFLUENCE OF THE INGESTION OF POTASSIUM CHLORATE, SODIUM CHLORIDE AND WATER ON THE OXYGEN CAPACITY OF THE BLOOD. By Victor Ross. Pp. 2. Reprinted from the Proceedings of the Society for Experimental Biology and Medicine, 1924. XXI. Pp. 182—184.

THE ELECTROLYTIC THEORY OF CORROSION. By Wilder D. Bancroft. Pp. 785—871. Reprinted from the Journal of Physical Chemistry, Vol. xxviii. August, 1924.

PRESENT-DAY PROBLEMS IN CROP PRODUCTION*

By SIR E. JOHN RUSSELL, F.R.S.

The visits of the British Association to Canada have hitherto very appropriately coincided with definite stages in the progress of agricultural science and practice. It was at the Montreal Meeting of 1884 that Lawes and Gilbert presented their well-known paper on the sources of the fertility of Manitoba soils which ended the first great period of the development of agricultural science. This period had lasted eighty years; it had been ushered in with the precise and scientific work of de Saussure published in 1804; its outstanding features had been the foundation of agricultural science by Boussingault in 1834, its enrichment by Liebig's brilliant essay of 1840, and its systematic development by Lawes and Gilbert at Rothamsted from 1843 onwards. The whole purpose of the scientific workers of the period was to feed the plant: in Gilbert's own words the message of the crops on the Rothamsted plots was, "If you won't feed us we won't grow." The success of the new science was remarkable; its great triumph was the discovery of artificial fertilisers and their introduction into farming practice, and the workers had the great joy of seeing the crop yields rise considerably as the direct and recognised result of their labours. The problems were largely chemical, and agricultural science was regarded as simply a branch of chemistry. Gilbert's paper in 1884 was read before the Chemical Section, and it presented soil fertility as essentially chemical; a fertile soil, he argued, is one containing much plant food, especially nitrogen; it is one "which has accumulated within it the residues of ages of natural vegetation, and it becomes infertile as this residue is exhausted." At the time of the Toronto Meeting in 1896 a new period had begun, quietly and unnoticed, but growth was so rapid that at the Winnipeg Meeting in 1909 the subject had grown right away from chemistry; it had become a definite subsection, and its importance was so widely recognised that a recommendation was passed asking the Council to set it up as a full section, which was subsequently done.

In this second period the purpose was not to feed the crop but to study it; to discover what factors are concerned in the growth of crops and how they operate. This period, which may be called the period of free exploration, since the workers were not usually tied down to any particular technical problem, began almost simultaneously in the United States, in France, and in Germany. As soon as agricultural science was studied in the United States it became evident that the cultivation of the soil was at least as important as the feeding of the crop. This fact had, of course, been fully recognised in the English experiments, but the English farmer was so skilled in cultivation that he could be taught but little by science. The early American work as developed by Kedzie at Michigan, King at Wisconsin, Hilgard, and Whitney, was largely physical, and it greatly widened the outlook of agricultural investigators, opening the way to the extensive physical and physico-chemical studies which have now become so characteristic a feature of American work. The French investigators, particularly Schloesing, Muntz, Berthelot, and Déhérain, and the brilliant Russian, Winogradsky, then in Paris, revealed a new world of soil micro-organisms, the wonder and mystery of which appealed to the imagination of the younger workers in a way that none of the older utilitarian work had done. The Germans methodically explored the fields thus opened up; Hellriegel and Wollny accumulated a mass of data as to plant growth and soil changes which still remains of value to the student. These pioneers were succeeded by a host of followers whom it would be impossible to enumerate at length, and from whom it would be invidious to select a few. Moreover, the chemists and physicists of the old school were no longer left in sole possession; van Bemmelen introduced the conception of colloids, and at a later date Mitscherlich, Baule, and others developed the idea of mathematical expressions for the data of agricultural science. Sachs and his pupils in Germany, Déhérain, Maquenne and Demoussy in France, joined up the new science of plant physiology with agricultural science. The plant breeder also came in; Gregor Mendel's work, after lying hidden for forty years, was revealed to the world by Bateson and was at once turned to agricultural use in England by one of Marshall Ward's pupils, R. H. Biffen; and in the United States by Webber and others. The selection method was developed to a high pitch of perfection in Canada by William Saunders, a revered leader in our science, whose dignified presence and kindly words of greeting remain as a vivid recollection of our visit fifteen years ago. His mantle has fallen on his son Charles, who has continued and developed the work.

The result of all this effort has been the accumulation of an enormous mass of information covering a very large part of the field with which agriculture has to deal. It has been essentially a pioneer period, with all the advantages of keen individual interest, controversy, sometimes even of excitement; but also with the disadvantages of a certain lack of perspective, failure to follow up important issues and some narrowness of outlook inevitable when a single individual is working alone at a great subject.

Generalisations that have emerged

But in spite of these drawbacks several important generalisations have emerged. One of the most pregnant in possibilities for the future is the recognition that the plant is a very plastic organisation and can be modified to a considerable extent within certain limits. Two methods are adopted: breeding, which may be on observational lines or on the Mendelian method of picking out the desired unit characters from plants in which they occur and assembling them in a new plant; and selection, in which a desirable plant is caused to produce seed from which stocks are multiplied. The scientific problems fall within the province of the science of genetics;

* Presidential Address before Section M (Agriculture) of the British Association, Toronto.

The practical significance of the work lies in the fact that it greatly simplifies the agricultural problem by providing plants more or less suitable to the existing natural conditions where otherwise the expert would have the difficult, if not impossible, task of making the conditions suit the available plants. The work has proved extraordinarily fruitful and has given astonishing results even in our own time. It has played no small part in the amazing development of wheat growing in Canada. When the British Association went to Winnipeg in 1909 we were all impressed by the fact that Canada had then passed the 160-million bushel mark in production, but who would have thought that within fourteen years the production would exceed 474 million bushels? Even in England, where wheat has been grown for 2000 years, and where farmers have a long traditional knowledge of the crop, the new varieties introduced by Biffen have increased the yields and the certainty of yields. The triumphs of Webber and others in the United States, of Nielson Ehle with cereals in Sweden, Jeffreys in standardising the quality of cotton in Egypt, the Howards in producing wheats for India, to mention only a few, are still fresh in our minds. In the first period in the development of agricultural science the honours in the matter of practical applications lay with the chemists for the artificial manures, but in the present period we must admit that they lie with the plant breeders and selectors who, indeed, are only on the threshold of what they may yet accomplish. And this great practical purpose of finding or producing varieties of crops specially suited to local conditions would be further advanced if the work were done in co-operation with plant physiologists who could precisely define the modifications required. Much saving of time and effort could be effected if it were possible to set up some international garden where small quantities of the plant breeders' productions could be grown, including those which each one has rejected as being unsuitable to his particular requirements. Many of these unwanted outcasts might prove of value in other conditions.

A second generalisation is that the soil is not a fixed, constant thing, but is pulsating with change. It contains a great population of micro-organisms which, among other activities, decompose the dead plant residues, producing nitrates, humic and other substances of great importance in crop production. But the numbers of these organisms fluctuate continually; and the bacteria at least change hourly; the nitrates suffer equally rapid changes in amount. Even the mineral part of the soil is not constant in composition. Modern research work shows that many of the properties determining fertility in soils are due to the soil colloids, and some of the most important are attributable to calcium complexes. These are unstable and are affected by the soil water. If the water is free from salts but contains carbon dioxide, the calcium may be replaced by hydrogen, and an acid soil results; if the water contains sodium chloride, the calcium is replaceable by sodium and the resulting complex may readily give rise to an alkali soil. So far as is known, the changes are governed by the ordinary stoichiometric laws, the equilibrium following the usual course expected when a colloid is concerned. But the important fact emerges that any soil not well supplied with calcium contains within itself the possibility of becoming acid and therefore infertile, or alkaline and probably sterile, according to the nature of the soil water soaking through it. The various biological and chemical changes tend to alter the composition of the soil solution. Apparently, however, the colloids have a steadying or "buffering" effect, reducing the degree of acidity caused by the production of acids and absorbing or precipitating various ions that might otherwise cause disturbances.

TABLE I

Soils of similar types as regards mechanical analysis, but varying greatly in fertility by reason of climatic differences

	Rich in finer fractions				Rich in coarser fractions	
	Waste land very difficult of cultivation	Fertile soil, millet & cotton	Poor farm land difficult to cultivate	Good prairie soil, Wheat	Waste land, Norfolk	Market garden, Anglesey
	Lias clay, Oxfordshire	Sudan	Weald clay, Kent	Brandon	22 in. rain	35 in. rain
Coarse sand, 2·0 to 0·2 mm.	0·7	7·6*	1·5	2·5	62·4	93·7
Fine sand, 0·2 to 0·04 mm.	2·0	20·9	11·0	15·4	25·7	2·8
Silt, 0·04 to 0·01 mm.	6·4	12·6 (silt and fine silt together)	19·6	17·7	0·2	0·5
Fine silt, 0·01 to 0·002 mm.	22·0		26·8	16·1	1·8	0·4
Clay (below 0·002 mm.)	41·0	55·9	22·1	29·2	0·6	Nil

* Mainly black nodules of calcium carbonate

A third important generalisation that has emerged is that the relations of the plant and the soil are not rigidly fixed but are capable of considerable variation, being profoundly influenced by a third factor, the climate. A soil moderately fertile in one set of conditions may be relatively unproductive in another. This happens repeatedly with soils containing much clay or much coarse sand. In Table I are given the mechanical analyses of two soils, one of which, the Lias clay from England, is quite unworkable and remains derelict under our conditions of cool temperature and moderate but frequent rainfall, by reason of its high content of clay and fine silt; while the other, which contains even more clay, is capable of carrying good crops of grain and cotton under the hot dry conditions

of the Sudan. The Western prairie soil is of similar physical type to that of the English Weald soil, but while the prairie soil under its climatic conditions of warm dry summer and cold dry winter is, and is likely to remain, a fertile wheat producer, the Weald soil, under the wetter conditions of England, is less fertile. In hot dry conditions the clay is no disadvantage and may even be an advantage, but in wet conditions it becomes a serious drawback; indeed, it might be possible to find some mathematical relationship between rainfall and degree of objectionableness in clay.

It appears then that if a fertile soil were carried from one country to another its productive power would not necessarily be carried with it. Its fertility is, to a considerable extent, dependent on the fact that it fits in with the climatic factors in producing conditions favourable to good growth of desirable crops.

Complexity of the Problem: *Methods of Attack*

The agricultural investigator is thus confronted with three closely interlocking agencies—the plant, the climate, and the soil—each of which is variable within certain limits, and each playing a large part in the crop production which it is his business to study.

Confronted with a problem of this degree of complexity there are two methods of procedure: the empirical method of field observations and experiments, in which there is no pretence of great refinement and no expectation that the same result will ever be obtained twice, it being sufficient if over an average of numerous trials a result is obtained more often than would be expected from the laws of chance; and the scientific method, in which the factors are carefully analysed and their effects studied quantitatively; a synthesis is then attempted, and efforts are made to reconstruct the whole chain of processes and results. The scientific method is, of course, the one to which we are naturally attracted. But common truthfulness compels one to admit that up to the present the greatest advances in the actual production of crops have been effected by the empirical method, and not infrequently by men who are really artists rather than men of science, in that they are guided by some intuitive process which they cannot explain, and that they have the vision of the result before they obtain it, which the scientific man commonly has not.

The best hope for the future lies in the combination of the empirical and the scientific methods. This is steadily being accomplished by the recent strong infusion of science into the art of field experimentation, which has much enhanced the value of the field work and the trustworthiness of its results. Modern methods of replication, such as have been worked out at Rothamsted, and in the United States by Harris of the Carnegie Trust (Cold Spring Harbour), Kiesselbach in Nebraska, Myers and Love of Cornell, and others, constitute a marked improvement in plot technique. And the figures themselves, besides being more accurate, can be made to yield more information than was formerly the case.

Great advances have been made in the methods of analysing the results. The figures are never the same in any two seasons, since the climatic conditions profoundly affect the yields. A few men, like J. H. Gilbert, have the faculty of extracting a great deal of information from a vast table of figures, but in the main even the trained scientific worker can make very little of them. The reason is that he has been brought up to deal with cases where only one factor is varying, while the growth of plants involves the interaction of three variable factors: the plant, the soil, and the climate. It is impossible to apply in the field the ordinary methods of the scientific investigator where single factors alone are studied; very different methods are needed, adapted to the case where several factors vary simultaneously.

Fortunately for agricultural science, statisticians have in recent years worked out methods of this kind, and these are being modified and developed by R. A. Fisher and Miss Mackenzie for application to the Rothamsted field data. It so happens that this material is very suitable for the purpose, since a large number of the field experiments have been repeated every year for seventy or eighty years on the same crop, and on the same piece of land, using the same methods; the field workers also remain the same for many years, the changes being rare and without break in continuity. Although the statistical investigation is only recently begun, mathematical expression has already been given to the relationship between rainfall and yield of wheat and barley under different fertiliser treatments, and precision has been given to some of the ideas that have hitherto been only general impressions. If on an average of years a farmer is liable to a certain distribution of rainfall, it is becoming possible to advise as to fertiliser treatment which enables the plant to make the best of this rainfall.

Unfortunately, few other Experimental Stations possess such complete masses of data as Rothamsted. Methods are now being devised, however, both by Fisher and by the able English investigator who modestly conceals his identity under the pseudonym "Student," for the study of smaller numbers of data, and it is hoped that these or others equally effective will be applied to the results of field experiments accumulated at various Experimental Stations throughout the world. A massed attack by a competent band of statisticians on the whole of the data of the best Experimental Stations, dealing with yields of crops under different conditions of nutrient supply, temperature, rainfall and other factors that go to make up the aggregate called season, would yield information of extraordinary value.

Investigations of this kind, however, are necessarily slow, and they do not themselves afford complete information; their value lies in the fact that they reduce a very complex problem to a set of single-factor problems of the type with which the scientific investigator is already familiar. In the meantime, while this work is proceeding, much is being done by observational methods. At Rothamsted the field plots are under continual observation by a group of three workers, a physiologist, an ecologist, and an agriculturist, who study such factors as rate or habit of

growth, earliness of starting or maturing, degree of resistance to insect or fungus attack; their observations are fully recorded and brought before the chemical, physical and botanical departments at regular and frequent intervals. Certain of the experiments are repeated at other centres on closely similar lines for purposes of comparison. In consequence our old field plots, which have been studied for the past eighty years by Lawes, Gilbert, Warington, and Hall, and might have been supposed to have no further tales to tell, are found to be still yielding results of great interest in agricultural science and practice.

The Results Obtained: Alterations in the Plant

We shall begin with the results obtained by effecting alterations in the plant. Reference has already been made to the changes brought about by the plant breeder, and we need not stop to argue whether the great improvements in crops made in pre-Mendelian days by the Suttons and Findlay in potatoes, by Chevalier in barley, by the Gartons in oats, Vilmorin in sugar beet, and others, should be labelled empirical or scientific. There are certain other changes in plants, however, of a purely temporary nature, which have been induced by changes in conditions. It is a commonplace among farmers that certain soil conditions influence not only the yield but also the quality of crops. The leaf and root are more easily affected than the seed. The case of mangolds has been investigated at Rothamsted; the sugar content of the root, an important factor in determining feeding value, was increased by increasing the supply of potassium to the crop. Middleton at Cockle Park showed that grass increased in feeding value—quite apart from any increase in quantity—when treated with phosphates. Potatoes are considerably influenced by manuring; increasing the supply of potassium influences the composition of the tubers and also that much more impalpable quality—the cook's estimate of the value of the potato; while we have found at Rothamsted that a high-class cook discriminated between potatoes fertilised with sulphate of potash and those fertilised with muriate of potash, giving preference to the former.

Grain is more difficult to alter by changes in environmental conditions; indeed, it appears that the plant tends to produce seed of substantially the same composition whatever its treatment—with the important exception of variation in moisture supply. Mr. Shutt has explored the possibilities of altering the character of the wheat grain by varying the soil conditions, and finds that increases in soil moisture decrease the nitrogen in the grain. Similar results have been obtained in the United States.

On the other hand, in England the reverse seems to hold, at any rate for barley. This crop is being fully investigated at the present time under the Research Scheme of the Institute of Brewing, because of its importance in the preparation of what is still Britain's national beverage. Increased moisture supply increases the percentage of nitrogen in the grain, and so also does increased nitrogen supply, though to a much less extent; on the other hand, both potassic and phosphatic fertilisers may decrease the percentage of nitrogen, though they do not always do so; the laws regulating their action are unknown to us.

The practical importance of these problems of regulating the composition of the plant lies in the fact that the farmer can control his fertiliser supply, and also to some extent his moisture supply, so that it lies within his power to effect some change should he wish to do so.

The following are the nitrogen contents and the valuations of barley grown in the same season from the same lot of seed on farms only a few miles apart:—

Effect of Moisture

	Drier soil	Moist land
Nitrogen per cent. in grain	1·44	1·80
Valuation per quarter of 448 lb.	52s. 5d.	41s. 6d.

Effect of Nutrients

	No nitrogenous manure	Nitrogenous manure
Nitrogen per cent. in grain	1·379	1·464
Valuation per quarter of 448 lb.	53s.	52s.

At present we know but little about the matter, and we are not in a position to advise the farmer as to how he may use these facts to the full advantage. The complete study of the problem necessitates the co-operation of a plant physiologist.

There is another direction also in which alterations in the plant would be of great value if only we knew with certainty how to bring them about.

In agricultural science one sometimes thinks only of the crop and the factors that affect its growth. But in agricultural practice there is often another partner in the concern: a pest or parasite causing disease. The amount of damage done by pests and diseases to agricultural crops is astounding; in Britain it is probably at least 10 per cent. of the total value of the crops, and the loss is probably some £12,000,000 sterling per annum; in some countries it is considerably more. Indeed, the number of insect pests and of harmful fungi and bacteria that skilled entomologists and mycologists have found in our fields might almost lead us to despair of ever raising a single crop, but fortunately the young plant, like the human child, grows up in spite of the vast number of possible deaths. The saving fact seems to be that the pest does harm only when three sets of conditions happen to occur together: the pest must be present in the attacking state; the plant must be in a sufficiently receptive state; and the conditions must be favourable to the development of the pest. It is because this favourable conjunction of conditions comes but rarely that crops manage to survive. And this gives us the key to control if only we knew how to use it. Complete control of any of these three conditions would end all plant diseases. Unfortunately, control is never complete even in glasshouse culture, still less out of doors. But even partial control would be very helpful. All these pests go through life cycles, which are being studied in great detail all over the world,

and especially in the United States. Somewhere there occurs a stage which is weaker or more easily controlled than others, and the pest would become harmless if the chain could be broken here or if the cycle could be sufficiently retarded to give the plant a chance of passing the susceptible stage before it is attacked.

The plants themselves, as we have just seen, are in some degree under control, and if they could be pushed through the susceptible stages before the pest was ready they would escape attack. Barley in England is sometimes considerably injured by the gout fly (*Chlorops tæniopus*). The larvæ emerge in spring from the eggs laid on the leaves and invariably crawl downwards, entering the young ear if, as usually happens, it still remains ensheathed in leaves. J. G. H. Frew, at Rothamsted, has shown that early sowing and suitable manuring cause the ear to grow quickly above the track of the larvæ, and thus to escape injury. E. A. Andrews, in India, has found that tea bushes well supplied with potassic fertiliser escape attack from the mosquito bug (*Helopeltis*) for the rest of the season, apparently because bushes so treated become unsuitable as food to the pest. And further, the conditions are alterable. H. H. King, in the Sudan, has effected some degree of control of the cotton thrips (*Heliothrips indicus*) by giving the plant protection against the drying North wind and so maintaining a rather more humid atmosphere—a condition in which the plant flourishes more than the pest. Tomatoes in England suffered greatly from *Verticillium* wilt till it was found that a small alteration of temperature threw the attack out of joint. They are also much affected by stripe disease (*B. lathyri*), but they become more resistant when the supply of potash is increased relative to the nitrogen. It has recently been maintained, though the proof is not yet sufficient, that an altered method of cultivating wheat in England will afford a good protection against bunt. These cultural methods of dealing with plant diseases and pests offer great possibilities, and a close study jointly by plant physiologists and pathologists of the responses of the plant to its surroundings, and the relationships between the physiological conditions of the plant and the attack of its various parasites, would undoubtedly yield results of great value for the control of plant diseases. Again, however, the plant breeder can save a world of trouble by producing a variety resistant to the disease; or there may fortunately be found an immune plant from which stocks can be had, as in the case of the potatoes found by Mr. Gough to be immune to the terrible wart disease.

Control of Environmental Factors

It thus appears that, if only plant breeders and plant physiologists could learn to alter existing plants or to build up new plants in such a way that they should be well adapted to existing soil and climate conditions, and not adapted to receive disease organisms at the time the organisms are ready to come—if only they could do this all agricultural land would become fertile and plant diseases and pests would become ineffective: at any rate until the pests adapted themselves to the new plants. Although no one can set limits to the possibilities of plant breeding and plant physiology, we cannot assume that we are anywhere near this desirable achievement or that we are likely to be in our time. There will always remain the necessity for altering the environmental conditions to bring them closer to the optimum conditions for the growth of the plant. No attempt is yet made in the field to control two of the most important of the factors: the light and the temperature, though it is being tried experimentally. There is a great field for future workers here; at present plants utilise only a fraction of the radiant energy they receive. At Rothamsted attempts have been made by F. G. Gregory to measure this fraction; the difficulties are considerable, but the evidence shows that our most efficient plants lag far behind our worst motor-cars when regarded as energy transformers for human purposes. One hundred years ago the efficiency of an engine as transformer of energy was about 2 per cent.; now, as a result of scientific developments, it is more than 30 per cent. To-day the efficiency of the best field crops in England as transformers of the sun's energy is about 1 per cent.*; can we hope for a similar development in the next hundred years? If such an increase could be obtained an ordinary crop of wheat would be about 400 bushels per acre, and farmers would feel sorry for themselves if they obtained only 200 bushels. But we are only at the beginning of the subject. Increases in plant growth amounting to some 20 or 25 per cent. have been obtained by V. H. Blackman in England under the influence of the high-tension electric discharge, which presumably acts by increasing in some way the efficiency of the plant as an energy transformer. Possibly other ways could be found. It needs only a small change in efficiency to produce a large increase in yield. Much could be learned from a study of the mass of data which could be accumulated if agricultural investigators would express their results in energy units as well as in crop yields as at present.

Interesting results may be expected from the attempts now being made in glasshouse culture both in Germany and at Cheshunt to increase the rate of plant growth by increasing the concentration of the carbon dioxide in the atmosphere.

Control of the Soil Factors

The soil factors lend themselves more readily to control and much has been already achieved. Water supply was one of the first to be dealt with. Civilisation arose in the dry regions of the earth, and as far back as 5,000 years ago irrigation was so advanced as a practical method that it came into the ordinances drawn up by the great Babylonian king Hammurabi. The chief problems at the present time are to discover effective means of economising water and to ascertain, and if possible control, the relationships between the soil, the

* The remaining energy being largely used up in transpiration. This figure refers to the total radiation received by the leaf, and not to the fraction received by the chloroplast surface. For this latter the value is much higher.

water, and the dissolved substances in the water. Economical use of water is necessary because it allows larger areas to be irrigated, and because water beyond a certain amount injures the soil and asphyxiates the plant roots. This part of the problem is largely one of engineering and police control. The more serious problem, perhaps the most serious confronting agricultural science to-day, is that presented by the soluble matter in the water and the soil. The terrible spectre of alkali looms ahead of every irrigation project; it may be kept under control for a longer or shorter time or it may completely wreck the scheme. Instances could be multiplied of schemes started with great expectations of results yet yielding only disappointment and loss. A volume could be filled with the tragedies of the alkali problem. Neutral salts, particularly sodium sulphate, are not harmful to plants unless their concentration exceeds a certain critical value; indeed, some of the heavy soils in dry countries, as in Egypt and the Sudan, become unworkable if washed with pure water; they remain flocculated only because some soluble salts are present. Chlorides beyond a critical concentration are more harmful to the plant, but sodium carbonate is deadly, and there is no certain way at present of overcoming its effects.

The empirical method has apparently gone as far as it can, and nothing more can be expected until some fresh opening is discovered by scientific workers.

Almost equally important is the more efficient utilisation of water in districts where the rainfall is sufficiently high to obviate the need for irrigation, but insufficient to allow of any wastage of water. The practical work of the Utah agriculturists as exemplified by Widstoe, and the laboratory results of Keen at Rothamsted, all indicate that something can be done. It is legitimate to hope that the next great advance will come from Canada, where in the West there are admirable opportunities for studying the problem.

Inseparably bound up with water supply are the questions of cultivation and of drainage, which affect not only the water but the air supply to the roots. This former subject is now attracting considerable attention: the great need is to discover means for expressing cultivation in exact physical and engineering units. The measurements of Keen and Haines at Rothamsted, and the chemical work of A. F. Joseph, N. Comber and others on clay, and of Odén, Page, and others on humus, indicate the possibility of finding exact expressions and of effecting co-operation with the workers in the new fields of agricultural engineering.

Another soil factor which readily lends itself to some degree of control is the amount of plant nutrients present. The possibility of increasing this by means of manure has been so frequently explored in field trials that it has sometimes been regarded as almost a completed story; indeed, Rothamsted tradition affirms that Lawes himself once gave orders to have the Broadbalk field experiments discontinued because they had nothing further to tell; it was only the earnest persuasion of Gilbert that caused him to countermand the order. So far from the subject being exhausted, it still bristles with problems. The new nitrogenous fertilisers, resulting from war-time activities in nitrogen fixation; the need for reducing the cost of superphosphate; the change in character of basic slag; and the Alsatian development in potash production are producing changes in the fertiliser industry the full effects of which are not easy to foresee. Economic pressure is driving the farmer to derive the maximum benefit from his expenditure on fertilisers, lime, farmyard manure and other ameliorating agents, and is compelling a more careful study of possibilities hitherto disregarded, such as the use of magnesium salts, silicates, and sulphur as fertilisers, and, above all, a much more precise diagnosis of soil deficiencies than was thought necessary in pre-war days.

But there are more fundamental problems awaiting solution. It is by no means certain that we know even yet all the plant nutrients. The list compiled by Sachs many years ago includes all needed in relatively large amounts, but Gabriel Bertrand has shown that it is not complete and that certain substances—he studied especially manganese— are essential, although only in very small amounts. Miss Katherine Warington, working with Dr. Brenchley at Rothamsted, has shown that leguminous plants fail to develop in the so-called complete culture solution unless a trace of boric acid is added. Mazé has indicated other elements needed in small amounts.

Another problem needing elucidation is the relationship between the quantity of nutrients supplied and the amount of dry matter produced. Is dry matter production simply proportional to nutrient supply, as Liebig argued, with the tailing off beyond a certain point, as demonstrated by Lawes and Gilbert, or is it always less than this, as indicated by Mitscherlich's logarithmic curve, or is the relationship expressed by one of the more complex sigmoid curves as there is some reason to suppose? We do not know; and the problem is by no means simple, yet it governs the "diminishing returns" about which farmers now hear so much. Again, very little is known of the relationship between nutrition and period of growth. One and the same quantity of a nitrogenous fertiliser, for example, may have very different effects on the plant according as it is given early or late in life; not only is there a difference in quantity of growth, but also in the character of the growth. Late dressings cause the characteristic dark-green colour to appear late in the season, and thus affect the liability to fungoid diseases; they increase the percentage of nitrogen in the grain and they may give larger increases of crop than early dressings.

Investigations are needed to find the best methods of increasing the supply of organic matter in the soil and its value for the different crops in the rotation.

All these problems will sooner or later find some solution. But there remains a greater problem of more importance than any of them: the linking-up of plant nutrition studies with those of the soil solution. As our cousins in the United States were the first to emphasise, the fundamental agent

in the nutrition of the plant is the soil solution, and they have made a remarkable series of investigations into what appeared at one time a hopeless proposition—the physico-chemical interactions between the soil and the soil water. Whitney and Cameron began the work, and it has gone on with much controversy—as important scientific investigations always do—and it is now being attacked with much vigour by some of the younger scientific workers, particularly in the Californian school; Burd, Hoagland, Kelley, Lipman, Stewart, Sharp, and others. There is also some valuable work by Gola and other Italians. The natural soil solution is not always the best for the growth of plants. It is reasonable to suppose that the most efficient method of using fertiliers would be for making up the soil solution to the optimum composition and concentration for each stage of the growth of the crop. Unfortunately, this cannot yet be done. The added fertiliser does not simply increase the concentration of the soil solution to the precise extent that might be expected; there are interactions, absorptions, and base exchanges of the kind studied first by Way, much later by van Bemmelen and by Gedroiz, and more recently by Hissink and by Wiegner. Further, the plant relationships are not constant; there is apparently—though this is not certain—more response to certain nutrients at one time of its life than at another. A great advance in crop production may be expected when the soil chemists have discovered the laws governing the soil solution, when the plant physiologists can give definite expression to the plant's response to nutrients, and when someone is able to put these results together and show how to alter the soil solution so that it may produce the maximum effect on the plant at the particular time. The new soil chemistry will yet have its triumphs.

The Soil Micro-organisms: Can they be Controlled?

It is now more than forty years since the discovery of the great importance of micro-organisms in determining soil fertility. Practical applications necessarily lag far behind; but already three have been made each of which opens out great possibilities for the future. The long-standing problem of inoculation of leguminous crops with their appropriate organisms has already been solved in one or two of its simple cases, chiefly lucerne on new land, and the new process has helped in the remarkable extension of the lucerne crop in the United States and in Denmark. We believe at Rothamsted that the more difficult English problem is now solved also. Interesting possibilities are opened up by the observation that a preliminary crop of Bokhara clover seems to facilitate the growth of the lucerne.

The organisms effecting decomposition are now coming under control, and are being made to convert straw into farmyard manure (or a material very much like it) without the use of a single farm animal. The process was worked out at Rothamsted, and is being developed by the Adco Syndicate, who are now operating it on a large scale and are already successfully converting some thousands of tons of straw annually into good manure.

The third direction in which control of the soil organisms is being attempted is by partial sterilisation. This process is much used in the glasshouse industry in England, and it has led to considerable increases in crop yields. The older method was to use heat as the partial sterilising agent, and this still remains the most effective, but owing to its costliness efforts have been made to replace it by chemicals. Considerable success has been attained; we have now found a number of substances which seem promising. Some of these are by-products of coal industries; others, such as chlor- and nitro-derivatives of benzene or cresol, are producible as crude intermediates in the dye industry.

The Need for Fuller Co-operation

Looking back over the list of problems it will be seen that they are all too complex to be completely solved by any single worker. Problems of crop production need the co-operation of agriculturists, plant physiologists, soil investigators, and statisticians. Even plant breeding necessitates the help of a physiologist who can specify just what the breeder should aim at producing. And this gives the key-note to the period of agricultural science on which we have now entered—it is becoming more and more a period of co-operation between men viewing the problem from different points of view. Good individual work will, of course, always continue to be done, but the future will undoubtedly see a great expansion of team work such as has already led to important results in medical research, and such as we know from our experience at Rothamsted is capable of giving admirable results in agricultural science.

The team work should not be confined to individuals working at the same institution. The world would gain greatly if co-operation such as now exists between the Imperial College Botany School and Rothamsted could be effected between other great institutions devoted to agricultural science in the various countries of the world. To take only one illustration: how much could be accomplished in the study of the very difficult alkali problem if it were possible to organise a team representing such great agricultural stations as, for instance, California and Utah, the Departments of Agriculture of India and other of the great Dominions affected, Rothamsted, Hissink's school, with power to lay down experiments anywhere and money to carry them out. And if extended co-operation of this kind should prove impossible of attainment, much could be done by fostering co-operation between the Agricultural Institutions of the Empire. There are certain great problems which are common to large parts of the Empire where the experience of one part would be of great value to the rest. The institutions in Britain, for example, have experience of problems connected with land long since settled and brought into cultivation, where men must produce 40 or more bushels per acre of wheat and 6 to 10 tons per acre of potatoes to make these crops pay, and where animal husbandry must be run on sound and economic lines. Canada has an unrivalled experience with wheat, and

in the Western provinces has a magnificent chance for studying one of the most important problems of the day—the water supply to the crop. Australia, New Zealand, South Africa, East, West, and Tropical Africa, India, the West Indies—to mention only a few in the great family that forms the British Empire—all have their special lines in agricultural development; each has some achievement that can be shown with pride and in the certainty that its study will benefit others. The Empire has already its Conference of Premiers, why should it not have its conference for agricultural science and practice?

With fuller co-operation both of men and of institutions we could do much to overcome the present difficulty in regard to utilising the information we already possess. In the last thirty years an immense stock of knowledge has been obtained as to soils and crops—knowledge that ought to be of supreme value in interpreting the facts of Nature as shown in the field. It is stored in great numbers of volumes which line the shelves of our libraries, and there much of it rests undisturbed in dignified oblivion. In the main it consists of single threads followed out more or less carefully; only rarely does some more gifted worker show something of the great pattern which the threads compose. But even the most gifted can see but little of the design; the best hope of seeing more is to induce people to work in groups of two or three, each trained in a different school and therefore looking at the problem from a different point; each seeing something hidden from the rest. Unlike art, science lends itself to this kind of team work; art is purely an individual interpretation of Nature while science aims at a faithful description of Nature, all humanistic interpretation being eliminated. There is certainly sufficient good will among the leaders of agricultural science to justify the hope of co-operation; there are probably in existence foundations which would furnish the financial aid.

And that leads to my last point. What is the purpose of it all? Team work, co-operation, the great expenditure of time and money now being incurred in agricultural science and experiment—these are justified only if the end is worthy of the effort. The nineteenth century took the view that agricultural science was justified only in so far as it was useful. That view we now believe to be too narrow. The practical purpose is of course essential; the station must help the farmer in his daily difficulties—which again necessitates co-operation, this time between the practical grower and the scientific worker. But history has shown that institutions and investigators that tie themselves down to purely practical problems do not get very far; all experience proves that the safest way of making advances, even for purely practical purposes, is to leave the investigator unfettered. Our declared aim at Rothamsted is "to discover the principles underlying the great facts of agriculture, and to put the knowledge thus gained into a form in which it can be used by teachers, experts, and farmers for the upraising of country life and the improvement of the standard of farming."

This wider purpose gives the investigator full latitude, and it justifies an investigation whether the results will be immediately useful or not—so long as they are trustworthy. For the upraising of country life necessitates a higher standard of education for the countryman; and education based on the wonderful book of Nature which lies open for all to read if they but could. How many farmers know anything about the remarkable structure of the soil they till, of its fascinating history, of the teeming population of living organisms that dwell in its dark recesses; of the wonderful wheel of life in which the plant takes up simple substances and in some mysterious way fashions them into foods for men and animals and packs them with energy drawn out of the sunlight—energy which enables us to move and work, to drive engines, motor-cars, and all the other complex agencies of modern civilisation? No one knows much of these things; but if we knew more, and could tell it as it deserves to be told, we should have a story that would make the wildest romance of human imagination seem dull by comparison, and would dispel for ever the illusion that the country is a dull place to live in. Agricultural science must be judged not only by its material achievements, but also by its success in revealing to the countryman something of the wonder and the mystery of the great open spaces in which he dwells.

THE TORONTO MEETING OF THE BRITISH ASSOCIATION

August 6—13, 1924

By unanimous consent the British Association's meeting has been this year a brilliant and stimulating function. No one who has been fortunate enough to attend the Conference can doubt its vitality or the importance of its task in educating the public as to the real meaning and value of science. The Canadian public, moreover, was only too ready to appreciate the benefits which have accrued to humanity, and to Canada in particular, from the disinterested labours of many generations of scientists. The twentieth century could not have been "Canada's century," without the numerous discoveries which have enabled its vast resources of water power and mineral wealth to be profitably utilised. Hence the very hearty welcome which British Scientists have received throughout their journey.

This is the fourth time the British Association has met in Canada, the last occasion having been in Winnipeg in 1909.

Over 500 members crossed the Atlantic, the Cunard liner *Caronia* alone carrying a party of about 250—and, together with the Canadian and American contingent, the number of those attending the Conference exceeded two thousand. It is greatly to the credit of the Local Organising Committee, under the chairmanship of Prof. J. C. McLennan, O.B.E., F.R.S., that all arrangements in connexion with the location of such an enormous number of visitors have proceeded smoothly. Many of the overseas visitors were privately entertained, whilst others were housed at residential colleges.

The extensive grounds and buildings of the University of Toronto which, according to the cautious *Baedeker*, are "perhaps the finest *ensemble* of college architecture in the Western hemisphere," formed a delightful centre for the activities of the Association. At this remarkable gathering not only England and Canada, but many other parts of the British Empire, including India and South Africa, were represented. There was, in addition, what amounted to an invasion of U.S. scientists; in the chemical and physiological sections one noticed Prof. E. W. Washburn, Prof. J. H. Bancroft (Cornell Univ.), Profs. Kendell, Shearman and Eddy (Columbia Univ.), Dr. van Slyke (Rockefeller Inst.), Prof. Underhill (Yale Univ.), Prof. Bloor (Rochester Univ.), Dr. Voegtlin, Dr. Clowes, and many other eminent chemists and bio-chemists.

The cosmopolitan appearance of the meeting was further emphasized by the presence of a large number of foreign mathematicians, delegates to the International Mathematical Congress, which held its annual session about the same time (August 11 to 16) in Toronto.

The papers presented to the different sections of the Association were, as usual, numerous and varied. Those of special interest to our readers were reported elsewhere.

Sir Robert Robertson's presidential address to Section B—illustrated with slides of eminent British scientists who had been in the service of the Government—was a masterly exposition of the importance of chemistry to the modern State, and attracted a large audience. The papers and discussion on the Canadian electro-chemical industries were suggestive.

An important point brought out was that, unlike the home country, Canada possesses an excess of harnessed power which frequently runs to waste; consequently, in certain circumstances it has even been found commercially advisable to produce steam by means of electrical energy. The speculative point was raised as to whether at some future date it may not be possible to store the excess of available power as chemical energy—*e.g.*, by the electrolysis of salt, or water, and the subsequent utilisation of the resulting elements as sources of heat.

Of equally great interest were the joint discussions —with Section C (Geology) on powdered fuels, with Section A (Physics) on Crystal Structure and Colloids, and with Section I (Physiology) on Vitamines. If one may venture a criticism, it is this—had the papers been printed and circulated in advance, more time could have been made available for these discussions which, after all, are among the most important features of a meeting of this type.

Owing to the absence of Dr. G. S. Hume the paper on liquid fuels was not read, but an important discussion took place on the use of pulverised coal in metallurgical plants and as locomotive fuel.

The X-ray analysis of crystals was dealt with by Sir Wm. Bragg in a characteristically lucid manner. Colloids and theories appertaining thereto formed the subject of an animated debate, Profs. McBain and Donnan expressing divergent views concerning the existence and function of the much-disputed Helmholtz double-layer.

The "Citizens' lectures" were an unqualified success. The immense Convocation Hall of the University was filled to overflowing, even on the occasion of a lecture on such an abstruse subject as "Einstein's theory of Relativity," by Prof. Eddington.

Of hardly less value than the theoretical discussions were the numerous excursions and visits to works and laboratories. Members of the Chemical Section had the opportunity of visiting paper and pulp factories at Ottawa, the plant of the International Nickel Co. at Port Colborne, the Research Laboratories of the Hydro-Electric Commission, and many other important manufacturing establishments. Those whose time permitted them to undertake the Western Excursion across the Continent were able to make an even more intimate acquaintance with the many important branches of the Canadian chemical and mining industries, including the famous mining areas of Cobalt, Porcupine and Sudbury.

Naturally, there was no lack of social amenities to lighten the austerity of scientific labours. The Canadian people have fully justified their fame for hospitality. In every city through which the overseas members passed they were lavishly entertained. Garden parties and receptions were plentiful and, in spite of the enforced "dryness," the spirit of joviality throve on lemonade and ice-cream. On one occasion youthful white-bearded professors were seen dancing the polka and mazurka to the rhythm of a syncopated tune.

An excursion to Niagara Falls terminated the local programme of this most successful meeting, and two train-loads of scientists have moved westwards across Canada on a tour which will last about three weeks, and will include visits to Winnipeg, Saskatoon, Edmonton, Vancouver, Victoria and many other points of interest.

NICKEL PRODUCTION IN CANADA

The revised statistics of nickel in Canada for the year 1923 show that there has been a marked revival in production. The output last year was 62,057,835 lb., contained in cupronickel matte, as compared with 17,355,056 in the previous year, whilst the nickel contents resulting from the treatment of silver-cobalt ores increased in 1923 to 396,007 lb. from 242,067 lb. in 1922. The total computed value of the nickel production was $18,332,077, based on a value of 29·35 cents. a pound. The total amount of ore mined by the three companies Mond, British America and International, was 1,187,355 tons. The output of nickel for the three months of this year shows an increase of 74 per cent., compared with the corresponding period of the past calendar year. The precious metals recovered during the first quarter of 1924, by the nickel refineries, were as follows:—gold $4988, silver $10,266, platinum $50,901 (495 oz.), palladium $42,586 (638 oz.), rhodium $20,476 (276 oz.), ruthenium $12,820 (105 oz.).

FORTHCOMING EVENTS

Sept. 8 to 11. INSTITUTE OF METALS. Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at Wembley.

The following papers will be read:—"A Method for Measuring Internal Stress in Brass Tubes," by R. J. Anderson and E. G. Fahlman; "The Application of the Ideal Solubility Curve to the Interpretation of Equilibrium Diagrams in Metal Systems," by D. H. Andrews and Prof. J. Johnston; "Seventh Report of the Corrosion Research Committee of the Institute of Metals," by G. D. Bengough and R. May; "Comparative Results on Copper-Silicon-Aluminium and Other Aluminium Alloys as Obtained on Separately Cast Specimens and Specimens cut from a Crankcase Casting," by E. H. Dix and A. J. Lyon; "The Determination of Sodium in Aluminium," by D. M. Fairlie and G. B. Brook; "The Extrusion of Brass Rod by the Inverted Process," by R. Genders; "Investigation of the Effects of Impurities on Copper. Part II—The Effect of Iron on Copper," by D. Hanson and Grace W. Ford; "The Relationship Between Tensile Strength, Temperature and Cold-Work in Some Pure Metals and Single Solid Solutions," by D. H. Ingall; "On the Effect of Progressive Cold-Rolling on the Brinell Hardness of Copper," by H. Moore; "Experiments on the Working of Nickel for Coinage," by Sir T. K. Rose and J. H. Watson; "Some Experiments on the Effect of Casting Temperature and Heat-Treatment on the Physical Properties of a High-Tin Bronze," by F. W. Rowe; "Some Experiments on the Influence of Casting Temperature and Mass on the Physical Properties of Admiralty Gun-Metal," by F. W. Rowe; "Studies in the Aluminium-Zinc System," by T. Tanabe; "Metal Spraying and Sprayed Metal," by T. H. Turner and W. E. Ballard.

Sept. 15. BRITISH EMPIRE EXHIBITION. Conferences of Engineering Societies, to be held in Conference Hall No. 4, at 10.30 a.m. Short papers on various Engineering Subjects will be read and discussed.

Sept. 18 and 19. THE CERAMIC SOCIETY, Refractory Materials Section Meeting, in Conference Hall No. 4, British Empire Exhibition, Wembley.

The following papers will be read:—"A Comparison of Gas and Coke Fired Drying Stoves, together with a Description of the Construction and Operation of the Hüttenes Coke-Fired Air-Blown Furnace," by T. W. Barley; "Some Properties of Clay Silimanite Mixtures," by J. W. Cobb and H. S. Houldsworth; "The Influence of Exposure on the Chemical and Physical Properties of Certain Fireclays," by W. Hugill and W. J. Rees; "On the Action of Heat on Kaolinite and Kolinitic Clays" (Communicated Paper), by W. Vernadsky; "Alumina-Silica Minerals in Firebricks," by W. J. Rees; "The Action of Heat on Kaolinite and other Clays," Part II, by J. W. Mellor and A. Scott; "The Origin of the Austrian Magnesite Deposits," by A. Scott; "X-ray Investigation of Clays and other Ceramic Substances. Researches into the Application and Practical Value of the Method," by A. Hadding; "Note on the Storage of Silica Refractories," by W. J. Rees; "The True Specific Gravity and After Expansion of Lime-bonded Silica Bricks," by W. J. Rees; "A Rapid Method for the Determination of True (or Powder) Specific Gravity," by W. Hugill and W. J. Rees.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

A circular letter with further particulars and a form of application for tickets is being issued to members.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

MANCHESTER SECTION, Session 1924–25

The meetings are held at 7 p.m. on the first Friday of the month, unless otherwise stated, and a programme of the arrangements is being prepared for early issue to the members of the Section.

The Chairman, Dr. H. Levinstein, will preside over the meetings, which commence on October 3, when the President, Mr. W. J. U. Woolcock, C.B.E., will deliver an address entitled "Science and Industry." On November 7 the Joint Meeting with the Local Sections of the Institute of Chemistry, and the Society of Dyers and Colourists, and the Manchester Literary and Philosophical Society will be held. On December 5 Mr. Slater will read an interesting paper on "Peptisation." The valuable series of papers which have appeared on fuel problems will receive an addition on January 9 (second Friday), when Messrs. F. S. Sinnatt and N. Simpkin will contribute a paper entitled "The Melting Point of Coal Ash, Part II." The papers for the February meeting will be detailed later, and Dr. T. Callan and Mr. Naunton have kindly promised communications on the estimation of alpha- and beta-naphthol and rubber accelerators respectively.

The Joint Meeting with the Liverpool Section will take place in Manchester on March 6, when it is hoped to arrange a luncheon and a visit to a works. The evening will be occupied by a paper on "Chemical Constitution and Properties of Azo Dyestuffs" by Dr. A. Schedler.

The Section has received, and has accepted, a cordial invitation from the Institution of the Rubber Industry to participate in a joint meeting to be held in Manchester at a date to be decided later. The suggestion has been made that papers on "Chemists and the Improvement in Pneumatic Tyres" might be read at this meeting.

Dr. Lander, Director of Fuel Research, Department of Scientific and Industrial Research, has accepted an invitation to deliver an address on "Smokeless Fuel and Oil" at the annual meeting of the Section on April 3. The above information is subject to alteration if the necessity arises.

CORRESPONDENCE

A POINT OF ORDER

Sir,—Your issue of August 8 contains some remarks by Professor Lowry (p. 811) on polarity and vinyl ethyl ether. The signs he uses represent the supposed charges on the atoms in his activated form of that compound. The signs used in my letter in your issue of July 25 were intended as generalisations of the final results of chemical changes which take place when the compound reacts with electrolytes, or potential electrolytes. Numerous criticisms nominally directed against the principle of induced alternate polarities and various misapplications of the principle have their origin in a similar confusion of these two aspects of the question.

Professor Lowry now virtually admits that his theory of the activation of the double bond by an oxygen atom is helpless in such a case as that of vinyl ethyl ether, and he evidently suspects that "oxonium chemistry" might supply the key to the mechanism of the activation of the molecule. The correct application of oxonium chemistry to such cases has in my opinion already been given; it was foreshadowed by Claus, Werner and Flürscheim (compare especially Flürscheim, *Ber.*, 1914, **47**, 590), but extended and brought to perfection by Robinson (in particular *J.C.S.*, 1917, **111**, 964). Robinson's expressions representing the theory of the activation of a double bonded system, by a singly bound oxygen atom rising in co-valency, are so complete and so general that any electronic expressions likely to be accepted in the future as capable of covering similar ground will almost certainly prove to be special cases of his generalised forms.

Thus if we adopt the view that a bond corresponds with an electron pair, vinyl ethyl ether (I) can yield the activated oxonium forms which in the limit take the form (Ib), corresponding with Robinson's figure for activated anisole (*loc. cit.*). This also corresponds with Fig. 1 (b) in a much later paper of mine (*J.C.S.*, 1922, **121**, 419) in which an attempt was made to find a general theoretical basis for the facts of which the principle of induced alternate polarities is a summary. Activated forms due to decrease in the covalency of the oxygen atom and corresponding with I (a) (*loc. cit.*), could only arise in opposition to the tendency of even distributions of valency (to which tendency I believe Professor Morgan was the first to direct special attention) and, in the limit, would lead to scission of the molecule as shown below on the left:—

$$\underset{\text{I (a)}}{\overset{\times}{CH_2{=}CH} + {-}O{-}Et} \longleftrightarrow \underset{\text{(I)}}{CH_2{=}CH{-}O{-}Et} \longleftrightarrow \underset{\text{I (b)}}{CH_2{-}CH{=}O{-}Et}$$

(× is here used to denote a defect of two electrons.)

If the electrical states of the atoms in the oxonium form, I (b), are considered, it will be noticed (assuming Prof. Lowry's criteria for such are correct, and I have no desire to join issue with him on this point) that the carbon atom of the CH_2 group must be negatively charged, that of the CH group electrically neutral, and that the oxygen atom must be positively charged as in ordinary oxonium salts. It will be observed that Robinson's formulæ for the activated oxonium forms of *m*-cresol (*loc. cit.*) actually display the oxygen atom as having a positive free affinity.

It is evident that, while the signs in the expression, $\bar{C}H_2{=}\overset{+}{C}H{-}\bar{\overset{+}{O}}{-}Et$, represent satisfactorily such facts as they were originally intended to represent, they are not all identical with the electrical charges in the activated molecules. Identities occur at certain points, however, and by paying attention to these the theoretical significance of the alternate polarity signs may be more readily grasped.

As Prof. Lowry's signs always refer to supposed electrical charges, there is just as wide a distinction in meaning to be drawn between his signs and those which I have since 1920 endeavoured consistently to use (though perhaps not always with complete success), as there is between the expressions "electropositive" and "positively charged."—I am, Sir, etc.,

ARTHUR LAPWORTH

The University of Manchester,
August 29, 1924

METHANOL

Sir,—I have noted with great interest the communication from the Federation of Swedish Chemical Industries under the above heading. In January, 1918, I read a paper before the London Section of the Society of Chemical Industry on the "Toxicity of Methyl Alcohol." Therein I pointed out that the Revenue Authorities are bound under the Spirits Act (which badly needs amending) to classify pure methyl alcohol as "plain" or "potable" spirits with the result that British chemical industry is handicapped by the usual Revenue control and restrictive conditions.

I suggested that methyl alcohol should be known by its scientific name of "Methanol" and that it be labelled "Poison." Let me quote one paragraph from the paper referred to (*J.S.C.I.*, 1918, **36**, 26 T—32 T):—

"We may revert now to my claim earlier in this paper that methyl alcohol is highly toxic and for that reason the Revenue Authorities should have no fear that it can be consumed as 'potable spirit.' Then why tax it as 'plain spirits'? Why penalise British chemical industry by taxation of a 'key' chemical? One may suppose that if methyl alcohol had been called by some other less alcoholic name it would never have been classified as 'spirits' at all."

Other countries do not find it necessary to regard methyl alcohol as "potential whiskey," and the only reason why the British Revenue Authorities do so is because we are labouring under an obsolete Act of Parliament.

There is only one method of dealing with this problem. Let all concerned in the welfare of the British chemical industry unite to promote an *Amending Bill to the Spirits Act.* The time is opportune. The President of the Society knows full well that much time has been devoted to the question of

he restrictions of the use of ethyl and methyl alcohol y committees appointed by the Council of the Association of British Chemical Manufacturers. Furthermore, the conditions regarding the manu-acture of methyl alcohol must be reviewed at an arly date. The successful inauguration of the manufacture of synthetic methyl alcohol in Germany and other countries opens up new possibilities for establishing the manufacture in this country.

Hitherto we have been dependent for our methyl alcohol on those countries with well developed wood-distillation industries. Our own wood distillers have found a ready outlet for their crude methyl alcohol as wood naphtha, and they have not found it necessary o manufacture pure methyl alcohol.

The manufacture of methyl alcohol by synthetic methods in this country is bound to be discouraged, f not actually prohibited, by our obsolete Spirit Laws.

Surely it is not too much to hope that the Society of Chemical Industry will take immediate steps to co-operate with the Association of British Chemical Manufacturers in promoting a Bill to regularise the position of methyl alcohol in respect of the law as to "spirits."

Meanwhile, I may add in conclusion and as some small practical contribution to the subject that my irm is now using the description "Methanol" for methyl alcohol, and all labels and containers for same bear the word "Poison."—I am, Sir, etc.,

THOMAS D. MORSON

Thomas Morson and Son, Ltd.,
Ponders End
August 30, 1924

PERSONAL AND OTHER ITEMS

The death of Sir William Bayliss deprives science of a great physiologist and an investigator with a wide philosophic outlook. Born in 1866, Bayliss was educated at University College, London, and Wadham College, Oxford. He carried out much important work with Prof. E. H. Starling on subjects such as the regulation of the heart and the action of hormones. In 1914 he published his work on "The Principles of General Physiology," a most remarkable treatise, and in 1919 he received the Copley Medal of the Royal Society. In 1923 he became editor of "Physiological Abstracts," although he was already occupied with much valuable public work.

Low-temperature Carbonisation of Coal in France

At the Fourth Congress of Industrial Chemistry, M. Ste. Claire Deville discussed the work carried out by the coking plant at Heinitz, with the object of improving the coke obtained by carbonising the so-called "fat" coals of the Saar. The work led to the specification of a semi-coke used in the proportion of roughly one-eighth in preparing the mixture for improved coke, and to the construction of a fixed oven with turning paddles by the Société de Fours à Coke. In addition a plant for primary tars under reduced pressure (one-fifth atmospheric) and able to treat five tons at a time was also devised. Numerous coke-ovens were tested, including a small rotary furnace resembling the large ovens of the same type used in the Ruhr. In this model the semi-coke is discharged at each half rotation by a hinged door which opens under its own weight, allowing the coke to fall. Despite the results obtained with this oven, at present trials are being carried out mostly with the Salerni plant, which includes two parts each composed of semi-cylindrical elements with corrugated bottoms placed in parallel and having a common cover. The movement communicated to the mass by turning shafts (one for each element) does not take place along the axis of the cylinder but in a plane parallel to it, the result being to drive the particles of coal from element to element and finally to the discharge. The mixing seems much more complete than in rotary ovens, and the surfaces in contact with the hot walls are continually being renewed. With crushed Velsen coal 100 parts of dry coal yielded 13 parts of anhydrous tar and the semi-coke showed a content of 11 to 12 per cent. of volatile matters. The mixing during carbonisation thus seems to have a favourable effect somewhat similar to that of injected steam, the minimum temperatures at which distillation commences being reduced, so that less heat is required and the plant lasts longer.

The administration of the Saar Mines is now building near Sarrebruck a small works for experiments on low-temperature carbonisation, including plant for treating tar and liquid fuels. The plant includes two batteries of Salerni elements which can deal with 30 to 40 tons of fuel per 24 hours. A precise scientific programme has been mapped out for this new works.

Artificial Silk

In 1913 the production of artificial silk was estimated at 9000 t., and 1922 at 31,000 to 32,000 t. The 1923 figures are uncertain, estimates ranging from 31,200 t. to 42,000 t.

Natural silk production is confined to those countries where the silk worm can thrive, but artificial silk manufacture is almost independent of consideration of raw materials and thus becomes established where the demand exists. The largest market is found in the United States, which besides producing one-third of the world's total output also imports further supplies. The largest exports of artificial silk are made from Belgium, which produces 10 per cent. of the world's total. France, with about the same production, has to import. From Germany, which produces about 16 per cent. of the world's total, a certain amount is exported.

Although the total production of textiles is now less than before the war it is noteworthy that production of both natural and artificial silk has increased, the former by about 25 per cent., the latter by over 200 per cent. The cause of this is to be found in the extension in the use of silk and artificial silk articles in America, where they are no longer regarded as luxuries; also artificial silk, which even in 1913 cost only one-third as much as natural silk, has in comparison with other textiles, become still cheaper.

REVIEWS

THE PLANT ALKALOIDS. By T. A. HENRY. Second Edition. Pp. viii+456. London: J. and A. Churchill, 1924. Price 28s.

The alkaloids interest a wider field than many groups of chemical compounds. Their occurrence in plants challenges the botanist's attention and their physiological action that of the pharmacologist, whilst the chemist is concerned with their isolation, estimation and structure. Moreover, many of them are employed medicinally and reach the patient by way of the medical man, the pharmacist, and the manufacturing chemist. Even the interest of the general public is occasionally directed to these compounds by cases of poisoning, accidental or otherwise. It is possible, therefore, to write of alkaloids from several points of view and for several classes of readers.

Dr. Henry has written for the chemist, assuming that he desires to know something about the physiological action of these compounds. His book is at the same time an admirable catalogue of the chemical and physical properties of the alkaloids and their salts, and a readable account of the methods employed in determining their constitutions and effecting their syntheses. The sources of alkaloids and the methods of isolating and estimating them are also adequately recorded. The alkaloids of known constitution are arranged in nine groups, according to their nuclear structure, as derivatives of pyrrole, pyridine, tropane, quinoline and so on, whilst those of unknown constitution are collected in a tenth group. Dr. Henry is to be congratulated on his excellent treatise, which will prove valuable more especially as a work of reference, the original papers being cited very fully, but also as a text-book for advanced students.

This second edition appears eleven years after the first, and in the meantime considerable additions have been made to our knowledge of this group of compounds. The structures of cryptopine, harmine, and hyoscine have been determined, cocaine has been synthesised, and new syntheses of tropine devised. A new formula for morphine has been put forward, and novel suggestions as to the methods of phytochemical synthesis of alkaloids. Many new alkaloids have been isolated, and progress has been made in the study of many previously known. The new work has been thoroughly digested and incorporated in the second edition. Expansion of the size of the volume has been avoided by various methods, but mainly by two, namely, by decreasing the unnecessarily sumptuous inter-linear spacing of the pre-war edition, so that each page now bears another half-dozen lines, and by cutting out the methods of assay of galenical preparations, which are of interest only to pharmacists, who can obtain them equally well from other sources. The introduction of a few plates, illustrating drugs, into the new volume seems, however, inconsistent with the latter policy. Another wise method of condensation is the omission of alleged manufacturing processes such as the futile method of isolating the solanaceous alkaloids given in the previous edition (pp. 50, 51). On the other hand, the percentage-content of some of the subsidiary alkaloids in opium, such as papaverine, should not have been left out. The reviewer takes this opportunity of disinterring the statement (Jowett, Pyman and Remfry, *Proc. 8th Internat. Cong. App. Chem.*, 1912, p. 165), quite excusably overlooked by the author, that Dale was unable to confirm the atropine-like action attributed to 1-ethyl-2-methylglyoxaline by Schulz.

FRANK LEE PYMAN

MODERN THEORY AND PRACTICE OF PUMPING. By NORMAN SWINDIN. Pp. 364. London: Ernest Benn, Ltd., 1924. Price 42s.

This book can be strongly recommended to all those who have to deal with pumping problems of any magnitude, and to the reviewer it has been a pleasure to study this excellent unification and expansion of the author's two previous books which were published in the "Chemical Engineering Library" of Messrs. Ernest Benn, Ltd. Not only in the various phenomena attendant on the movement of liquids, but in many other branches of engineering, whether distinguished by the prefix of chemical or not, there has been a wide gap between the work of the theoretical experimentalist or mathematician, and that of the purely practical industrialist. In many cases, however, there are happy indications that this gap is becoming less and, in the particular case of pumping, it is highly satisfactory that the scientific and practical aspects can now be almost completely correlated, and that the empirical formulæ, which alone have been available previously, and have in many ways tended to make confusion worse confounded, may be relegated to the rubbish heap.

Stanton's law, which is so clearly expounded in this book, presents a scientific method of calculating the flow of viscous liquids independent of all empirical factors except that of roughness of surface. What must be known when any particular liquid is under consideration is the kinematical viscosity, *i.e.*, the ratio of absolute viscosity to density, but, if that is known, the necessary calculations are simply and easily effected. The effect of roughness of surface and of pipe fittings slightly modifies the results obtained by the use of the law which assumes continuous straight pipes without any joints. Where it is necessary to make allowance for departure from the ideal conditions and until further experimental work has been carried out, sufficient approximations based on experience can be safely utilised without seriously affecting the results. One must not swallow a camel and strain at a gnat, nor accept a scientific solution of an old difficulty and quibble at a few details which are not at the moment accurately determined.

The chapters dealing with the various types of pumps and ram, the centrifugal, the rotary and the displacement are very satisfactory, and the different form which each takes under varying conditions of service are explained with the aid of well-chosen examples made by various firms in this and other countries. The author has devoted special attention to the air lift, which undoubtedly could be of con-

ıerable practical value in many cases, and it is ıimed that if the same attention were given to its sign as has been given to that of other appliances, efficiency of 80 per cent. should be possible.

There are a few printing errors such as "connecon" for "correction" (p. 30), $P = P_1$ instead of $- P_1$ (p. 95) and so on, but on the whole there is ry little fault to find in this respect. The paper ıd printing are all that could be desired, and the blication reflects great credit on both author and ıblishers. It is a valuable contribution and of prac-ıal value to both the makers and users of pumps.

C. Elliott

ATERPROOFING TEXTILE FABRICS. By H. P. PEARSON. Pp. 112. New York: Chemical Catalog Company, Inc., 1924. Price $3.00.

The book is an attempt to supply an authoritative xt-book on the subject, which is described as a tle-understood art having a meagre literature. ne chapters, occupying, however, only sixty-three ges, deal with basic principles; the value of water ısisting processes; the testing of water resistance; ocesses for cotton goods, clothing fabrics and for e former, and new developments; the rest of the lume is given up to a bibliography of the subject. ıe processes described are said to be published for e first time and the information to be derived from ıstworthy sources in the industry; it is said to be fficiently concise to enable anybody with a knowlge of the finishing of textile fabrics to go into e waterproofing industry. Later, however, it is ıd that there is little profit in that industry because keen competition, and the author states that the lustry will never be remunerative as long as no leration of waterproofers exists. In fact, since left this country he seems to have become obsessed th such commercial considerations. A federation waterproofers would compel the education of the y cleaner, who removes by his solvent the material ıich is put into the fabric to make it water resistant. ɔst articles of clothing are not treated to make em water resisting, but the treatment is coming ore into use, and effort is required to educate the ıblic as to its value. Being principally a descripɔn of processes, the book does not admit of much iticism, and being a small one it is worth the rusal of those engaged in the industry which it ıats and on kindred industries.

S. H. Higgins

Good progress is being made in the development of ·dro-electric power in the Lakes St. John and enogami district, Quebec. The principal source of wer, in this district, is the Grand Discharge on the guenay River, at the outlet of Lake St. John. ıe latter has an area of 400 sq. miles, and drains a ıter shed of about 30,000 sq. miles. The drop from ıke level, within a few miles, is 145 feet. This ıole district has available over 1,650,000 h.p., of ıich only 450,000 h.p. is under development and veloped at the present time.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.: Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d.
Nickel Sulphate	£38 per ton d/d. Normal business.
Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1 cwt kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.

Antimony sulphide—
Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow 1s. 11d. per lb.
Barytes .. .. .. £3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide .. 3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide .. £30—£33 per ton, according to quantity. Again dearer.
Carbon Black .. .. 7d.—7½d. per lb. ex wharf. Dearer.
Carbon Tetrachloride .. £60—£65 per ton, according to quantity, drums extra. Again dearer.
Chromium Oxide, green .. 1s. 3d. per lb.
Indiarubber Substitutes White and Dark .. 5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black .. .. £48 per ton, barrels free. Advanced.
Lead Hyposulphite .. 7½d. per lb.
Lithopone, 30% .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. .. £16 5s. per ton f.o.r. London.
Sulphur .. .. .. £10—£12 per ton, according to quality.
Sulphur Precip. B.P. .. £56—£57 per ton, according to quantity.
Sulphur Chloride .. 4d. per lb., carboys extra. Dearer.
Thiocarbanilide .. .. 2s. 6d. per lb.
Vermilion, pale or deep .. 5s. 1d. per lb. dearer.
Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

"Summer conditions" prevail in this as in most industries.

Acetate of Lime—
Brown .. .. .. £12—£12 5s. per ton d/d. Market easier.
Grey .. .. .. £17—£18 per ton. Market easier.
Liquor .. .. .. 9d. per gall. 32° Tw.
Charcoal .. .. .. £7 10s.—£9 per ton, according to grade and locality. Demand fairly good.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. ,, ,, 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 7d. per gall. Unrefined.
Wood Naphtha—
Miscible .. .. 4s. 10d.—5s. per gall. 60% O.P. Market dull.
Solvent .. .. .. 5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar .. .. £4 per ton. Cheaper.
Brown Sugar of Lead .. £44 per ton. Cheaper.

TAR PRODUCTS

Acid Carbolic—
Crystals .. .. 6½d. per lb. Quiet.
Crude 60's .. .. 1s. 9d.—1s. 11d. per gall, according to district. Still quiet.
Acid Cresylic, 97/99% .. 2s.—2s. 1d. per gall. Demand fair.
Pale 95% .. .. 1s. 9d.—2s. per gall.
Dark .. .. .. 1s. 9d.—2s. per gall. Quiet.
Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—
Strained .. .. 7½d.—9d. per gall. Quiet.
Unstrained .. .. 6½d.—7½d. per gall.
Benzole—
Crude 65's .. .. 10½d.—1s. per gall, ex works in tank wagons.

Benzole—
Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure .. .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% .. .. 1s. 5d.—1s. 5½d. per gall. Small demand.
Pure .. .. .. 1s. 8d.—2s. per gall. Small demand.
Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 8½d. per gall. Not much business.
Middle Oil .. .. / Heavy Oil .. .. / Standard Specification — 5d.—6½d. per gall., according to quality and district. Small export inquiry. Market quiet but fairly steady.
Naphtha—
Solvent 90/160 .. 11d.—1s. 5d. per gall., according to district. Fair demand.
Solvent 90/190 .. 11d.—1s. 4d. per gall. Fair demand.
Naphthalene Crude—
Market dull. Not much export inquiry. Cheaper in Yorkshire than Lancashire.
Drained Creosote Salts £4—£6. Quiet.
Whizzed or hot pressed £7—£9 per ton.
Naphthalene—
Crystals and Flaked .. £13—£16 per ton in Yorkshire and London respectively.
Pitch, medium soft .. 55s.—60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160 .. 19s. per gall. Again dearer. Market firm.
Heavy .. .. 12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

Business in dyestuffs has not been good lately, but an improvement is expected after the holidays. Prices remain firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 7d. per lb.
Acid H. .. .. .. 4s. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic .. 9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. 1s. per lb. d/d.
Aniline Oil .. .. 7½d.—8½d. per lb. naked at works.
Aniline Salts .. .. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 1d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 19/31° C. .. 4½d. per lb. Demand steady.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £85 per ton.
Diethylaniline .. .. 4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline .. .. 2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 2s. 10d. per lb. d/d.
Monochlorbenzol .. .. £63 per ton.
βNaphthol .. .. 1s. 1d. per lb. d/d.
αNaphthylamine .. .. 1s. 4d. per lb. d/d.

aphthylamine	.. 4s. per lb. d/d.
Nitraniline	.. 4s. 9d. per lb. d/d.
Nitraniline ..	.. 2s. 3½d. per lb. d/d.
trobenzene ..	.. 5½d.—5¾d. per lb. naked at works.
Nitrochlorbenzol	.. 2s. per lb. 100% basis d/d.
tronaphthalene	.. 10½d. per lb. d/d.
Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
Phenylene Diamine	.. 4s. per lb. d/d.
Phenylene Diamine	.. 10s. 3d. per lb. 100% basis d/d.
Salt	.. 2s. 6d. per lb. 100% basis d/d.
dium Naphthionate	.. 2s. 3d. per lb. 100% basis d/d.
Toluidine ..	.. 8½d. per lb.
Toluidine ..	.. 3s. 6d. per lb. naked at works.
Toluylene Diamine	.. 4s. 3d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

id, Acetic 80% B.P.	.. £45 per ton.
id, Acetyl Salicylic	.. 3s. 2d.—3s. 4d. per lb., according to quantity. Good demand. Price firm.
id, Benzoic B.P.	.. 3s. per lb.
id Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
id, Camphoric ..	.. 19s.—21s. per lb.
id, Citric ..	.. 1s. 4½d.—1s. 5d. per lb., less 5% for ton lots. Market very weak.
id, Gallic ..	.. 3s. per lb. for pure crystal.
id, Pyrogallic, Cryst.	.. 6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm; increasing demand.
id, Salicylic ..	.. 1s. 6d.—1s. 9d. per lb. Market little better, but demand fluctuating.
id, Tannic B.P.	.. 3s. per lb. Market quiet.
id, Tartaric ..	.. 1s. 1¼d. per lb. less 5%.
nidol	.. 9s. per lb. d/d.
etanilide ..	.. 2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
nidopyrin ..	.. 13s. 3d. per lb. Neglected. Stocks low.
nmon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
nmon. Carbonate B.P.	£37 per ton.
ropine Sulphate	.. 12s. 6d. per oz. for English make.
rbitone	.. 15s.—15s. 6d. per lb. Quiet market.
nzonaphthol ..	.. 5s. 3d. per lb. Small inquiry.
smuth Salts ..	.. Prices reduced by about 1s. 3d.—2s. 3d. per lb. on account of the fall in the price of the metal.
smuth Carbonate	.. 10s. 6d.—12s. 6d. per lb.
,, Citrate ..	.. 10s. 3d.—12s. 3d. ,,
,, Salicylate	.. 9s.—11s. ,,
,, Subnitrate	.. 8s. 8d.—10s. 8d. ,,
orax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
omides	.. Market exceedingly firm, and material rapidly advancing. Spot supplies very limited.
Ammonium ..	.. 1s. 4d.—1s. 7d. per lb.
Potassium ..	.. 1s. 2d.—1s. 5d. per lb.
Sodium	.. 1s. 3d.—1s. 6d. per lb.
lcium Lactate ..	.. Market fairly firm and higher prices talked of. Good English make can be had from 1s. 6d. upwards.
loral Hydrate ..	.. 4s.—4s. 3d. per lb. Very firm and scarce.
loroform ..	.. 2s. per lb. for cwt. lots. Very steady.
eosote Carbonate	.. 6s. 6d. per lb. Little demand.
rmaldehyde ..	.. £52 per ton, *ex* works. English make in casks.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. ,,
Guaiacol Carbonate	.. 10s. 6d.—11s. 3d. per lb.
Hexamine ..	.. 3s. 6d. per lb. for English make—market steady.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	.. English make offered, 120s. per oz.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £25 per ton, less 2½%. Price reduced.
Heavy Pure ..	.. 2s. 2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 57s. 6d. per lb.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Strong demand.
Mercurials ..	.. Market very quiet.
Red oxide ..	.. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. ,,
White precip. ..	.. 4s. 7d.—4s. 8d. ,,
Calomel ..	.. 3s. 11d.—4s. ,,
Methyl Salicylate	.. 1s. 10d.—2s. 1d. per lb. Keen competition.
Methyl Sulphonal	.. 26s. per lb.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 2s. 10½d.—3s. per lb. Not very active.
Paraldehyde ..	.. 1s. 5d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin ..	.. 6s. per lb. Price and demand steady.
Phenazone ..	.. 7s. 6d. per lb. A shade firmer. Forward prices higher.
Phenolphthalein ..	.. 6s. 6d. per lb. Ample supplies.
Potass. Bitartrate—99/100% (Cream of Tartar) ..	.. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Good steady demand.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate	.. 7¼d. per lb.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 5s. 2d. per lb.
Saccharin ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. 6d. per lb.
Silver Proteinate ..	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb. Ample supplies. B.P. quality available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.

Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside ..	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt) ..	75s.—82s. 6d. per cwt., according to quantity. Steady market, good demand.
Sod. Salicylate	Market rather firmer and more enquiry. Powder 2s. 3d.—2s. 5d. per lb. Crystal at 2s. 5d.—2s. 7d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	15s. 6d. per lb. Easier.
Thymol	20s. per lb. nominal. Very scarce indeed nominally.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d.	per lb.	
Aubepine	15s. 3d.	,,	
Amyl Acetate	2s. 6d.	,,	Cheaper.
Amyl Butyrate	6s. 9d.	,,	
Amyl Salicylate	3s.	,,	
Anethol (M.P. 21/22° C.)	4s. 6d.	,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d.	,,	
Benzyl Alcohol free from Chlorine	2s. 9d.	,,	
Benzaldehyde free from Chlorine ..	3s. 6d.	,,	
Benzyl Benzoate	3s. 6d.	,,	
Cinnamic Aldehyde—Natural	16s.	,,	
Coumarin	19s. 6d.	,,	
Citronellol	17s.	,,	
Citral	8s. 6d.	,,	Cheaper.
Ethyl Cinnamate ..	12s. 6d.	,,	,,
Ethyl Phthalate	3s. 3d.	,,	
Eugenol	10s. 6d.	,,	
Geraniol (Palmarosa)	[illegible]5s.	,,	
Geraniol	11s.—18s. 6d.	per lb.	
Heliotropine	7s. 3d.	,,	
Iso Eugenol	15s. 9d.	,,	
Linalol ex Bois de Rose ..	26s.	,,	
Linalyl Acetate	26s.	,,	
Methyl Anthranilate ..	9s. 6d.	,,	
Methyl Benzoate	5s.	,,	
Musk Ambrette	45s.	,,	
Musk Xylol	14s.	,,	
Nerolin	4s. 9d.	,,	
Phenyl Ethyl Acetate ..	15s.	,,	
Phenyl Ethyl Alcohol ..	16s.	,,	
Rhodinol	60s.	,,	Advanced.
Safrol	1s. 10d.	,,	
Terpineol	2s. 4d.	,,	
Vanillin	26s. per lb.		

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	1[illegible]s. 6d. per lb.
Aniso Oil	[illegible]s, 6d. per lb.
Bergamot Oil	17s. 6d. per lb.
Bourbon Geranium Oil ..	36s. 6d. per lb.
Camphor Oil	65s. per cwt.
Cananga Oil Java	10s. 6d. per lb.
Cinnamon Oil, Leaf ..	6½d. per oz.
Cassia Oil 80/85% ..	10s. per lb. Advanced.
Citronella Oil—Java 85/90%	5s. 8d. per lb.
Ceylon	3s. 7d. per lb.
Clove Oil	7s. 6d. per lb. Cheaper.
Eucalyptus Oil 70/75% ..	2s. 3d. per lb.
Lavender Oil—French 38/40% Esters	27s. 6d. per lb. Cheaper.
Lemon Oil	3s. per lb.
Lemongrass Oil	3d. per oz.
Orange Oil, Sweet ..	12s. per lb.
Otto of Rose Oil—Bulgarian	37s. 6d. per oz. Production below average.
Anatolian	18s. per oz.
Palma Rosa Oil	18s. per lb.
Peppermint Oil—Wayne County ..	22s. 9d. per lb. Firm spot and forward.
Japanese	17s. per lb. Market firm.
Petitgrain Oil	9s. 3d. per lb.
Sandal Wood Oil—Mysore	26s. 7d. per lb.
Australian	21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition within two months of the date given; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, 15 days after the date given.

I.—Applications

Brégeat. Recovery of volatile sovents. 19,829. Aug. 21.

Cook and Gallimore. Ovens and furnaces. 19,669. Aug. 20.

Davies and Johnston. Apparatus for heating granular material. 19,624. Aug. 19.

Gibbons Bros., Ltd., and Van Marle. Muffle furnaces. 19,863. Aug. 22.

Kerr and Lambert. Apparatus for heating liquids. 19,838. Aug. 21.

Lenart. Centrifugal mills for grinding colours etc. 19,735. Aug. 20.

Sauer. Manufacture of adsorbent materials. 19,596. Aug. 19. (March 26, 1923.)

I.—Complete Specifications Accepted

10,139 (1923.) McClelland. Apparatus for removing solid impurities and scum from steam and other boilers, evaporators, clarifiers, and similar apparatus. (220,348.)

24,036 (1923). Fasting. Rotary kilns. (205,069.)

32,617 (1923). Karpinsky and Anderson. Centrifugal separators. (214,577.)

2391 (1924). Akt.-Ges. Kummler and Matter. Liquid evaporators. (210,464.)

II.—Applications

Butterworth and Mumford. 19,791. *See* III.

Dorgelo. 19,896. *See* XXIII.

Dvorkovitz. Means for treatment of coal etc. 19,580. Aug. 18.

Evans. Production of coke. 19,653. Aug. 19.

Geipert. Apparatus for manufacture of generator or producer gas. 19,814. Aug. 21.

Klusmeyer. Carburetting raw and heavy oils. 19,929. Aug. 22.

Laing and Nielsch. Distillation etc. of carbonaceous etc. materials. 19,769. Aug. 20.

Sauer. 19,596. *See* I.

II.—Complete Specifications Accepted

10,251 (1923). Lane. Composition for use as a substitute for bitumen. (220,349.)

13,448 (1923). Atherton. Bituminous compositions. (220,393.)

23,084 (1923). Soc. Ricard, Allenet, et Cie. Apparatus r dehydrating mixtures of alcohol and liquid hydrocarbons. 04,697.)

31,508 (1923). Fülscher. Apparatus for cooling incan-escent coke. (208,557.)

2805 (1924). Fabry. Construction of coke oven heating-tes. (220,556.)

I.—Applications

Butterworth and Munford. Preparation of tar, bitumen, .c. for roads etc. 19,791. Aug. 21.

Sulzer Frères Soc. Anon. Tar distillation apparatus.),703. Aug. 20. (Switz., 15.12.23.)

/.—Applications

Farbwerke vorm. Meister, Lucius, and Brüning. Manu-cture of vat dyestuffs containing sulphur. 19,818. Aug. 21. Ger., 17.9.23.)

Lenart. Manufacture of thick oil from linseed etc. oils.),815. Aug. 21.

—Applications

Bate, British Dyestuffs Corporation, and Perkin. 19,889. ee VI.

Bemberg Akt.-Ges. Spinning artificial silk. 19,759. ug. 20. (Ger., 5.11.23.)

Bemberg Akt.-Ges. Apparatus for spinning artificial silk.),760. Aug. 20. (Ger., 17.11.23.)

Craig and Spence and Sons. Fire-proofing textile fibres etc.),515. Aug. 18.

—Complete Specifications Accepted

26,572 (1923). British Celanese, Ltd. (formerly British ellulose and Chemical Manufacturing Co., Ltd.), and Ellis. ee VI.

27,174 (1923). Hopkinson, Morgan and Wright. See XIV.

I. Applications

Bate, British Dyestuffs Corporation, and Perkin. Dyeing etyl silk. 19,889. Aug. 22.

Johnson (Smith, Drum, and Co.). Agitating-devices for ye-vats etc. 19,659. Aug. 19.

Ransford (Cassella und Co. Ges.). Dyeing. 19,733. ug. 20.

'I.—Complete Specification Accepted

26,572 (1923). British Celanese, Ltd. (formerly British ellulose and Chemical Manufacturing Co., Ltd.), and Ellis. yeing or colouring of products made with cellulose acetate. 20,505.)

II.—Applications

Blackburn. Manufacture of ammonia. 19,655. Aug. 19.

Franco. Manufacture of salt etc. 19,960. Aug. 23.

Sakurai and Suzuki. Process of producing an acid and s salts strongly absorbing ultra-violet rays. 19,568. Aug. 18.

Synthetic Ammonia and Nitrates, Ltd. Treating gases earing gaseous synthetic ammonia. 19,511. Aug. 18. (U.S., 5.8.23.)

Thomas. Manufacture of ammonia. 19,655. Aug. 19.

II.—Complete Specifications Accepted

15,401 (1923). Krafft. Processes for the purification of urner gases and for obtaining chemically-pure sulphuric cid. (220,413.)

22,616 (1923). Mond (Chemische Fabrik Griesheim Elek-ron). Process for the production of aluminium-fluoride-lkali-fluoride double compounds technically free from iron. 03,708.)

1276 (1924). Wefelscheid. Process of and apparatus for e production of lead oxide. (220,548.)

III.—Application

Skold. Manufacture of magnesium boro-silicate glass.),768. Aug. 20.

X.—Application

Butterworth and Munford. 19,791. See III.

IX.—Complete Specification Accepted

24,036 (1923). Fasting. See I.

X.—Applications

Booth, British Vacuum Cleaner and Engineering Co., and Came. Recovery of gold. 19,642. Aug. 19.

Haagn and Heraeus. Alloys for tipping metallic surfaces. 19,839. Aug. 21.

Heraeus. Alloys for tipping metallic surfaces. 19,832. Aug. 21. (Ger., 10.9.23.)

Metals Production, Ltd., and Perkins. Leaching ores etc. 19,910. Aug. 22.

Wellesley. Alloys. 19,666. Aug. 19.

X.—Complete Specifications Accepted

12,499 (1923). Wade (Naamlooze Vennootschap Philips' Gloeilampenfabrieken). Process of separating zirconium and hafnium. (220,358.)

12,500 (1923). Wade (Naamlooze Vennootschap Philips' Gloeilampenfabrieken). Process of separating hafnium and zirconium. (220,359.)

13,727 (1923). Turnbull. Baths for galvanising. (220,398.)

XI.—Application

Baily. Electric furnaces. 19,875. Aug. 22. (U.S., 28.8.23.)

XI.—Complete Specification Accepted

296 (1924). Electro-Osmose Akt.-Ges. (Graf. Schwerin Ges.). See XVII.

XII.—Applications

Genoocke and Metallbank und Metallurgische Ges. Process of purifying oils and fats. 19,727. Aug. 20. (Ger., 18.9.23.)

Haas. Soaps and washing colloids. 19,884. Aug. 22.

Haddan (Lenart). 19,815. See XIII.

Kiegel. 19,552. See XIXa.

Morgan and Patent Borax Co. Soaps, detergents, etc. 19,667. Aug. 20.

XII.—Complete Specification Accepted

13,307 (1923). Andrews and Rose, Downs and Thompson, Ltd. Thickening and bleaching, or thickening or bleaching of oils. (220,390.)

XIII.—Applications

Brown and Klein. Pigments. 19,907. Aug. 22.

Haddan (Lenart). Manufacture of thick oil from linseed etc. oils. 19,815. Aug. 21.

Lenart. 19,815. See IV.

Soc. of Chemical Industry in Basle. Manufacture of artificial shellac. 19,817. Aug. 21. (Switz., 30.8.23.)

Western Electric Co., Ltd. (Western Electric Co., Inc.). Coating-composition, and process of producing same. 19,618. Aug. 19.

XIII.—Complete Specifications Accepted

13,307 (1923). Andrews and Rose, Downs and Thompson, Ltd. See XII.

1276 (1924). Wefelscheid. See VII.

XIV.—Complete Specification Accepted

27,174 (1923). Hopkinson, Morgan and Wright. Method and apparatus for rubberising filamentary material. (210,397.)

XV.—Applications

Consortium fur Elektrochemische Industrie Ges. Agglutinant or cement. 19,746. Aug. 20. (Ger., 20.8.23.)

Ehrenreich. Process of treating skins of plagiostome fishes. 19,555. Aug. 18. (Fr., 7.12.23.)

Haller and Rosenzweig. Manufacture of artificial horn. 19,924. Aug. 22. (Austria, 23.8.23.)

XVI.—Complete Specification Accepted

13,540 (1923). Carpzow, Mann and Heppes. Production of manures. (220,395.)

XVII.—Application

Chemische Fabrik Pyrgos Ges. and Haller. Manufacture of soluble starch products. 19,660. Aug. 19. (Ger., 21.2.24.)

XVII.—Complete Specification Accepted

296 (1924). Electro-Osmose Akt.-Ges. (Graf Schwerin Ges.). Process for the electro-osmotic purification of saccharine juices. (214,578.)

XVIII.—Complete Specification Accepted

23,084 (1923). Soc. Ricard, Allenet, et Cie. *See* II.

XIXa.—Application

Kiegel. Manufacture of margarine. 19,552. Aug. 18.

XIXb.—Application

Jackson (California Spray-Chemical Co.). Insecticides 19,574. Aug. 18.

XX.—Applications

Austerweil. Preparation of thymol and menthol. 19,797. Aug. 21. (Ger., 21.8.23.)

Fryer and McDougall. Production of heterocyclic compounds containing nitrogen in the ring. 19,562. Aug. 18.

XX.—Complete Specification Accepted

3663 (1924). Wacker Ges. fur Elektrochemische Industrie Ges. Manufacture of acetic anhydride. (211,167.)

XXI.—Application

Campbell. Natural-colour kinematography. 19,706. Aug. 20.

XXII.—Complete Specification Accepted

11,304 (1924). Gerlach. Match-striking composition. (219,646.)

XXIII.—Application

Dorgelo. Determining calorific value gases. 19,896. Aug. 22. (Holl., 1.10.23.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number :—*Brazil :* Leather (B.X./1135). *British India :* Metals, hardware (239) ; Leather (B.X./1169) ; Wire, bronze, iron (The Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1). *Canada :* Leather (B.X./1157). *Chile :* Electro-plate, cutlery (B.X./1150). *Cuba :* Silk (257) ; Hardware, paint, varnish (258). *Egypt :* Paper (13781/F.E.). *France :* Leather (B.X./1151). *Greece :* Oils, tin, tinplate, copper, copper sulphate (246). *Norway :* Chemicals, oils (247). *Rumania :* Glasses, rubber hose (251). *South Africa :* Paint, oils (243) ; (572). *Turkey :* Bronze wire (A.X./1270). *Uruguay :* Paint (B.X./1186).

Trade Information

Through the Furnace Door is the title of a pamphlet published by Meldrums, Ltd., of Timperley, Manchester, with the object of showing how economies can be effected in the fuel and labour required for raising steam by installing the Meldrum furnace. The advantages claimed for this furnace are that it enables the steam to be kept continuously at the correct working pressure, whilst being sufficiently elastic to meet any sudden demand, and that it makes use of all kinds of low-grade fuels. Messrs. Meldrums, Ltd., also make special fire bars, stokers suitable for any type of fuel, as well as destructor furnaces that are much in use in municipalities, tanneries and other places where combustible refuse is available. Messrs. Meldrums are so convinced of the merits of their furnaces that they offer to fit them on trial after ascertaining the conditions they have to meet.

Canadian Metallurgy and Mining Notes

The report of the International Nickel Co. for year ended March 31, 1924, shows a net profit of $1,206,786 after deduction of taxes, depreciation, depletion, etc., equivalent, after preferred dividends, to 40 cents a share (par $25) earned on $41,834,600 of outstanding common stock. This compares with $48,170, or 54 cents a share on $8,912,600 preferred stock, in the previous year. After preferred dividends the surplus was $672,030 comparing with a deficit of $486,586 in preceding year.

The Treadwell-Yukon Co., at Keno Hill, Yukon, has struck a big vein of ore at a depth of 600 feet. This settles the question of the Mayo district being a deep mining camp, and assures permanence of these rich silver-lead mines. The higher grade ore is shipped to the smelter, and a mill will be erected by the company to handle the lower grade.

A Glasgow syndicate has purchased 55 iron-ore claims at Goudreau, Ont., the amount involved being approximately $1,500,000. The purchasers propose to develop and use 180,000 h.p. on the Missinaibi River. The new bounty, promised by the Ontario Government, is reported to be the incentive to the mining and concentrating of these low-grade ores.

German iron masters, in the Ruhr district, are endeavouring to close a contract for five years' delivery of iron ore from the Wabana mine of the British Empire Steel Corporation, of Montreal.

The Alberta Salt Co. Ltd., has operations under way for the establishment of a salt plant capable of producing 15,000 to 20,000 tons a year, at Fort McMurray Alta. The latter place is 300 miles north of Edmonton, Alta.

PUBLICATIONS RECEIVED

TRANSACTIONS OF THE INSTITUTION OF CHEMICAL ENGINEERS. VOLUME I. Pp. xv+120. London: W. Speaight and Sons, Ltd., 1923.

CADMIUM: ITS METALLURGY, PROPERTIES AND USES. By N. F. Budgen, Ph.D., M.Sc. With a foreword by Prof. Thos. Turner, M.Sc. Pp. xii+239. London: Charles Griffin and Co., Ltd., 1924. Price 21s.

QUANTITATIVE ORGANIC MICROANALYSIS. By F. Pregl, D.Sc., Ph.D. Pp. xv+190. Translated from the second revised and enlarged German edition by E. Fyleman, B.Sc., Ph.D. London: J. and A. Churchill, 1924. Price 12s. 6d.

CHARTS OF THE CHEMICAL REACTIONS OF THE COMMON ELEMENTS. By John A. Timm, Ph.D. Pp. ix+81. London: Chapman and Hall, Ltd., 1924. Price 10s.

ANALYTICAL CHEMISTRY, BASED ON THE TEXT OF F. P. TREADWELL. Translated and enlarged and revised by W. T. Hall. Vol. II. Quantitative Analysis. Sixth edition. Pp. xiii+811. London: Chapman and Hall, Ltd., 1924. Price 25s.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

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EDITORIAL

ONE of the most valuable features of the meetings of the British Association is, perhaps, the arrangement of discussions in which two different sections meet to consider a problem common to both. Discussion of a problem from different standpoints cannot but lead to a clearer understanding of the points involved, so that unprofitable issues can be abandoned and promising lines of work decided upon. It is a very appropriate moment, as Prof. Drummond remarked in opening the discussion on "Vitamins," for chemists and physiologists to meet together to discuss this difficult subject. Already the literature devoted to vitamins is very large, and it is regrettable that so much of the work is nullified by imperfect appreciation of the real nature of the problem. As Prof Drummond says, some workers have failed to differentiate between substances essential for life and growth and those which apparently act rather as stimulants of growth. Caution in interpreting the results of experiments is particularly necessary when the reactions of living organisms are being studied, and the vitamins themselves, despite the skilful wording of Prof. Drummond's definition, are rather vague substances. Real progress cannot be made until we know what a vitamin is as well as what it does, and we await another Annual Meeting when, at least, the synthesis of insulin and the manufacture of a vitamin will be described

We have read somewhere of a Utopian country in which there was no legal system and no lawyers, where the citizens lived solely by the light of reason and for the common weal. There is ground for the belief that such a country would be very dull, however much we should like to find Utopian beginnings in our own times. We are now confronted with an excellent suggestion by the Joint Committee for the Standardisation of Scientific Glassware. The recommendation is unanimous and the membership of the Committee is more than ample warrant of its desirability. If we lived in Utopia we should all, at a given date, abandon the deceitful "c.c." and replace it by the trusty "*ml.*" We do not live in Utopia, and so we read, in the report, that some chemists still prefer to use Mohr's system of units and would be unwilling at present to change their existing practice. But, it is suggested that they shall brand their units with "G.W.A." Did not Shakespeare write "Great G.W.A. doth sway my life," and though there is no hint that the problem is as old as that, there is Florentine guile in the suggestion that the "ml." and "G.W.A." units can be used side by side during the transitional period that must precede the general adoption of the litre and millilitre for general chemical work. The report, which will be found on another page, deserves close attention and should convince all chemists that the time has come when the sibilant "c.c." should no longer be heard in the land. But if conviction is still to seek, why, there is still the transitional period.

Despite the recent and extensive demonstration of our capabilities for which we are still paying, we still seem, as a nation, doubtful of our own powers. "They do things better over there," is still our cry. Our dyestuffs industry has received much blame and but little praise, yet it has gone on, training chemists, making dyes better and better, and steadily improving. In the glass industry, the same process has gone on and laboratory glassware that meets all requirements is produced, but its wartime difficulties are remembered, not its post-war successes. It is sometimes valuable to see how things are really done outside this country. The Berlin correspondent of the *Financial Times* reports that the firms—Bayer, Agfa, Badische, Meister, Lucius, and Bruning, Weiler Ter-Meer, and the Griesheim-Elektron composing the German dyestuff trust, "announce that they can pay no dividend for the past year, as in no instance was their earning sufficient and in some cases work was carried on at a small loss. Results for the current year are not satisfactory."

SOME MODERN TENDENCIES OF VITAMIN RESEARCH *

BY PROF. J. C. DRUMMOND

Probably at no previous stage in vitamin research has it been more appropriate that a joint discussion on this subject between chemists and physiologists should be held than at the present time, for, after much laborious research has been carried out on the distribution of these substances in foodstuffs, and on the significance of vitamins in relation to human dietaries and rations for animals, practical applications which became of urgent importance during and immediately after the years of the war, investigations are now being directed more definitely towards ascertaining the chemical nature of these curious substances, and their mode of action in the animal body.

I would first direct your attention to considering what vitamins are. The classic researches of Hopkins demonstrated that for normal growth and health the higher animals require certain components of natural foods other than proteins, fats, carbohydrates and salts, and to these substances the name vitamins was given by Funk; a name, which, in spite of many objections, has become well established. What, then, are we to regard as a vitamin?

In the present state of our knowledge we may reasonably regard a substance as a vitamin if it is essential to the life and wellbeing of an organism which does not possess the power to synthesise that substance, and also if it is organic in nature, and does not belong to any one of the three great classes of foodstuffs, proteins, fats and carbohydrates. Furthermore, compared with these foodstuffs the vitamins appear to be required by the organism in relatively minute amounts. One of the modern problems of vitamin research is to ascertain to what extent these substances are essential for all living organisms, rather than for the higher animals in particular.

In preparing this paper I have made a careful survey of the available work on this subject, only to find that the literature is in a most confused and unsatisfactory state. If we review very rapidly the more outstanding of these papers, and deal with the organisms more or less according to the evolutionary scale, we are first attracted by the work of Allen and Nelson on the growth of marine diatoms (*J. Marine Biol. Assn.*, 1910, **8**, 361; Allen, *ibid.* 1914, **10**, 417). These observers believed they had obtained evidence of the existence in natural sea-water of a substance, apparently organic, of which minute amounts are necessary for the satisfactory growth of certain marine diatoms. This work has been carefully examined in my laboratory recently by Miss Peach (*Biochemical J.*, 1924, **18**, 364), who finds that the diatom *Nitzschia closterium* can grow satisfactorily in artificial culture media prepared from pure inorganic salts and as free from organic matter as possible. Similar experiments with the organism used by Allen, *Thallassiosira gravida*, are in progress, but are as yet incomplete.

After all, it would in my mind be an extraordinary fact if in the progress of evolution, even simple green plants had lost their autotrophic nature and become to a certain extent dependent on preformed organic matter. The next work which calls for our attention are the researches of Bottomley on the substances which he termed "auximones," present in peat allowed to undergo changes induced by inoculating with cultures of certain soil bacteria. He and his co-workers claimed to have shown that these substances are essential for the growth and development of a number of green plants (*Proc. Roy. Soc. Lond., B.*, 1914, **88**, 237; **89**, 102, 481). Careful re-examination of his work has, as far as I am aware, not yet been undertaken, but his claims are somewhat generally discredited, and are certainly not supported by studies on the growth of plants such as wheat in water cultures. What stands out most clearly from a careful survey of much of this work is the failure to differentiate between substances essential for life and growth and those which appear to act more as stimulants of growth. This will be appreciated even more when the experiments on the lower plants devoid of chlorophyll have been studied. As far back as 1901, Wildiers (*La Cellule*, 1901, **38**, 465) showed that growing cultures of yeast contain a substance to which he gave the name "bios," which he found to be a necessary addition to an artificial medium if a small inoculation of yeast is to grow. Large inoculations would, however, carry their own supply of "bios." This work, which virtually reopened the famous controversy begun between Pasteur and Liebig, and carried on between Mayer and v. Nägeli, has stimulated a large amount of research, particularly since Williams suggested that "bios" is identical with the substance now usually referred to as vitamin B (*J. Biol. Chem.*, 1919, **38**, 465; 1920, **42**, 259), but here again, much confusion has apparently been caused by insufficient distinction being made between substances which merely stimulate growth and others in the absence of which no growth will occur. Undoubtedly, substances are produced during the growth of yeast which, when added to new cultures, tend to stimulate cell multiplication, but the careful experiments of Fulmer Nelson and White (*J. Biol. Chem.*, 1923, **57**, 397) seem to make it clear that *Saccharomyces cerevisiae* can grow in a synthetic artificial medium prepared from inorganic salts and pure sugars, even when for the latter one uses the synthetic sugar, methose. This result may indicate either that yeast growing in such a medium can itself produce the substance which stimulates its own growth, or that the growth of the organism does not require such a substance. The fact that yeasts growing under these conditions synthesise the factor known as vitamin B which has so great an influence on the growth of many species of animals may, perhaps, be taken as evidence in support of the former alternative (*J. Biol. Chem.*, 1923, **56**, 489). If such be the case it is incorrect, as Fulmer, and Nelson (*J. Biol. Chem.*, 1922, **51**, 77),

* Paper read to open the Discussion on "Vitamins" organised by Sections B (Chemistry) and I (Physiology) at the Toronto meeting of the British Association, 1924.

Macdonald (*J. Biol. Chem.*, 1923, **56**, 489) and others have pointed out, to apply the term vitamin to stimulating substances such as "bios," as Funk and Dubin have done (*J. Biol. Chem.*, 1920, **44**, 487).

Regarding the bacteria the facts are less clearly defined than in the case of the yeasts. Certain species such as the sulphur bacteria, studied with such care by Waksman and his colleagues, and the nitrite bacteria, appear able to flourish in a wholly inorganic medium, and to be quite independent of pre-formed organic matter. This is in agreement with what is known concerning their strictly autotrophic character. The vast majority of bacteria, lacking this power to synthesise organic materials from carbon dioxide by utilising the energy made available by simple exothermic reactions, are dependent to a greater or a lesser extent on organic foodstuffs. For many species it has been claimed that in addition they require minute amounts of certain growth stimulants akin to the vitamins (Lloyd, *J. Path. and Bact.*, 1916, **21**, 113; Shearer, *Lancet*, 1917, **1**, 59), particularly in the case of the so-called hæmophilic bacteria (Legroux and Mesnard, *Comptes rend.*, 1920, **170**, 901). A close examination of this work, however, immediately impresses one with the unsatisfactory nature of much of the experimental evidence presented.

Probably the substances in these cases are more of the nature of the yeast "bios," and stimulants of growth rather than essentials.

When we turn to the animal kingdom, having passed by cases of symbiosis between plant and plant and between plant and animal, where the conditions are obviously too complex to investigate in the present state of our knowledge, we find the information available rather less confusing and more reliable. Investigations of the nutritive requirements of the simplest animals seem to show that certain protozoa, at any rate, can be grown for many generations in artificial culture media free from any substances resembling the vitamins. Peters (*J. Physiol.*, 1921, **55**, 1) has maintained the ciliate organism *Colpidium colpoda* for over a year in pure culture in a medium in which the only organic material was ammonium glycerophosphate.

T. B. Robertson insists, however, that during the growth of the protozoon *Enchelys* a substance is found which stimulates cell-division of this organism. Indeed, on the basis of this work he has built up a most elaborate theory of the autocatalytic nature of cell growth. ("The Chemical Basis of Growth and Senescence." London. 1923.)

Attractive as much of his theorising appears at first sight, it must be remembered that, as yet, the experimental foundation is insecure. Cutler and Crump (*Biochem. J.*, 1923, **7**, 174) could obtain no indication of his autocatalytic—or as he prefers to call it, allelocatalytic—effect when studying the growth of *Colpidium*, but, on the other hand, they appear to find that the addition of small quantities of substances similar in nature to "bios" have a marked effect on the growth of this organism.

Once again we must attempt to distinguish between the essential and the non-essential factors, although when one essays to do this the difficulties are at once apparent. If we exclude substances such as "bios," which are believed to be produced by the cell itself, and consider only those elaborated by other cell units, we not only have the essential vitamins, but a host of other factors which in one sense or another are equally essential; such, for example, are the minute trace of malic acid, which will cause the larva of the wood boring organism Toredo to swim towards the wood which is to be the home of the mature animal (Harrington, *Biochem. J.*), or the infinitesimally small traces of substances of unknown character which Carrel has shown are produced by leucocytes growing in pure culture, and which appear necessary for the growth of fibroblasts (*J. Exp. Med.*, 1922, **36**, 385).

As far as I am aware, the next animal, higher in the evolutionary scale, to have been studied is the fruit fly, Drosophilia. Here we have clear evidence derived from the carefully planned experiments of Loeb and Northrup (*J. Biol. Chem.*, 1916, **27**, 309) and Harden and Bacot (*Biochem. J.*, 1922, **16**, 148), that the substance known as vitamin B is essential to the development and growth of the larvæ. Apparently the other vitamins (A and C) required by higher animals were not essential for this species.

Studies on the tadpole and frog have shown that whereas vitamin B is absolutely essential, there may be some dependence on vitamin A, but probably none on the antiscorbutic substance C (Emmett and Allen, *J. Biol. Chem.*, 1919, **38**, 325; Harden and Zilva, *Biochem. J.*, 1920, **14**, 262.) Fish require both A and B. When we study the birds we find dependence on both A and B factors marked, but the C substance of doubtful importance, whilst for the mammals not only are the former substances essential, and in some cases the antiscorbutic factor also, but there appears to be a dependence on other as yet less clearly defined factors, such as the antirachitic vitamin, and the substance necessary for reproduction discovered by the careful work of Evans and Bishop.

These few facts tend to support the view that in the progress of evolution the animal becomes more and more dependent on certain definite molecular structures synthesised by plant agency, and one recalls the words of Hopkins, spoken when, at a meeting of the Society of Public Analysts in London in 1906, he first announced the existence of the substances we now term vitamins, "The animal body is adjusted to live either on plant tissues or other animals, and these contain countless substances other than proteins, carbohydrates and fats. Physiological evolution, I believe, has made some of these wellnigh as essential as are the basal constituents of the diet."

I fear I have strayed somewhat from the usual path followed in discussions on vitamins, but I have done so deliberately in order to present an aspect of this subject which too frequently is lost sight of in the hope that it will stimulate much-needed work to resolve the factors which influence cell growth, particularly of the lower animals and plants, for we can scarcely hope to gain a knowledge of the development of the higher animals whilst we are almost wholly ignorant of those governing the growth of the unicellular organisms.

Having dealt with a physiological aspect of the vitamins I wish now to turn to discuss for a few moments what is known of their chemical nature, for we are at last beginning to gain some reliable information on this most important subject.

Vitamin A and the Antirachitic Vitamin D*

I propose to deal with these two substances together since we have recently obtained some evidence of their similarity on chemical grounds.

If one takes any natural substance containing one or both of these factors and subjects it to hydrolysis by means of a boiling alcoholic solution of caustic alkali under conditions preventing oxidative changes, one can extract both vitamins unchanged as regards physiological activity by light petroleum or ether.

The unsaponifiable matter prepared from cod liver oil, the usual raw material employed on account of its richness in both substances, represents a little under 1 per cent. of the original oil, but contains all the vitamin activity. Oxidation of this material rapidly destroys the growth-promoting substances A and rather more slowly the antirachitic factor D. By crystallisation from methyl alcohol at low temperature and by subsequent precipitation with digitoriss all the cholesterol present may be removed without affecting the vitamin activity of the residue, which is a red-brown oil corresponding to about 0·4 per cent. of the original cod liver oil. Attempts to isolate active fractions from this material are of little use, owing to the presence of considerable amounts of resinous substances formed during saponification. These may be removed by subjecting the material to distillation in superheated steam in an atmosphere of nitrogen. The purified material appears on analysis to consist very largely of unsaturated alcohols, possibly aliphatic but more probably allied to the hydroaromatic group. On fractional distillation in high vacuum four main fractions may be obtained :—

I. A small amount of an unsaturated alcohol of low-boiling point which, on hydrogenation, yields octyl alcohol.

II. B.p. 220–240°/2 mm. Consists chiefly of an unsaturated alcohol. B.p. approximately 225 at 2 mm. This fraction has as yet been examined very little, as it contains only traces of growth promoting or antirachitic activity.

III. B.p. 240–260°/2 mm.

IV. A fraction boiling between 260° and 300° at this pressure.

The growth-promoting substance A is definitely associated with fraction III, and, from some preliminary experiments which Miss Soames has recently carried out on my material, it appears to contain the antirachitic factor as well. Fraction III seems to consist almost entirely of an unsaturated alcohol, boiling approximately at 255°/2 mm., and containing two double bonds and one hydroxyl group and with molecular weight about 350. The evidence available does not yet enable us to say whether this alcohol is one of the vitamins, but I am inclined to the view that it is not, and that they are present as impurities. Even if this fraction were one of the vitamins a simple calculation makes clear how exceedingly small is the amount required by an animal in comparison with its ordinary foodstuffs. A rat of 100 g. eats daily about 3 g. of protein, 2 g. of fat, and 10 g. of carbohydrate. To supply the vitamins A and D it is only necessary to give the rat about 20 mg. of cod liver oil daily. This corresponds to approximately 0·2 mg. of unsaponifiable matter, and to 0·02 mg. of the active Fraction III. If the vitamins are, as we suspect, merely impurities present in that fraction the dose becomes vanishingly small. The vitamins will withstand the acetylation, and benzoylation, and apparently also the reduction of the unsaturated groupings of the alcohol, but oxidative changes destroy their activity. These preliminary researches exhausted the material at our disposal, but a large amount of unsaponifiable matter has now been prepared, and we are confident that the examination now in progress will give us a clearer indication of the chemical nature of vitamins A and D. At any rate, however hard our task, we have the satisfaction of knowing that we are dealing with clearly defined chemical units and not elusive substances such as the enzymes. The active fractions contain only carbon, hydrogen and oxygen. The crystalline material prepared by Takahashi (*Proc. Japan. Chem. Soc.*, 1922, 43, 828) and claimed by him to be the active substance, has been shown by us to be a crude mixture of the alcohols I have described. His view that the vitamin is an aldehyde is based on quite inadequate evidence, and although it would fit in with the ready destruction by oxidation, is not supported by the resistance of the active substances to vigorous hydrolysis with alkalis.

An attractive suggestion was that the active substances may be hydrocarbons of the type of spinacene found in certain fish liver oils. So far we have no evidence in support of this. Spinacene is itself inactive.

It might be mentioned in passing that the old sulphuric acid test for cod liver oil is invariably given by fractions containing the active substance, which lends support to the view, tentatively put forward by Drummond and Watson (*Analyst*, 1922, 47, 341) that the vitamins may be responsible. If this should prove true we will at last have one chemical test for the presence of a vitamin. No research is more urgent than that which will lead to replacement of the present laborious biological tests by quantitative chemical or physical methods of assay.

Vitamin B

No one of the vitamins has been more studied from the chemical side than this substance. In spite of this we are still in almost complete ignorance of its chemical nature. The most recent claim of isolation is that put forward by Bertrand and Seidell (*Bull. Soc. Chim. biol.*, 1923, 5, 794), who describe the separation of the active substance in

* The term vitamin D has been applied by Funk and Dubin (*loc. cit.*) to the substance which stimulates the growth of yeast. Since this substance appears to be not essential it is not well classified as a vitamin. The letter D can then be applied to the antirachitic factor which McCollum and his co-workers have satisfactorily differentiated from the growth-promoting vitamin A.

the form of a picrate, of which a daily dose of some milligrams will protect pigeons from beri-beri. The picrate can be separated by crystallisation from water into two picrates, melting at 202° and 160° respectively, the latter being the more active physiologically. Dr. Seidell informs me that he believes the active substance to be a pyrimidine. This will recall the similar belief held by Funk (*J. Physiol.*, 1911, 43, 395) and by Edie, Evans, Moore, Simpson and Webster (*Biochem. J.*, 1912, 6, 234), concerning the substances they isolated. Confirmation of the results of Bertrand and Seidell is urgently required.

Vitamin C

Curiously, this factor, although apparently of relatively simple character, has until recently received practically no attention from the hands of chemists. During the last year or two, however, the painstaking researches of Dr. Zilva at the Lister Institute have given us a good deal of valuable information regarding its properties.

He has shown that it is readily destroyed by oxidation when in solution reacting on the alkaline side of neutrality, and that its molecule is probably not much larger than that of a hexose. His attempt to isolate the active principles may be illustrated by the scheme outlined below (from *Biochem. J.*, 1914, 18, 632):—

1 litre lemon juice
80 g. of solid matter.
↓ precipitation with lime

80 g. citric acid, etc., inactive ← → 10 g. active material, largely sugar
↓ Fermentation

7·5 g sugar removed (inactive) ← → 2·5 g. active residue
↓ Alcohol pptn.

0·8 g. precipitate (inactive) ← → 1·7 g. active residue
↓ Basic lead acetate pptn.

1·4 g. inactive material not precipitated ← → 0·3 g. active substance pptd. by lead acetate.

The last stage he has reached, namely the basic lead acetate fraction, contains extremely small amounts of nitrogen and phosphorus, but possesses approximately the whole of the vitamin activity. It represents 0·03 per cent. of the original juice.

"*Bios.*"—I have intentionally omitted reference to the substance or substances which stimulate yeast-growths, since it is doubtful whether we should regard them as vitamins. They will, however, receive attention from other speakers to-day.

If more time were at my disposal I would direct your attention to other phases of present-day vitamin research, in particular to the important studies that are being made to ascertain the role of these deeply interesting substances in the life of the organisms. In this field much is being learnt about the extraordinary complexity of the processes of bone formation in the higher animals, and of the part played in those processes by the antirachitic vitamin D. One would also like to devote a short time to passing in review the extraordinary developments which have followed the recent application of knowledge regarding the vitamins to the practical problems of human nutrition and animal husbandry.

One cannot help feeling, however, that the most urgent problems are those concerning the chemical nature of the vitamins, for only when reasonably pure preparations of the active substances are available can we expect to gain a clear knowledge of their physiological action on the body.

THE LIMITATION OF STEAM CONSUMPTION IN CHEMICAL WORKS

By C. FRED HOLMBOE, D.Sc., Christiania

During recent years a great deal of work has been done to improve and control the efficiency of boiler plants, not only in connexion with steam generation for the production of power, but also with the generation of steam used for heating, drying and similar purposes in the chemical and kindred industries. Special requirements as to steam temperature, pressure, fluctuations in the steam consumption and other points, have also been thoroughly studied in order to make it possible to design a boiler plant which in each individual case will give the best economical result.

With a well-designed boiler plant with stokers, economisers and superheaters—if necessary—a total efficiency of 75 to 80 per cent. may be obtained in continuous work by using average good coal. In order to control the efficiency of the boiler plant and the working of each individual boiler the installation of automatic coal-weighing machines, water meters, differential draught indicators, carbon dioxide and pressure recorders, and temperature recorders is essential.

Particularly in big works where a large amount of steam is used in many different processes, it is necessary, in order to arrive at a good economy, not only to have an up-to-date boiler plant, but also to see that steam is not wasted. On this side of the question I think that a great deal still has to be done before satisfactory conditions are arrived at in most works.

In the steam meter of to-day, which in accordance with my experience is very reliable for tests which require an accuracy within a couple of units per cent., we have an instrument of great utility for investigating the steam consumption necessary for plants and apparatus.

It is obvious that a man in charge of a plant is at a loss as far as the steam-consumption goes when he has no other means of control than a steam valve,

and he may be using considerably more steam than actually required without knowing it. On the other hand, it would be too expensive to put a steam meter on to every apparatus to check the flow of the steam, as it generally is quite sufficient for controlling the cost of production to have one meter for each department.

I have, therefore, tried another way in order to economise the steam, and as this in practical use has proved to give a very satisfactory result without complicating the plant, I shall here shortly describe the methods adopted.

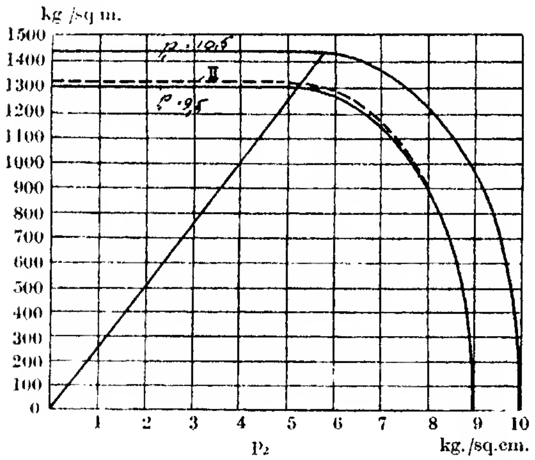

FIG. 1

If steam is used in an apparatus either under atmospheric pressure or vacuum by blowing the steam through a nozzle or perforated coil into the chemicals to be treated, the steam consumption is only controlled by the opening of the valve, and it is well known that the valve at times is opened more than is actually required for the process. The steam pipe leading to the apparatus is, as a rule, calculated for a velocity of the steam ranging from 30 to 60 m./sec. depending upon the maximum drop in steam pressure, but this speed can often be increased to 80–100 m./sec. and more, without the drop in pressure increasing to an extent which interferes with the carrying out of the process. This also applies to plant in which the steam is used for indirect heating in jackets and coils, particularly when, as often happens, the steam trap behind the jacket or coil is left with an open by-pass, or the heating surface is bigger than required.

In order to limit the flow of steam to a maximum figure, which has to be ascertained by calculation or experiments, I have arranged a nozzle between the regulation valve and the apparatus (or a series of apparatus) which automatically limits the flow of steam to the maximum as long as the steam pressure actually required is less than a critical pressure p_m which is about 57 per cent. of the initial pressure p_1. This can be applied to a great number of cases where steam is used direct or indirect and the process only requires the heat of the steam.

The critical pressure :—

$$p_m = p_1\left(\frac{2}{k+1}\right)^{\frac{k}{k-1}}$$

In this formula is k the exponent for polytropic expansion :—

$$p.v^k = \text{Constant}.$$

For dry saturated steam $k = 1.135$, and $p_m = 0.5744 p_1$.

The velocity of the steam through a cylindrical nozzle under these conditions and without taking the friction loss into account is

$$c_0 = \sqrt{2g\frac{k}{k+1}\cdot p_1 v_1}$$

With the initial pressure and volume expressed in kg./sq. cm. and cb. m./kg. Then for saturated steam with $k = 1.135$

$$c_0 = 323\sqrt{p_1 v_1}.$$

The amount of steam passing through the nozzle with Fm^2 opening is in kg. per sec. :—

$$P = F\sqrt{2g\frac{k}{k-1}\,\frac{p_1}{v_1}\,\frac{k-1}{k+1}\left(\frac{2}{k+1}\right)^{\frac{2}{k-1}}}$$

or for $k = 1.135$,

$$P = F.199\sqrt{\frac{p_1}{v_1}}$$

The actual velocity, $C = \phi . C_0$

ϕ is the coefficient of friction which, for properly designed nozzles, is about 0·97—0·98.

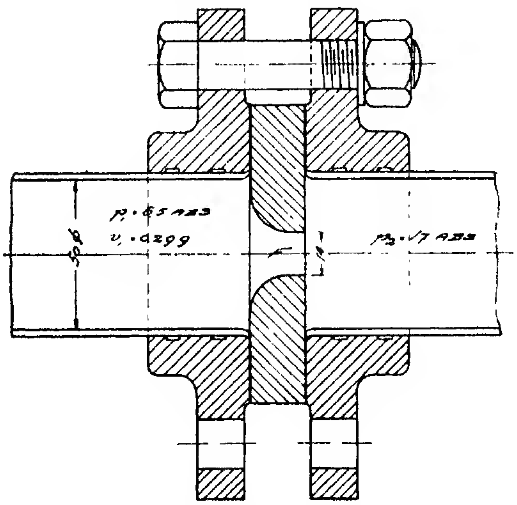

FIG. 2

Fig. 1 gives some results of tests carried out at $p = 9{\cdot}5$, and $10{\cdot}5$ kg./sq. cm with a nozzle 5·4 mm. diameter. The ordinate gives the weight of steam passing through the nozzle in kg. per sq./m. per sec. The curve II is the theoretical weight calculated. It will be noted from these curves that the friction in a well-designed nozzle has very little influence.

Fig. 2 shows the nozzle 1 arranged in a 2 in. pipe leading to fourteen open coils in order to limit the maximum steam supply to about 500 kg. per hour, with $p_1 = 6{\cdot}5$ kg./sq.cm. and $p_2 = 1{\cdot}7$ kg./sq.cm. absolute pressure.

The maximum velocity of the steam (dry saturated) in the nozzle is about 440 m/sec. or 1430 feet per sec.

The influence of the nozzles on the steam consumption in the department is shown in the diagrams, Fig. 3. A gives the steam required without the nozzles on a double shift of 16 hours on June 12, 1923, with 10 coils, and B the steam required on June 12, 1924, with 14 coils after the nozzles were fitted and on an 8 hours shift. The production in the department was the same in both cases.

The saving in steam calculated from the diagrams (Fig. 3) was 56·5 per cent. and the total saving over one month 44·7 per cent., equal to £670 per year. The cost of the nozzles was about £3.

After having obtained this satisfactory result in one department I introduced the same arrangement for limiting the maximum steam consumption in all departments where it could be used with advantage.

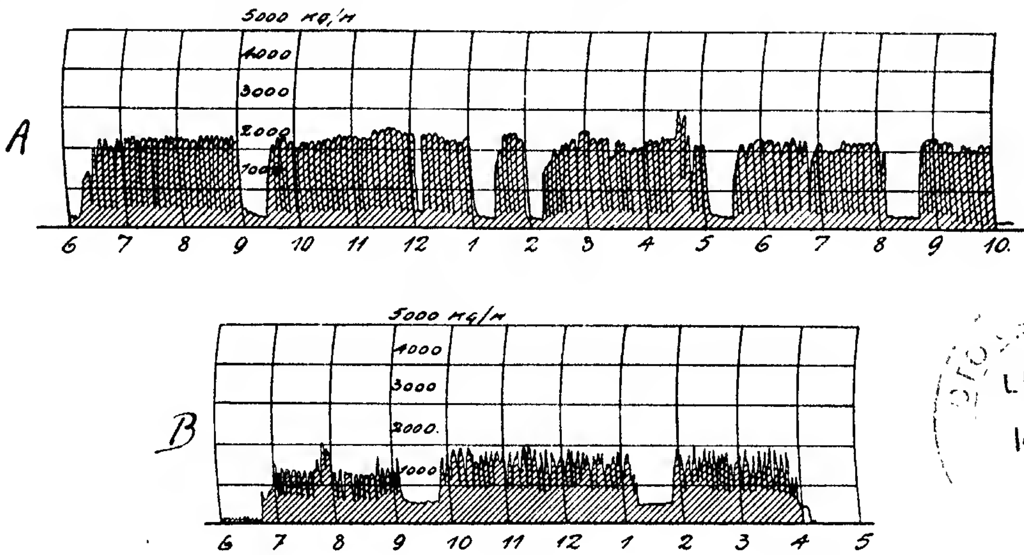

Fig. 3

In order to find the right size of the nozzles we studied the curves of the main steam meter of the department and calculated the nozzle or nozzles to give about 60 per cent. of the maximum indicated by the meter. In some cases it was necessary to give the nozzle a larger diameter, when experience showed that the work could not be satisfactorily carried out because the nozzle did not give sufficient steam. In such cases we increased the diameter step by step, by 0·5 to 1 mm. at a time, in order to avoid getting too big nozzles. The result in every case was a reduction in the amount of steam used.

We have also adopted, with good results, the same system to limit the quantity of cooling-water used in coolers with coils or jackets, as it was found that when the cooling water could leave the cooler with a temperature of, say, 30 to 35° C. it actually ran off at 15 to 20° C., which, of course, meant an extravagant use of water, and power for the pump supplying the water.

JOINT COMMITTEE FOR THE STANDARDISATION OF SCIENTIFIC GLASSWARE

Report on Units of Volume*

The Committee have given much careful consideration to the question of units of volume, and as a result of their deliberations they unanimously recommend:—

That the recognised international metric units—the *litre* (*l*) and *millilitre* or thousandth part of the litre (*ml*)—shall be used as the standard units of volume, and that standard volumetric glassware shall be graduated in terms of these units and marked *ml* instead of *c.c.*

In making this recommendation, the Committee have had in mind the great advantages to be gained by the general use of a uniform system which has been recommended by many scientific bodies, and is at present already extensively used, notably in America. The substitution of the millilitre for the cubic centimetre involves no practical difficulties, as the two units differ only very slightly in magnitude. The difference in capacity between a 1000 c.c. and a 1000 ml. flask is, for example, only one-seventh of the permissible error on a standard 1000 ml. flask.

As in the course of the discussion, it became evident that some chemists still prefer to use Mohr's system of units, and would be unwilling at present to change their existing practice the Committee has felt it desirable to couple with the above recommendation certain proposals designed to remove the confusion at present existing between the two systems of units. These are :—

(1) That the unit of volume on Mohr's system shall

* Slightly abridged. The full pamphlet can be obtained, price 6d. post free, from the Secretary to the Joint Committee, Mr. G. W. Marlow, B.Sc., 30, Russell Square, London W.C. 1.

in future be designated "G.W.A.," and that these letters shall be marked on all volumetric glass vessels graduated on the basis of Mohr's system, and shall be used by chemists when reporting results obtained by the use of such vessels.

(2) That the "G.W.A." unit shall be defined thus:—

1000 G.W.A. = 1002 ml.

These additional recommendations will enable the two systems to be used side by side with a minimum of inconvenience during the transitional period which the Committee realise must precede the universal adoption of the litre and millilitre for general chemical work.

The Committee understands that in view of the above recommendations the National Physical Laboratory will accept for test† vessels graduated on the basis of G.W.A. units, and clearly marked to indicate this, and will place a distinctive mark on approved vessels graduated on this system, but not the Laboratory monogram *NP*, which will be reserved for vessels graduated in millilitres.

Information relating to the two systems of units, and the reasons underlying the above recommendations are given in the following notes.

Metric Units of Volume

The volume of a body of simple geometrical shape can readily be calculated from the linear dimensions of the body. Hence, once the unit of length has been decided upon, the unit of volume should theoretically be defined in terms of the unit of length. The volume of a cube each of whose sides is of unit length becomes automatically the unit of volume; such a definition by its logical simplicity makes an instant appeal to the mind, and it is therefore natural to find in common use such units as the cubic centimetre and the cubic foot, based on the corresponding units of length.

Volumetric measurements, however, are most extensively used when dealing with fluids, and hollow vessels of known capacity have long been used for measuring volumes of liquid. But whereas it is extremely difficult to determine accurately the capacity of a hollow vessel from measurements of its internal dimensions, the weight of liquid required to fill a vessel can, on the contrary, be determined easily and with a high degree of precision. Hence units of volume have come into use which are not defined in terms of the units of length, but as the volumes occupied by specified weights of a particular liquid—usually water. The gallon and the litre are units of this kind.

Two distinct types of units of volume have thus come into general use. Sooner or later under any system the necessity arises of determining the relation between the two types of units, of determining, for example, the number of gallons in a cubic foot. In the older systems of units the two types of units of volume were defined independently of each other, and as a result no simple numerical relation exists between them. The number of gallons in a cubic foot, for example, is not represented by a simple whole number.

One of the objects of the founders of the Metric System was to secure a simple numerical relation between the two types of units of volume. It was intended to achieve this by defining the unit of mass, the kilogram, as the mass of a quantity of water which at its temperature of maximum density occupied a cubic decimetre. The unit of volume, the litre, could then be defined indifferently either as a cubic decimetre or as the space occupied by a kilogram of water at its temperature of maximum density.

A cubic decimetre of water is, however, manifestly unsuitable for practical use as a standard weight. To give practical effect to the system it was necessary to make a standard kilogram weight whose mass should be in accordance with the definition laid down. A standard kilogram weight—the "Kilogramme des Archives"—was prepared with great care and skill at the end of the eighteenth century, but during the nineteenth century distrust in the accuracy of the work arose. Consequently in 1872 the *Commission Internationale du Metre* discussed the matter fully in all its bearings and decided that the International Kilogram should be deduced from the Kilogram des Archives in its actual state. The original definition of the kilogram was thus abandoned, and the kilogram was re-defined as the mass of a particular standard weight.

The definition of the litre was subsequently revised* in conformity with this change, and the accepted definition at the present time is:—

"The unit volume for determinations of high precision is the volume occupied by a mass of one kilogram of pure water at its temperature of maximum density and under normal atmospheric pressure†; this volume is termed the litre."

It is important to observe that the definition of the litre is now absolutely independent of the metric units of length. The cubic centimetre, on the other hand, being simply the volume of a cube whose edges are one centimetre long, is completely defined without any reference to the volume of a mass of water. Thus no direct relation between the litre and the cubic centimetre results from the definitions of these units. This relation can only be obtained by direct experimental determination, and the most accurate determination available is that carried out at the Bureau International des Poids et Mesures. M. Benoit‡ in his summary of the work gives as the most probably value

1 litre=1000·027 c.c.

and states that the uncertainty of this value probably does not exceed one unit in the last decimal place.

The difference between the cubic centimetre and the millilitre is so small as to be negligible for ordinary volumetric glassware. The term "cubic centimetre" has, however, been misapplied by the

† A pamphlet giving details of the tests on volumetric glassware carried out at the National Physical Laboratory may be obtained free of charge on application to The Director, The National Physical Laboretory, Teddington, Middlesex.

* *Trav. et Mem.*, 1920, 12.

† Water is slightly compressible, and hence the volume of any given quantity of water varies slightly with the pressure to which it is subjected. Hence, to be precise the definition of the litre must state the pressure to which the water is to be subjected.

‡ *Trav. et Mem.*, 1910, 14.

users of Mohr's system to denote the volume of a quantity of water having an apparent weight in air of 1 gram. A flask which contains an amount of water weighing 1000 grams in air has a capacity of almost exactly 1002 c.c. To speak of such a flask as a 1000 c.c. flask is clearly inadmissible. Volumetric glassware, manufactured by the leading British firms, and marked "c.c.," may safely be relied upon as having been calibrated on the basis of the cubic centimetre. Volumetric glassware of foreign manufacture similarly marked "c.c.," may have been calibrated in terms of either the cubic centimetre or grammes of water.

In view of this confusion in the use of the term cubic centimetre, and of the fact that the cubic centimetre is not exactly one thousandth part of a litre, and further, because the mass of water which occupies 1 c.c. under definitely specified conditions cannot be directly derived from the accepted definition of the litre, the Committee adopted the recommendation given above.

The acceptance of this recommendation by chemists and manufacturers of volumetric glassware would bring the practice in this country into line with that in other countries, notably America, and would give effect to the recommendation of numerous scientific bodies that the litre, as defined above, should be exclusively used as the unit of volume in all scientific work. The publication of all results in terms of millilitres would secure a uniformity which is at present lacking, and remove the uncertainty due to the term cubic centimetre being used sometimes correctly, sometimes as equivalent to the millilitre, and sometimes as the space occupied, under conditions not generally well defined, by a quantity of water which has an apparent weight in air of one gram.

Mohr's System

According to Mohr's original proposal a "litre" flask would be adjusted so that when filled with water at 17·5° C. it would contain an amount of water which, when weighed in air against brass weights, had an apparent weight of 1000 grams. Such a flask would contain almost exactly 1002 c.c. The term cubic centimetre was misapplied to the thousandth part of this volume. This misuse of both the terms litre and cubic centimetre still persists.

Some chemists still maintain that it is more convenient in practice to use as a unit of volume the space occupied by a quantity of water which has an apparent weight of 1 gram in air at ordinary room temperature.

To avoid confusion resulting from the use of the terms "litre" and "cubic centimetre" in connexion with such units, the Committee recommends (see (1),) that the letters "G.W.A."—a mnemonical abbreviation for "grams of water in air"—shall be used in describing such units.

It is further necessary that an exact definition of the "G.W.A." unit be adopted.

A quantity of water which weighs 1000 grams in air of density 0·0012 g./ml. when weighed against brass weights of density 8·4 g./ml. occupies a volume of 1002·021 ml. at 60° F. This volume differs from 1002 ml. by only two parts in a hundred thousand, which is negligibly small in comparison with the tolerances allowed on volumetric glassware, and the accuracy attainable in the ordinary use of such glassware. Hence the committee on grounds both of convenience and precision has adopted the definition given in recommendation (2), namely :—

1000 G.W.A. = 1002 ml.

This relation defines the G.W.A. unit in a simple and accurate manner, and at the same time gives it a value which differs only by a negligible amount from the volume occupied at room temperature (60° F.) by a quantity of water which has an apparent weight of 1 g. when weighed in air against brass weights.

The above definition enables conversion from millilitres to G.W.A. units and *vice versa* to be easily made, and will enable the two units to be used side by side without confusion during the transitional period which must elapse before the universal adoption of the litre and millilitre is obtained in this country.

August, 1924

ACADÉMIE DES SCIENCES

On August 11, Monsieur M. Vinogradski described his work on the microscopic analysis of arable soild and on August 18, Prof. Haller read a paper on the decomposition of chloroform. On August 25 M. Leconte communicated a paper by E. Picard on the solubility of tannins in relation to extraction. The work shows that to extract the different tannins completely from vegetable tissues, different solvents have to be used

FORTHCOMING EVENTS

Sept. 15. British Empire Exhibition. Conferences of Engineering Societies, to be held in Conference Hall No. 4, at 10.30 a.m. Short papers on various Engineering Subjects will be read and discussed.

Sept. 18 and 19. The Ceramic Society. Refractory Materials Section Meeting, in Conference Hall No. 4, British Empire Exhibition, Wembley.

The following papers will be read :—"A Comparison of Gas and Coke Fired Drying Stoves, together with a Description of the Construction and Operation of the Huttenes Coke-Fired Air-Blown Furnace," by T. W. Barley; "Some Properties of Clay Silomanite Mixtures," by J. W. Cobb and H. S. Houldsworth, "The Influence of Exposure on the Chemical and Physical Properties of Certain Fireclays," by W. Hugill and W. J. Rees; "On the Action of Heat on Kaolinite and Kolinitic Clays" (Communicated Paper), by W. Vernadsky; "Alumina-Silica Minerals in Firebricks," by W. J. Rees; "The Action of Heat on Kaolinite and other Clays," Part II, by J. W. Mellor and A. Scott; "The Origin of the Austrian Magnesite Deposits," by A. Scott; "X-ray Investigation of Clays and other Ceramic Substances. Researches into the Application and Practical Value of the Method," by A. Hadding; "Note on the Storage of Silica Refractories," by W. J. Rees; "The True Specific Gravity and After Expansion of Lime-bonded Silica Bricks," by W. J. Rees; "A Rapid Method for the Determination of True (or Powder) Specific Gravity," by W. Hugill and W. J. Rees.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr W. J. U. Woolcock, C.B.E., President of the Society.

A circular letter with further particulars and a form of application for tickets has been sent out to the members.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

BRISTOL SECTION, SESSION 1924-25

The meetings are held at 7.30 p.m. in the Chemical Department of the University (Woodland Road), and will be held in each case jointly with the local section of the Institute of Chemistry. On October 2 the session opens with an address by H. T. Ringrose, on "Combustion Control in Boiler Houses." E. J. Holmyard will speak on "The Present Position of the Geber Problem" on November 6, and on December 4 W. E. Fearnsides will present a paper on "Some International Aspects of the Dye Industry."

The meetings in 1925 will commence on January 8 and will be held jointly with the Chemical Society, the title of the address to be announced later. On February 5, P. G. J. Gueterbock will speak on "Tin," and on March 5 a General Meeting for the election of officers will take place, the Chairman's address being on "Paint and Paint Making."

It is proposed to hold the Annual Dinner jointly with the Institute of Chemistry and the Chemical Society. The date will be announced later. Visits to works are also being arranged.

SYDNEY (NEW SOUTH WALES) SECTION

The Secretary of the Section reports that an additional meeting was held in July, and that it is hoped to hold one regularly every month, as there is plenty of matter to discuss.

At the meeting on July 23, a discussion took place upon a previous lecture on Chilean Nitrates.

The Section has made an arrangement with a leading firm of technical booksellers by which the most recent publications are lent to be displayed at the evening meetings, and as quite a number of members living over a scattered area have no chance of seeing those books during the day, the plan appears to be thoroughly appreciated.

The practice of members holding a little dinner before each meeting has also been adopted.

It is proposed to follow the example of many of the Home and Canadian Sections of the Society in admitting Associates to the Section. In this way it is hoped to attract to the meetings students who will ultimately become members of the Society.

CORRESPONDENCE

JOINT COMMITTEE FOR THE STANDARDISATION OF SCIENTIFIC GLASSWARE

Sir,—The Joint Committee for the Standardisation of Scientific Glassware is a committee, working under the *ægis* of the Institute of Chemistry, having members representing the users, manufacturers, dealers and Government Departments interested in scientific glassware. The Committee was formed to consider questions relating to the standardisation of scientific glassware. A list of members is given in the report on Units of Volume.

The Committee have given very careful consideration to the fundamental question of units of volume, and desire to call your attention to the enclosed report* which embodies their recommendations. It is hoped that these recommendations will be accepted generally by those responsible for the instruction of students.

A further question to which the Committee have devoted considerable time is the accuracy of volumetric glassware. It was considered that two grades of volumetric glassware, and two only, are desirable and necessary, namely :—

Class A, or Standard Apparatus

This must be of the highest accuracy reasonably attainable, of best quality materials and workmanship, and each vessel should be tested and approved by an impartial institution before being accepted as of standard grade. The National Physical Laboratory is the appropriate institution in this country for carrying out the tests.

Class B, or Commercial Grade Apparatus

This is a cheaper quality apparatus for general use, but guaranteed by the manufacturer to conform with definitely recognised limits of accuracy and other necessary requirements.

The specification for Class B apparatus must necessarily be less stringent than for Class A apparatus and should, for the sake of economy, make the minimum demands on the manufacturer consistent with satisfactory service for work in which commercial grade apparatus may reasonably be employed.

The Committee consider that the regulations for the Class A Tests and Class B Tests on volumetric glassware laid down by the National Physical Laboratory form a satisfactory basis for the two grades of apparatus. These regulations are contained in a Laboratory test pamphlet † which has recently been revised and the National Physical Laboratory has afforded the Committee the fullest opportunity of co-operating in the revision.

The manufacturers' representatives on the Committee have agreed to supply, in addition to standard Class A apparatus tested at the National Physical Laboratory, Class B apparatus guaranteed by themselves. They will undertake to replace any article so guaranteed and found not to fulfil the requirements of the National Physical Laboratory regulations for Class B apparatus, with apparatus tested at the National Physical Laboratory, and bearing the Laboratory mark signifying that it complies with the

* See p. 913. † See p. 919

Class B requirements. No charge will be made by the manufacturers for any such replacements.

The sale, purchase or use of volumetric apparatus inferior in quality to Class B apparatus is detrimental to the best interests of all concerned, and the Committee hopes to see the elimination of all such inferior apparatus. Candidates for examination, in particular, should be entitled to put confidence in the accuracy of the apparatus with which they are provided, and if they are given inferior apparatus they are liable to suffer grave injustice in the assessment of their work by reason of errors which lie outside the scope of their own manipulation.

The success of the Committee's efforts must ultimately depend upon the action taken by purchasers of volumetric glassware. The Committee would therefore urge upon educational authorities and institutions the desirability, when they are purchasing volumetric glassware, of specifying either:—

(*a*) That the apparatus must have passed the Class A tests at the National Physical Laboratory and be accompanied with a Laboratory certificate.

or (*b*) That the apparatus must have passed the Class A tests at the National Physical Laboratory—certificate of corrections not required.

or (*c*) That the apparatus must have passed the Class B tests at the National Physical Laboratory.

or (*d*) That the apparatus must be guaranteed by the vendor to comply with the National Physical Laboratory regulations for Class B tests.

The alternative adopted will, of course, depend upon the purpose for which the apparatus is required.

The Joint Committee fully realise that for elementary teaching purposes economy in initial outlay on apparatus is a necessity. They feel confident, however, that subject to a satisfactory demand, manufacturers will be able to supply guaranteed Class B apparatus at prices consistent with reasonable economy. They also believe that it will be found ultimately more economical for advanced work and research, for which apparatus of doubtful accuracy cannot be tolerated and calibration is essential, to purchase tested Class A apparatus rather than to purchase untested apparatus and invariably carry out a calibration after purchase.

Finally, the Committee would urge most strongly that under no circumstances should orders for volumetric glassware be placed without definite limits of error being specified, as failure to do so tends to encourage the production of inferior apparatus in which quality and accuracy are unduly sacrificed for cheapness. Some of the cheaper calibrated apparatus is known to be so inaccurate as to lead to grave errors, even in the most simple determinations. The Committee believe it will be found that the simplest and most satisfactory way of specifying limits will be to refer to the National Physical Laboratory tests as indicated previously.—I am, Sir, etc.,

G. W. Marlow

Secretary to the Joint Committee

30, Russell Square, W.C. 1
August, 1924

OPTICAL ACTIVITY AND POLARITY THEORIES

Sir,—Much of the criticism passed by Dr. Boyd in your issue of August 22 upon some suggestions of mine relating to optical activity and the polarity of groups (*J.C.S.*, 1924, **125**, 1121) is based on misunderstanding which would probably disappear on a more careful reading of the paper in question.

It is true that there is as yet no agreement between chemists as to the exact meaning of the word polarity used in connexion with atoms and groups, and these differences are rightly emphasised by Dr. Boyd. But from the order in which he raises the points in his letter he appears under the impression that my derivation of a polar series from inductive capacities was purely by way of confirmation to that derived from benzene substitution and acidic strengths. A further reference to the paper will, I think, convince him that the whole argument is based on certain conclusions of Sir J. J. Thomson (*Phil. Mag.*, 1923, vi, **46**, 497), by means of which the relative polarity of *simple* substituents may be derived from inductive capacities.

Sir J. J. Thomson compares the introduction of a substituent into a hydrocarbon chain to that of an electric doublet of variable sign and strength. In the case of a *methyl* or *hydroxyl* group, for example, the doublet is arranged with its positive end at the electron linking the group to the parent molecule and its *negative* end free. On the other hand, a *nitro* or *carboxyl* group is represented as a doublet with its negative end towards the parent molecule and its *positive* end free. In this manner substituents are divided into two classes of opposite polarity, *e.g.*, NO_2, COOH, CN, and H of the one type, and CH_3, the halogens and OH of the other. This classification is in complete agreement with that adopted by the exponents of induced alternate polarity. An induced alternate polarity, however, is not necessarily the only or even the chief result of the presence of a substituent of high polar character. Moreover, induced alternate polarity is presumably transmitted through the chain of atoms, whereas the polar influence of a substituent may, as suggested by Sir J. J. Thomson, be due to the electrical changes around as well as within the molecule.

Dr. Boyd fails to understand how a series such as NO_2, CN, H, CH_3, Cl, is obtained from inductive capacities. Sir J. J. Thomson states that the change in inductive capacity following on substitution is a measure of the strength of the doublet introduced. Hence the relative effect produced by different substituents when attached to hydrogen or hydrocarbon radicals, which are themselves of low inductive power, provides a means of estimating their relative polarity. With a comparatively non-polar compound such as a hydrocarbon the inductive capacity is raised by positive and negative substituents alike, although the electrostatic moment of the derivative formed in the one case will be of the opposite orientation to that formed in the other. For this reason the sign to be attached to the substituent must be determined in some other manner, and the general polar series NO_2, CN, Cl, CH_3, H

which represents relative magnitudes irrespective of sign, must be rearranged to NO_2, CN, H, CH_3, Cl, indicating a change from high positive polarity through neutral to high negative polarity.

In its final form the series closely represents the relative effect of the substituents on benzene substitution and the optical activity of certain *d*-amyl and *l*-menthyl derivatives.

The derivation of this series from inductive capacities is described in the above paper, followed by the statement that approximately the same sequence can be obtained *in a similar manner* from the dissociation constants of acetic or benzoic acids. Dr. Boyd has evidently overlooked the words here italicised.

Again, Dr. Boyd first and quite unjustifiably assumes that when I refer to the polarity of a group I am thinking of the induced polar influence of this group, and then applies the principle of induced alternate polarities to examples quoted in my paper in order to show that the induced effects bear no relation to the optical activity. His conclusion at all events is in agreement with the facts as we know them, but it does not affect my argument. I have in no way attempted to correlate optical activity with induced alternate polarity. According to Sir J. J. Thomson (*loc. cit.*) the intense electric field due to the introduction of a radical such as Cl or OH will bring about a great change in the distribution of electrical forces in and around the molecule. The change due to a negative substituent must therefore be in the opposite direction to that due to a positive one.

Finally Dr. Boyd writes that I use the term polarity in a sense differing from either of the meanings hitherto attached to it. In this I think he is confusing polarity with the effects supposed to be consequent upon polarity. The suggestions under discussion have yet to be tested in the light of further experimental evidence, but they require no new conception of polarity. Rather do they allow two of the meanings at present in use to be reduced to one.—I am, Sir, etc., H. G. Rule

Edinburgh University

PERSONAL AND OTHER ITEMS

At the luncheon held by the Institute of Metals in the Connaught Rooms on September 9, Mr. W. J. U. Woolcock, C.B.E., President of the Society of Chemical Industry, responded to the toast of "Our Guests."

On September 13, Dr. E. F. Armstrong, F.R.S., will commence his two months' tour in America, where he will travel extensively in the Eastern States. On October 17 he will address a joint meeting of several chemical organisations in New York. He will also lecture at Yale, Princetown and Philadelphia. His subject on October 17 will be "The Fats from Many Aspects."

Prof. F. Soddy, F.R.S., has been elected a foreign member of the Reale Accademia Nazionale dei Lincei of Rome.

Mr. Roscoe Brunner, chairman of Brunner, Mond and Co., Ltd., and Captain the Hon. William Hulme-Lever, a director of Lever Brothers, Ltd., have been appointed Deputy Lieutenants for the county of Chester.

On September 6, a bronze tablet commemorating the centenary of the discovery of Portland cement by Joseph Aspdin was unveiled in the entrance of the Leeds Town Hall, by a delegation of the Portland Cement Company of America, the donor of the memorial.

Dr. W. J. Huff has been appointed to the chair of gas engineering established at the John Hopkins University, with funds provided by the Southern Gas Association.

August 16 was the twenty-fifth anniversary of the death of Bunsen (1811—1899).

The death is announced of Dr. Adolf Römer, a pupil of Lothar Meyer, who, after working some time with the Badische Co., did valuable work on dye and tannin extracts, particularly in connexion with the use of mangrove bark, work described at the seventh International Congress of Applied Chemistry in London.

Alex. E. Macrae, B.Sc., chemical and metallurgical examiner in the Canadian Patent Office, has retired. He has established himself, in Ottawa, as a Patent Solicitor. Mr. Macrae is Secretary of the Ottawa Section of Society of Chemical Industry.

Prof. C. E. Munroe, chairman of the Committee on explosives investigations of the U.S. National Research Council, has been elected an honorary fellow of the American Institute of Chemists. The only other honorary fellow of the American Institute is Prof. C. F. Chandler.

Dr. Ellwood Hendrick has been appointed curator of the Chandler Chemical Museum at Columbia University. The museum, due to Prof. C. F. Chandler, includes the raw and finished products of manufacture of most of the important industries. Amongst the exhibits are dyestuffs and intermediates, many inorganic and organic chemicals, oils and fats and their products, ceramic and metallurgical products as well as natural products, photographic products and processes, and many other products of industry.

From Italy the death is announced of Prof. F. Martinotti, Director of the Royal Experimental Station for Oenology at Asti. Prof Martinotti had carried out investigations on the cultivation of vines, insecticides, the use of refrigeration in wine-making, and the modern technique for making sparkling wines is largely due to him His last work bore on the production of non-alcoholic sparkling wines, a problem which he had apparently solved.

Dr. E. Galli, whose death is announced, was director of the municipal chemical laboratory of Milan and had founded a successful school of baking.

Tests on Volumetric Glassware

The Metrology Department of the National Physical Laboratory has issued a revised edition of the pamphlet describing tests on volumetric glassware, including both Class A and Class B tests. Descriptions are given of tho general conditions and methods of tests, details of regulations and tolerances for various apparatus and regulations governing Class B tests, and for vessels graduated in "G.W.A." units, together with a list of fees chargeable. Any member of the Society of Chemical Industry who desires a copy may obtain one free of charge, on application to the Director of the National Physical Laboratory, Teddington, Middlesex.

Phosphatic Fertilisers in Germany

According to the "Deutsche Berwerkszeitung," the consumption of phosphatic fertilisers during the current agricultural year has decreased by 65 per cent. compared with the previous year. During the period May 1—December 31, 1923, only 82,000 tons was applied, whereas 336,000 t. was used during the same period of 1913. Prices are much higher than during the war.

Copper Consumption in Szechwan (China)

The amount of copper consumed annually by the Chengtu Mint, the Chungking Mint and the Chengtu Arsenal is 12,000 t., either in the coinage of coppers or in the manufacture of alloys for arms and ammunition. The province itself produces about 600 t. a year, and imports about 1200 t. from the neighbouring province of Yunnan. For the remainder Szechwan province relies on foreign importations, chiefly from the United States. As the province is not politically at rest, only about 8000 t. is now consumed, mostly for the coinage of copper coins.

New Soap Works in Chungking

A new soap works known as the Sun Soap Manufacturing Co has just been opened in the immediate neighbourhood of Chungking. A wholesale department of the same company will also be opened up in the Chungking Bazaar. The company has turned out over twelve kinds of soaps.

Bromine Production in Germany

The output of bromine in Germany in 1923 amounted to 1140 t., compared with 1280 t. in 1922 and 460 t. in 1921. This increase in 1922 and 1923 is attributed, in part, to the greater consumption of the photographic industry.

A Giant Coke-Oven Plant

The Carnegie Steel Company has just completed what is said to be the largest by-product coke plant in the world at its Clairton, Pa., works. It has been in course of construction for about two years, and supplements the original by-product coke plant at this place. The new plant consists of 366 ovens, arranged in six batteries of 61 ovens each. It has a daily capacity for carbonising 8500 t. of coal, producing in this period a total of 6000 t. of coke, 55 million cb. ft. of gas, 90,000 gall. of tar, 215,000 lb. of ammonium sulphate and 25,000 gall. of benzol products. It is proposed to develop the new works to their maximum capacity as soon as the conditions warrant.—(*Chem. and Met. Eng.*, *July* 14, 1924.)

REVIEWS

Drying by Means of Air and Steam. By E. Hausbrand. Third revised English edition. Pp. viii+77. London: Scott, Greenwood and Son, 1924. Price 6s.

Previous editions of this standard work have made it familiar to most of those who deal with this type of problem. The main difference in the present edition is the addition of an appendix containing various diagrams relating English and metric units. This is a distinct help, though it would be more so if it included a few compound conversions such as "kilos per cubic metre" to "lbs. per cubic foot," etc. Also in Tables 1 and 3 it would be helpful if there were a blank space at every sixth line, as the eye is apt to lose its way among such closely packed figures.

There is no revision of any consequence in the text itself. The initial chapters deal with the calculation of the amount of vapour in a kilo of air at various temperatures and pressures, and the results are tabulated and also shown on a chart. The method is then extended to deal with the weight and volume of air, and expenditure of heat to evaporate 100 kilos of water, under various conditions of temperature, pressure and final saturations. The tables of volumes, weights and pressures of saturated vapour and the accompanying dry air are very convenient. Drying by means of superheated steam without air is discussed, and also the necessary dimensions of heating surfaces and drying rooms.

The calculations are clear and readily followed, though the formulæ used for ascertaining the latent heat of evaporation, etc., may appeal less to some than, say, those employed in compiling the Callendar steam tables. Some of the assumptions might be called a little into question: for instance, that a very slightly superheated vapour behaves as a permanent gas (p. 19), but may be justified on the ground of the complication which would be introduced by a more exact consideration, which would lead to substantially similar results in practically all cases.

The book is indispensable to all students of the subject, and even the experts will find a useful guide in the tables and charts.

Chemisch-Technische Vorschriften. Part IV.—Dungemittel (Sprengstoffe), Futtermittel, Lebensmittel. By Dr. O. Lange. Third edition, completely revised and enlarged. Pp. 21+750. Leipzig: O. Spamer, 1924. Price: Paper 45 goldmarks, bound 50 gm.

This is volume four of "a handbook of special chemical technology, especially for chemical factories and related technical industries, containing recipes from all branches of chemical technology and comprehensive references to the literature." It comprises 716 large closely printed pages of matter, and 33 three-column small type pages of index.

A brief summary of the chief contents will give some idea of the number of subjects treated in this volume:

Fertilisers—Plant nutrition, 6 pp.; Alkali salts, potash and lime fertilisers, halogens, 44 pp.; Phosphorus, sulphur and compounds, 42 pp.: Nitrogenous fertilisers (nitrogen, oxygen, ozone, hydrogen peroxide, per-salts, oxidation of nitrogen, nitrates, cyanogen derivatives, carbides, acetylene, calcium cyanamide, metallic nitrides, hydrogen, ammonia, ammonium compounds), 128 pp.; Farm manures, mixed fertilisers, plant stimulants, soil sterilisation, 30 pp.; Explosives nitrate powders, chlorate, perchlorate and liquid oxygen explosives, guncotton, nitroglycerine, etc., propellants, aromatic nitro-explosives, detonators, 103 pp.; Pyrotechnics, matches, fire-lighters, fuel briquettes, fire extinguishers, 48 pp.; Fodder, 32 pp.; Foodstuffs—Food preservatives and colourings, starch, flour, bread, sugar, legumes and vegetables, seasonings, milk and dairy products, milk preparations, casein, cheese, edible fats and oils, eggs, flesh, products from blood, ferments and albumin, nutritive salts, 195 pp.; fruits and beverages, organic acids, 52 pp.; tea, coffee, cocoa, tobacco, 30 pp.

The diversity of the subject-matter necessitates the briefest treatment of even the most important processes, and many of the less important ones are dismissed in a few lines with a reference to a patent, usually German. A few examples taken at random will show the scope of the treatment. The description of the various processes for the manufacture of caustic alkali by the electrolyses of alkali chlorides is compressed into three and a third pages. Of the 51 references to literature in this section 15 are to German scientific publications, 1 to this *Journal*, 28 to German patents, 4 to English patents, 2 to American patents and 1 to a Norwegian patent. The manufacture of superphosphate occupies a page, with 10 references to German literature and 1 to English. Three and half pages are devoted to the manufacture and properties of nitroglycerin and the recovery of the waste acids; the description of the actual manufacturing process occupies only a page. There are 33 references to German literature and patents, 3 to French, 2 to American, and 1 to English.

The appearance of this, the third edition, indicates that there is a demand for the book, and it certainly contains a mass of compressed information on a great variety of subjects, many of which are unfamiliar to the ordinary chemist. This applies especially to the section on food stuffs, and the manufacturer of food preparations or his chemist (if he employs one) might obtain a new idea here and there. To British manufacturers engaged in the larger chemical industries, however, the book does not seem to offer much that is not already accessible in English.

J. KNOX

Dr. J. E. Mills has been appointed chief chemist in charge of the research work of the United States Chemical Warfare Service. He has already served many years in the Service as chief co-ordinator at Edgewood Arsenal.

COMPANY NEWS

NOBEL INDUSTRIES, LTD.

According to the report for the year 1923, the gross profit amounts to £1,178,443, an increase of £21,306, whilst the net profit, after meeting the interest on debenture stock requiring £112,977 (against £176,100 for note interest), is £1,065,466, compared with £980,137. During the year the £3,000,000 eight per cent. notes were repaid, and £1,750,000 5½ per cent. debenture stock issued. After providing £30,000 premium on redemption of the notes, and writing off one-thirtieth of the cost of the debenture issue £2977, there remains £1,032,489, to which is added £509,018 brought in, making £1,541,507 available. A dividend of 8 per cent. less tax, has been paid against 7 per cent., less tax, for 1922, and the directors propose to place £100,000 to the special investment reserve (against £50,000), thereby increasing that fund to £500,000, carrying forward the increased balance of £650,130. The cost of note issue has now been wiped out, £186,181 having been taken from the profits of 1922 for the purpose. The cost of debenture issue now stands at £86,333.

CALICO PRINTERS' ASSOCIATION, LTD.

The accounts for the year ended June 30, show a net profit of £540,786, after providing for corporation tax, for maintenance, depreciation, repairs, renewals and upkeep, and for debenture interest. This amount, with £235,432 brought forward, makes available £776,218, of which £155,725 is to be placed to reserve, and £50,000 to the employees' benefit fund. With a dividend of 10 per cent. (less tax on the ordinary shares, £218,614 is left to be carried forward. The net profit for 1922–23 was £800,208 and £237,371 was brought in. The reserve received £150,000, dividend reserve, £150,000, and employees fund, £100,000. The ordinary dividend was 10 per cent., plus a bonus of 2½ per cent., compared with 7½ per cent. paid for 1921–22.

SILICA GEL, LTD.

The registered capital is £315,500 in 300,000 8 per cent. non-cumulative preference shares of £ and 310,000 ordinary shares of 1s. each. The object of the company are to acquire any interests in any invention relating to modern processes and apparatus for effecting the separation of/and or recovering gases, and for processes for the recovery of liquid solutes from non-aqueous solutions and processes for the treatment of liquids, to remove or recover substances therefrom for the manufacture of silica gel and other gels and similar products, or generally any invention which may seem to the company capable of being profitably dealt with; in particular to acquire from the Silica Gel Corporation a right to use and vend all patents and processes, plant machinery and apparatus belonging to that company in connexion with silica gel, and to carry on the business of manufacturers of and dealers in the same and other similar substances, chemists, druggists

drysalters, oil and colourmen, manufacturers of and dealers in chemicals and manures, distillers, dye-makers, gas makers, iron founders, engineers, winners and workers of minerals, producers and workers of metals, and producers and preparers of any other materials, including oil, which may be usefully and conveniently combined with the engineering or manufacturing business of the company, etc.

BRITISH SULPHATE OF COPPER ASSOCIATION, LTD.

The policy of this new Association, which has been registered as a private concern, limited by guarantee, will be the co-ordination of British manufacturers, thereby reducing overhead charges, so as to compete more easily with foreign manufacturers, who by using their depreciated currency, are enabled to sell abroad at "cut" prices. The brands affected by this arrangement are, at present, "Maple," "Three Leaf," "Macclesfield," sometimes called "Crown" and "McKechnie." The control is invested in a management committee, the first members of which are the Mond Nickel Co., Ltd., McKechnie Bros., and J. H. Dennis and Sons.

The registered offices are at 39, Victoria Street, Westminster, S.W. 1, but the headquarters of the Association will eventually be established at Victoria House, Victoria Street, S.W. 1. Mr. W. J. Livesey, sales manager of the Mond Nickel Co., Ltd., is acting as general manager to the Association.

EASTMAN KODAK COMPANY OF NEW JERSEY

A regular dividend of $1\frac{1}{2}$ per cent. on preferred stock, and of 1·25 dollars per share on common stock, and an extra dividend of 75 cents. per share on common stock is payable on October 1.

AMERICAN CYANAMID CO.

The net income for the year ended June 30, amounted to $1,447,026 ($1,878,089 in the preceding year). This figure does not include the net income of the subsidiary companies, amounting, after allowing for taxes, to $108,488. The surplus brought forward was $1,496,352, and the past year's net income provides a total of $2,943,377. The deductions made from this sum are: Sundry charges, less credits for periods prior to July 1, 1923, $69,322; reduction of investment in Amalgamated Phosphate Co., $1,000,000; dividends on preferred stock, $335,754; dividends on common stock, $362,687 (against $65,943). The surplus as at June 30 last is thus reduced to $1,039,268. It is stated that $1,371,576 was expended during the year for additional real estate and for plant extensions, etc., principally at Niagara Falls. The claim of the Government for additional taxes still remains undetermined. Settlements have been made, or arranged for with respect to the principal claims pending against the company growing out of contracts made by the Amalgamated Phosphate Company before its acquisition by this company.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder..	£47 per ton.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non arsenical, £6 15s. per ton.
Ammonia Alkali.. ..	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal..	£25 per ton.
Powder..	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d.
Nickel Sulphate	£38 per ton d/d. Normal business.
Nickel Ammon. Sulphate	
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	$5\frac{1}{4}$d. per lb.
Potass. Chlorate.. ..	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake..	£3 10s. per ton d/d.
Soda Caustic, solid ..	Spot lots: delivered £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton, carr. paid.
Sod. Bichromate.. ..	$4\frac{1}{2}$d. per lb.
Sod. Bisulphite Powder 60/62%..	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst. ..	£9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	$5\frac{3}{4}$d.—1s. 4d. per lb., according to quality.

Antimony sulphide—	
Crimson	.. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	.. £3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	.. 3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	.. £30—£33 per ton, according to quantity. Again dearer.
Carbon Black ..	.. 7d.—7½d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	.. £60—£65 per ton, according to quantity, drums extra. Again dearer.
Chromium Oxide, green ..	1s. 3d. per lb.
Indiarubber Substitutes White and Dark ..	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black ..	.. £48 per ton, barrels free. Advanced.
Lead Hyposulphite	.. 7½d. per lb.
Lithopone, 30% ..	.. £22 10s. per ton.
Mineral Rubber "Rubpron"	.. £16 5s. per ton f.o.r. London.
Sulphur	.. £10—£12 per ton, according to quality.
Sulphur Precip. B.P.	.. £56—£57 per ton, according to quantity.
Sulphur Chloride	.. 4d. per lb., carboys extra. Dearer.
Thiocarbanilide ..	.. 2s. 6d. per lb.
Vermilion, pale or deep ..	5s. 1d. per lb. dearer.
Zinc Sulphide ..	.. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

"Summer conditions" prevail in this as in most industries.

Acetate of Lime—	
Brown	.. £12—£12 5s. per ton d/d. Market easier.
Grey	.. £17—£18 per ton. Market easier.
Liquor	.. 9d. per gall. 32° Tw.
Charcoal	.. £7 10s.—£9 per ton, according to grade and locality. Demand fairly good.
Iron Liquor ..	.. 1s. 7d. per gall. 32° Tw. 1s. 2d. ,, ,, 24° Tw.
Red Liquor ..	.. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote ..	.. 2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible ..	.. 4s. 10d.—5s. per gall. 60% O.P. Market dull.
Solvent	.. 5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar ..	.. £4 per ton. Cheaper.
Brown Sugar of Lead ..	£44 per ton. Cheaper.

TAR PRODUCTS

Acid Carbolic—	
Crystals ..	.. 6½d. per lb. Quiet.
Crude 60's ..	.. 1s. 9d.—1s. 11d. per gall, according to district. Still quiet.
Acid Cresylic, 97/99	.. 2s.—2s. 1d. per gall. Demand fair.
Pale 95% ..	.. 1s. 9d.—2s. per gall.
Dark	.. 1s. 9d.—2s. per gall. Quiet.
Anthracene Paste 40% .	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained ..	.. 7½d.—9d. per gall. Quiet.
Unstrained ..	.. 6½d.—7½d. per gall.
Benzole—	
Crude 65's ..	.. 7½d.—9d. per gall. ex works in tank wagons.
Benzole—	
Standard Motor	.. 1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Pure	.. 1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90% ..	.. 1s. 5d.—1s. 5½d. per gall. Small demand.
Pure ..	.. 1s. 8d.—2s. per gall. Small demand.
Xylol coml. ..	.. 2s. 3d. per gall.
Pure ..	.. 3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	..8 ½d. per gall. Not much business.
Middle Oil .. Heavy Oil .. Standard Specification	5d.—6½d. per gall., according to quality and district. Small export inquiry. Market quiet but fairly steady.
Naphtha—	
Solvent 90/160	.. 11d.—1s. 5d. per gall., according to district. Fair demand.
Solvent 90/190	.. 11d.—1s. 4d. per gall. Fair demand.
Naphthalene Crude—	
Market dull. Not much export inquiry. Cheaper in Yorkshire than Lancashire.	
Drained Creosote Salts £4—£6. Quiet.	
Whizzed or hot pressed £7—£9 per ton.	
Naphthalene—	
Crystals and Flaked	.. £13—£16 per ton in Yorkshire and London respectively.
Pitch, medium soft	.. 55s.—60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160	.. 19s. per gall. Again dearer. Market firm.
Heavy ..	.. 12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

Business in dyestuffs has improved and enquiries are now much better. Prices remain firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 7d. per lb.
Acid H.	.. 4s. per lb. 100% basis d/d.
Acid Naphthionic	.. 2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	.. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic	.. 9½d. per lb. 100% basis d/d.
AluminiumChloride,anhyd.	1s. per lb. d/d.
Aniline Oil ..	.. 7¾d.—8½d. per lb. naked at works.
Aniline Salts ..	.. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base ..	.. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	.. 1s. 1d. per lb.
p-Chlorphenol ..	.. 4s. 3d. per lb. d/d.
p-Chloraniline ..	.. 3s. per lb. 100% basis.
o-Cresol 19/31° C.	.. 4½d. per lb. Demand steady.
m-Cresol 98/100%	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline ..	.. 3s. per lb.
Dichloraniline S. Acid	.. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol ..	.. £85 per ton.
Diethylaniline ..	.. 4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline ..	.. 2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene ..	.. 9d. per lb. naked at works.
Dinitrochlorbenzol	.. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine ..	.. 2s. 10d. per lb. d/d.
Monochlorbenzol ..	.. £63 per ton.
βNaphthol ..	.. 1s. 1d. per lb. d/d.
αNaphthylamine	.. 1s. 4d. per lb. d/d.

βNaphthylamine	4s. per lb. d/d.
m-Nitraniline	4s. 9d. per lb. d/d.
p-Nitraniline	2s. 3½d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	10½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	4s. per lb. d/d.
p-Phenylene Diamine	10s. 3d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 3d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 3d. per lb. naked at works.
m-Toluylene Diamine	4s. 3d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£47 per ton.
Acid, Acetyl Salicylic	3s. 1d.—3s. 3d. per lb., according to quantity.
Acid, Benzoic B.P.	3s. per lb.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 4½d.—1s. 5d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm, increasing demand.
Acid, Salicylic	1s. 6d.—1s. 9d. per lb., according to quantity. Demand rather easier.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1¼d. per lb less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
Amidopyrin	13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s.—15s. 6d. per lb. Quiet market.
Benzonaphthol	5s. 3d. per lb. Small inquiry.
Bismuth Salts	Prices reduced by about 1s. 3d.—2s. 3d. per lb. on account of the fall in the price of the metal.
Bismuth Carbonate	10s. 6d.—12s. 6d. per lb.
,, Citrate	10s. 3d.—12s. 3d. ,,
,, Salicylate	9s.—11s. ,,
,, Subnitrate	8s. 8d.—10s. 8d. ,,
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Market firm, and Continental prices fully maintained with upward tendency.
Ammonium	1s. 4d.—1s. 7d. per lb.
Potassium	1s. 2d.—1s. 5d. per lb.
Sodium	1s. 3d.—1s. 6d. per lb.
Calcium Lactate	1s. 7d.—1s. 9d., according to quantity. Fair demand and steady market.
Chloral Hydrate	4s.—4s. 3d. per lb. Very firm and scarce.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Formaldehyde	£52 per ton, *ex* works. English make in casks.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	7s. per lb.
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. ,,
Guaiacol Carbonate	10s. 6d.—11s. 3d. per lb.
Hexamine	3s. 6d. per lb. for English make—market steady.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£25 per ton, less 2½%. Price reduced.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	57s. 6d. per lb.
Synthetic	26s.—35s. per lb., according to quantity. English make. Good demand. Steady market.
Mercurials	Market very quiet.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	1s. 10d.—2s. 1d. per lb. Keen competition.
Methyl Sulphonal	26s. per lb.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 10½d.—3s. per lb. Not very active.
Paraldehyde	1s. 5d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin	6s. per lb. Price and demand steady.
Phenazone	7s. 6d. per lb. A shade firmer. Forward prices higher.
Phenolphthalein	6s. 6d. per lb. Ample supplies.
Potass. Bitartrate—99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Good steady demand.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate	7¼d. per lb.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 2d. per lb.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d. per lb.
Silver Proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 6d. per lb. Ample supplies. B.P. quality available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.

Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside ..	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt) ..	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Market rather easier. Powder 2s. 1d.–2s. 3d. per lb. Crystal at 2s. 3d.–2s. 5d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s.–£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal..	15s. 6d. per lb. Easier.
Thymol	20s. per lb. nominal. Very scarce indeed.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.
Aubepine	15s. 3d. ,,
Amyl Acetate	2s. 6d. ,,
Amyl Butyrate	6s. 9d. ,,
Amyl Salicylate	3s. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,
Benzyl Alcohol free from Chlorine	2s. 9d. ,,
Benzaldehyde free from Chlorine	3s. 6d. ,,
Benzyl Benzoate.. ..	3s. 6d. ,,
Cinnamic Aldehyde—	
Natural	16s. ,,
Coumarin	19s. 6d. ,,
Citronellol	17s. ,,
Citral	8s. 6d. ,,
Ethyl Cinnamate ..	12s. 6d. ,,
Ethyl Phthalate	3s. 3d. ,,
Eugenol	10s. 6d. ,,
Geraniol (Palmarosa) ..	35s. ,,
Geraniol	11s.—18s. 6d. per lb.
Heliotropine	7s. 3d. ,,
Iso Eugenol	15s. 9d. ,,
Linalol ex Bois de Rose..	26s. ,,
Linalyl Acetate	26s. ,,
Methyl Anthranilate ..	9s. 6d. ,,
Methyl Benzoate.. ..	5s. ,,
Musk Ambrette	45s. ,,
Musk Xylol	14s. ,,
Nerolin	4s. 9d. ,,
Phenyl Ethyl Acetate ..	15s. ,,
Phenyl Ethyl Alcohol ..	16s. ,,
Rhodinol	60s. ,,
Safrol	1s. 10d. ,,
Terpineol	2s. 4d. ,,
Vanillin	26s. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 6d. per lb.
Bergamot Oil	17s. 6d. per lb.
Bourbon Geranium Oil ..	36s. 0d. per lb.
Camphor Oil	65s. per cwt.
Cananga Oil Java ..	10s. 6d. per lb.
Cinnamon Oil, Leaf ..	6½d. per oz.
Cassia Oil, 80/85% ..	10s. per lb.
Citronella Oil—	
Java 85/90%	5s. 8d. per lb.
Ceylon	3s. 7d. per lb.
Clove Oil	7s. 6d. per lb.
Eucalyptus Oil, 70/75%..	2s. 3d. per lb.
Lavender Oil—	
French 38/40% Esters	27s. 6d. per lb.
Lemon Oil	3s. per lb.
Lemongrass Oil	3d. per oz.
Orange Oil, Sweet ..	11s. per lb.
Otto of Rose Oil—	
Bulgarian	37s. 6d. per oz. Production below average.
Anatolian	18s. per oz.
Palma Rosa Oil	17s. per lb.
Peppermint Oil—	
Wayne County ..	27s. per lb. Market very active and prices rising.
Japanese	17s. 6d. per lb.
Petitgrain Oil	9s. 3d. per lb.
Sandal Wood Oil—	
Mysore	26s. 7d. per lb.
Australian	21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Nov. 3rd; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Sept 18th.

I.—Applications

Bendixen. Apparatus for extraction, solution, and mixing. 20,295. Aug. 27.

Chem. Fabr. vorm. Sandoz. Preparation of an adsorption compound. 20,477. Aug. 29. (Switz., 20.9.23.)

I.—Complete Specifications Accepted

5549 (1923). Baker-Perkins, Baker, Prescott, and Gilderdale. Centrifugal separators. (220,671.)

13,626 (1923). Lenz and Jupp. Apparatus for separating liquids of different specific gravities. (220,713.)

13,688 (1923). Eldred. Recovery of values from mixtures. (220,716.)

29,638 (1923). Delpech. Dehydration of air containing volatile substances. (220,858.)

30,401 (1923). Tugwood (Jeffrey Manuf. Co.). Crushing-machines. (220,862.)

32,197 (1923). British Thomson-Houston Co., Ltd. Separating vapour, or vapour and liquid, from a non-condensible gas. (209,081.)

7811 (1924). Somerville and Williams. Application of absorbent materials. (220,899.)

13,112 (1924). Rheinische Maschinenfabrik. Crushing-mills. (216,886.)

II.—Applications

Allan, Moore, and Burmah Oil Co. Wax sweating and crystallising apparatus. 20,132. Aug. 29.

Brooke. Retort settings in gas manufacture. 20,138. Aug. 26.

Curties. Fuel for firing bricks etc. 20,128. Aug. 26.

Dewar. Carbonisation of coal etc. 20,478. Aug. 29.

Dewar. Production of smokeless fuel etc. from coal. 20,479. Aug. 29.

Fuchs. Heating arrangement for petroleum distillation etc. 20,376. Aug. 28. (Austria, 28.8.23.)

Leadbeater. 20,215. *See* XIII.

Seidenschnur. 20,516. *See* III.

Stern. Removal of water from fine coal. 20,453. Aug. 29.

Terry. Fuels for internal-combustion engines. 20,400. Aug. 28.

II.—Complete Specifications Accepted

4924 and 30,128 (1923). Auld, Dunstan, and Herring. Treatment of liquid hydrocarbons. (220,664.)

8107 (1923). Nielsen and Laing. Gas manufacture. (220,676.)

10,685 (1923). Vickers, Ltd., and Lucas. Retort furnaces. (220,684.)
13,259 (1923). Marconnet. Gas-generators. (197,948.)
13,963 (1923). Davidson and Lewis. Cracking of hydrocarbon oils and the treatment of solid carbonaceous substances. (220,732.)
23,958 (1923). Wallet. Gas producer. (220,829.)
24,847 (1923). Kohlenveredlung Ges. Distillation of carbonaceous substances. (205,100.)
26,484 (1923). Scaravelli. Motor spirit. (206,147).
29,977 (1923). Zwoyer. Carbonising fuel briquettes. (211,101.)
40 (1924). Soc. L'Air Liquide. Preliminary treatment or purification of gas. (214,196.)

III.—Applications

McDermott. Treatment of benzol etc. 20,277. Aug. 27.
Seidenschnur. Production of tar etc. from coal. 20,546. Aug. 30. (Ger. 30.1.24.)

IV.—Applications

Imray (Soc. of Chemical Industry in Basle). Manufacture of diazo compounds. 20,197. Aug. 26.
Soc. of Chemical Industry in Basle. Manufacture of indigo dyestuffs. 20,304. Aug. 27. (Switz., 17.7.24.)

IV.—Complete Specifications Accepted

4924, and 30,128 (1923). Auld, Dunstan, and Herring *See* II.

VI.—Applications

Ashworth and Trickett. Printing or painting on felt, rubber, etc. 20,135. Aug. 26.
Durand et Huguenin Soc. Anon. Dyeing or printing textile goods etc. 20,067. Aug. 25. (Ger. 25.8.23.)

VII.—Applications

Boehringer u. Sohne, and Giemsa. 20,192. *See* XX.
Cooke. Purification of soda. 20,330. Aug. 28.
Jacobson. Method of producing pure alumina. 20,044 Aug. 25. (Sweden, 29.8.23.)

VII.—Complete Specifications Accepted

17,237 (1923). Texas Gulf Sulphur Co. Burning of sulphur. (202,283.)
17,467 (1923). Johnson (Badische Anilin und Soda Fabrik). Catalytic production of hydrocyanic acid. (220,771.)
21,103 (1923). Nelson. Process for the production of ammonia. (220,807.)
23,229 (1923). Price, and Quirk, Barton and Co., Ltd. Production of lead oxide. (220,823.)

IX.—Applications

Fergusson. Preservation of road beds etc. 20,236. Aug. 27.
Youngman. Cement. 20,079. Aug. 25.

IX.—Complete Specifications Accepted

8125 (1923). Garrow, Case, and Novocretes, Ltd. Treatment of wood etc. with calcareous cement. (220,677.)
13,706 (1923). Russell and Broomfield. Manufacture of asbestos or asbestos products. (220,718.)

X.—Application

Williams. Protecting coat for iron etc. 20,393. Aug. 28. (Ger., 28.8.23.)

X.—Complete Specifications Accepted

5145 (1923). Chemical Treatment Co. Desulphurising iron, steel, ferro-alloys, and copper. (193,851.)
11,022 (1923). Thayer. Treating metalliferous pulp. (196,922.)
13,565 (1923). Etchells, Popplewell, and Cameron and Son, Ltd. Alloys. (220,710.)
13,752 (1923). Perkins, Taplin, and Metals Production Ltd. Leaching-systems particularly for copper. (220,720.)
19,746 (1923). Dreifuss. Acid-proof alloys. (220,791.)
24,625 (1923). Imray (Bellis Heat Treating Co.). Heat-treating metals. (220,837.)

XI.—Applications

Bauer and Vogel. 20,059. *See* XIII.
Holmboe. Electrolytic apparatus. 20,205. Aug. 26. (Norway, 19.2.24.)

XI.—Complete Specifications Accepted

16,680 (1923). Fuller's United Electric Works, Ltd., and Fuller. Galvanic batteries. (220,763.)
5251 (1924). Strasser and Müller. Lead electrodes for accumulators. (212,542.)

XIII.—Applications

Bauer and Vogel. Protective and electrically insulating coating. 20,059. Aug. 25. (Ger., 29.12.23.)
Brown. Titanium pigments. 20,027. Aug. 25.
Leadbeater. Manufacture of carbon black. 20,215. Aug. 27.

XIV.—Applications

Ashworth and Trickett. *See* VI.
Robel und Fiedler Ges. Preserving vulcanised rubber. 20,185. Aug. 26. (Ger., 13.10.23.)

XV.—Applications

Bendixen and Ehrenreich. Process for utilising skins of fishes. 20,102. Aug. 25.
Caunce and Lloyd. Production of leather. 20,248, 20,249. Aug. 27.
Caunce and Lloyd. Preparation of chrome-tanned leather. 20,250. Aug. 27.
Caunce and Lloyd. Stuffing of chrome-tanned leather 20,251. Aug. 27.

XVII.—Application

Curties. 20,128. *See* II.

XIX.—Complete Specifications Accepted

12,889 (1923). Takahashi and Kenkyujo. Extraction of the fat-soluble vitamin. (220,697.)
26,764 (1923). Benoit. Process for treating or purifying waste liquids, especially waste water of chemical factories. (220,849.)

XX.—Applications

Austerweil. Preparation of thymol from 2-cymidine or p-cymene. 20,516-7. Aug. 30. (Ger., 30 and 31.8.23.)
Boehringer u. Sohne, and Giemsa. Preparation of sodium-tribismuth tartrate. 20,192. Aug. 26.

XX.—Complete Specifications Accepted

5374 (1923). Margulies. Production of organic arsenic compounds. (220,668.)
13,751 (1923). Wade (Karpen and Bros.). Manufacture of esters. (220,721.)
30,633 (1923). Stern and Battelli. Obtaining hormones from internally secreting glands. (208,151.)

XXI.—Application

Schmitz. Photographic developing. 20,061. Aug. 25.

XXII.—Applications

Ruth Akt.-Ges. and Weithoner. Priming compositions. 20,388. Aug. 28.
Udal. Manufacture of nitroglycerin. 20,179. Aug. 26.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London. S.W. 1), has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*British India*: Steel (Director-General, India Store Department, Branch

No. 10, Belvedere Road, Lambeth, S.E. 1); *Belgium*: Cast iron and steel (A.X./1286); *Canada*: Paper, Rubber goods (260); Leather (B.X./1198); *Denmark*: Copper, mercury, and soda products (265); *Dominican Republic*: Oil, paints, chemicals (278); *South Africa*: Cast iron (A.X./1279); Oil (B.X./1187); *United States*: Leather (B.X./1203).

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during August has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee: The total number of applications received during the month was 421, of which 330 were from merchants or importers. To these should be added 12 cases outstanding on August 1, making a total for the month of 433. These were dealt with as follows: Granted, 327 (of which 304 were dealt with within seven days of receipt). Referred to British makers of similar products—69 (of which 54 were dealt with within 7 days of receipt). Referred to Reparation Supplies available, 25 (all dealt with within two days of receipt). Outstanding on August 31, 1924, 12. Of the total of 433 applications received, 383 or 88 per cent. were dealt with within seven days of receipt.

Exports of Chemicals from the United States

Exports of chemicals and allied products from the United States during the first six months of 1924 were valued at $67,328,598, a decline of 10 per cent. compared with the export during the same period of 1923, when the value was $74,836,422. The decline was due to smaller exports of industrial chemicals, coal-tar products, fertilisers, explosives, gums, resins, paints and varnishes. Exports of fine chemicals, though forming only a small proportion of the total, showed a gain.

Canadian Chemical Production in 1923

The High Commissioner for Canada in London has received from the Dominion Bureau of Statistics at Ottawa, a preliminary estimate made by Mr. S. J. Cook, Chief of the Mining, Metallurgical and Chemical Branch, showing that the production of chemicals and allied products in Canadian factories last year reached a total value of more than $106,500,000.

Exports of Canadian products in this class were valued at 15·7 million dollars, and imports amounted to 26·1 million dollars in the same period. Over 124 million dollars of capital was invested in concerns operating 466 plants and employment was furnished to about 14,600 employees. Salaries and wages paid totalled 17·8 million dollars, and the cost of materials used was about 52·9 million dollars. The value added by manufacturing or the difference betewen the selling value of the products made and the cost of raw materials used in their manufacture was 53·5 million dollars. Increases were noted in the amount of capital employed, the number of employees, payments of salaries and wages, cost of materials and value of products, as well as in the value of imports and exports.

Nearly 82 per cent. of the 1923 chemical exports went to the United States, United Kingdom and Mxeico in the order named, and nearly 13 per cent. was shipped to Newfoundland, Japan, British West Indies, Australia and New Zealand. On the other side, more than 98 per cent. of Canada's import business in chemical products was from seven countries with the United States leading and the United Kingdom next, followed by Germany, France, the Netherlands, Belgium and Switzerland. The remaining 2 per cent. of Canada's chemical import trade was drawn from more than a score of different countries.

Trade Information

The Electric Furnace Company, Ltd.—Arrangements have been made by which Automatic and Electric Furnaces, Ltd., and the Electric Furnace Co., Ltd., will jointly design Wild-Barfield internally-heated electric furnaces having an input greater than 25 k.w., which in future will be supplied by the latter company. Arrangements have also been made with George J. Hagan Co., of Pittsburg, U.S.A., who have constructed a large number of electric resistance furnaces up to 350 k.w. capacity, for the use of their drawings and information, so that the best British and American practice will be incorporated in the designs.

Foreign Company News

The report of the Cie Belge de l'Union Minière du Haut Katanga for 1923 records a total output of copper amounting to 57,886 m.t. (43,362 tons in 1922, and 30,464 t. in 1921), the production in June, 1924, being estimated at 7000 t., since when the output has increased. In the area held by the company, investigations have shown the existence of copper ores estimated at 72,660,000 t., containing 6·20 per cent. of copper. Cobalt is also abundant, and three electrical furnaces have been installed at Panda to produce a copper-cobalt-iron alloy, which is treated in Belgium by the Société Générale Metallurgique de Hoboken. Work at the radio-active deposit at Chinkolobwe has resulted in shipments of large quantities of ore to the Oolen Works in Belgium, which can now furnish two-thirds of the world's consumption of radium. The company finds employment in Africa for 916 Europeans and 10,059 natives.

The Société Chimique des Usines du Rhône is producing 500 kg. of acetate silk daily in its Roussillon factory, and the plant is to be extended. Two new factories are to be built, one for the preparation of the artificial fibre and the other for spinning the Rhodiaseta artificial silk. The new factories are planned to produce four tons a day, although the production at first will be only one ton.

The Société des Matières Colorantes et Produits Chimiques de St. Denis (Etablissements Poirrier et Dalsace), has decided to increase its capital from 24,000,000 to 30,000,000 francs.

PUBLICATION RECEIVED

FUR DERMATITIS, REPORT OF AN INQUIRY INTO THE OCCURRENCE OF DERMATITIS ATTRIBUTED TO THE WEARING OF FUR COLLARS, 1922-23. By A. C. Parsons, M.R.C.S. Ministry of Health, Reports on Public Health and Medical Subjects, No. 27. Pp. 31. London: H.M. Stationery Office, 1924. Price 9d. net.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

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EDITORIAL

THERE are many indications that in the political world, criticism from those who have no responsibility is far simpler than progress on the part of those who have the detailed knowledge of the obstacles to progress, and the responsibility of carrying proposals to a successful issue. Those who stand on the top of a cliff and watch the ships struggling in the storm see how easy it is to make for smoother water. Those whose business it is to write books or plays can with case solve the problems of peace and war, restore our trade to its former prosperity, and persuade the trade unionist to do the maximum of work in the shortest possible time, and secure, in spite of foreign competition, such a remuneration as will enable him to cultivate the muses in his abundant spare time. Mr. Bernard Shaw can solve our marriage and property problems, and discover instant remedies for all the ills which confront modern civilisation. Mr Tom Shaw, our Minister of Labour, finds some of these problems not quite so easy. Prof. Soddy, by his new system of economics, can make us all happier and richer: Mr. Sidney Webb, presiding over the Board of Trade, is thankful for an improvement so slow as almost to require a microscope. The Communists see how easy it is to promote an era of universal peace; meanwhile, the generals in Morocco, in China, in Georgia, and in some countries nearer to our own country, sharpen their swords and prepare reserves of high explosives. It is not only in the political world that this is true; it is true, also, in the chemical world and in almost every other aspect of human organisation. If a few individuals of rather more than average intelligence and industry are striving to do their best with an awkward situation, it must be remembered that they are probably acquainted not only with the difficulties obvious to the critic, but with many other difficulties unknown to him, some of which perhaps—for reasons of expediency—they do not even desire to mention publicly. The successful accomplishment of a task is not, therefore, to be taken as a mere matter of course; it looks easy, perhaps, but everything looks easy until you attempt it. We have just read in the Transactions of the Institution of Chemical Engineers the brief account of the formation of that body, and we have somewhat hastily perused the scientific papers which form the bulk of that volume. We are struck by the fact that so considerable an achievement has been accomplished in so brief a period of time. We are well aware of the existence of critics of the Institution; that proves nothing. The papers on "Industrial Oxygen," by Mr. Finlayson; on "Absorption Towers," by Messrs. Donald and Tyson; on "Flow in Filter Presses," by Messrs. Donald and Hunneman; and on "Corrosion," by Mr. Donald, together with Mr. Alliott's excellent bibliography, prove that the Institution is making important additions to our knowledge, printing them clearly in good type and a convenient form, and justifying its existence and prosperity. Let us think for a moment of the difficulties which are certain to have existed though our knowledge of them is so meagre, and offer our sincere congratulations to the Institution on its flourishing state and the excellent standard it has set.

* * *

The oyster—we are speaking of the race not of the individual—has a long and a glorious history. He has been honoured by many of the Greek and Latin poets; Juvenal mentions the connoisseur who could tell immediately whether the morsel, it could hardly be described as a mouthful, came from the Lucrine rocks or from Whitstable. Writers of poetry, verse and prose, in all ages and in most languages, have paid well-deserved compliments to this delicacy. To us the British oysters are the best, but we recollect

superb specimens culled from American, French, Dutch and Portuguese waters and the native men and women of those countries may even prefer their own natives to their settlers. These children of the rocks and grey sea to use a phrase of Alcæus, have a due place in the economy of Nature. There are, we know, some misguided but useful people who value, not the ostrean virtue; to sit next to one of these at a public banquet, which includes the inspiring delicacy, is a privilege that may be due to cunning or to happy chance. On such an occasion, secure of fate the epicure may say, "Fate cannot harm me, I shall dine to-day." From his grateful soul he pours forth a sincere thanksgiving, commencing with the melodious phrase, "Bountiful Jehovah!" Careless students, learned professors, wily doctors and convalescent patients have blessed the oyster. Our Government chemists—glory be to them—have given a rational explanation of its tonic qualities. The oyster collects, assiduously and laboriously, arsenic from the sea-water and the solid particles which carpet the bottom of the ocean, the mattress, as it were, of the oyster-bed. The oyster may contain from one to three parts per million of arsenic: three dozen oysters may contain as much as a medicinal dose; the oyster frequently contains so much arsenic as to exceed that narrow limit authorised and hall-marked as safe. The present Minister of Health may earn undying fame by adopting as a new standard the limit adopted by that sagacious epicure, the oyster. This short note contains all that is worth remembering in a Report on Oysters just published by the Ministry of Agriculture and Fisheries; those who love evidence and statistics should buy the Report; those who love oysters should store in their cellar a barrel of Colchester ones and another barrel of Whitstable, and in their minds the contents of this editorial summary.

* * *

Prof. J. C. Drummond treats of the cod and the oil extracted from the cod-liver in a manner more instructive and more dignified. Problems of health and nutrition are not the occasion for indecent mirth or airy persiflage. Prof. Drummond and his co-workers have made a study of vitamins in a thoroughly scientific spirit. They have shown us the very constituent of cod-liver oil which includes the two vitamins which have brought cod-liver oil into such universal use: soon we may learn more of the constitution of that alcohol which now seems so essential. It is singular that the vitamins are so indestructible by the ordinary processes of digestion, and we wonder whether cormorants and other fish-eating birds are able to store up for their own gratification vitamins A and D derived from diatoms in the indirect manner described in Prof. Drummond's article. We do not recollect any account of the fate of the vitamins in the human body. What happens to them there? Are they stored up in our livers, or do they undergo some sort of oxidation of the same sort as the oxidation of starch in our bodies? Are the vitamins substances or are they merely phases in the life-history of a substance, as we are told enzymes are?

COD LIVER OIL *

By PROF. J. C. DRUMMOND

Historical

The general use of cod liver oil in the treatment of conditions of malnutrition and the associated diseases is of comparatively recent date. There is evidence that both the livers themselves and the oil derived from them were used as household remedies for centuries along many coast lines, particularly those of Scandinavia and Japan. From Norway it appears to have been introduced into Germany, probably by the Hanseatic merchants trading with Bergen, and under the name Bergenthran was used to a limited extent in the seventeenth and eighteenth centuries.

It is uncertain, however, whether its use spread from Germany to England, or whether in our country it arose directly from the reputation that liver oils had established on the coast of North Scotland as a cure for rickets (Barton, "De Rachitide," Diss., Edinburgh), or from the fact that considerable quantities of "train oil" were imported every year along the well-known trade route between Newfoundland and the villages and towns of the Dorsetshire coast. Thomas Hardy in "A Changed Man" refers to the importation of "trayne oyle" into Wessex from Newfoundland as far back as 1540. This oil would appear to have been sometimes cod liver oil, but more frequently whale oil. However, about 1766, we find a physician, Dr. Kay, prescribing cod liver oil at the Manchester Infirmary on a scale sufficient to consume 50—60 gallons a year (Percival, Medical Essays, Warrington, 1789. Treatise on Oleum Jecoris Aselli or Cod Liver Oil as a Therapeutic Agent in certain forms of Gout, Rheumatism and Scrofula; John Hughes Bennett, London, 1841). Writing of the use of the oil at Manchester Infirmary, Bardsley (*Med. Rep.*, London, 1807) remarks. "This medicine has preserved its reputation unimpaired for the period of 30 years."

Apparently during this period the Infirmary was visited by a German physician, Dr. Schenck of Siegen, who returned to Germany deeply impressed with what he had seen of the therapeutic use of cod liver oil. Schenck, in a memoir in *Hufeland's Journal*, published in 1822, strongly emphasised the value of the oil, and largely on his urging it was established as a remedy in the pharmacopœia of Prussia, Hanover, Saxony, Sleswig and Holstein.

This seems to have led to a somewhat widespread use of the oil in Germany and to a vigorous expansion of the trade in Norwegian oil from Bergen. Prof. Naegele of Dusseldorf informed Dr. Bennett in 1840 that the peasants seldom applied to him until after they had tried the effect of taking cod liver oil at home. About 1830 the use of the oil spread to France and soon became general over Western Europe.

The almost specific action of cod liver oil in the treatment of rickets and diseases of malnutrition

* Lecture delivered before Section I (Physiology), British Association for Advancement of Science, Toronto meeting, August, 1924.

was appreciated quite early, and theories to account for its beneficial effect were soon forthcoming.

Old Theories concerning Therapeutic Value

Willmot ("Glycerin and Cod Liver Oil. Their History, Introduction, Therapeutic Value and Claims upon Professional and Public Attention," London, 1860) gives an amusing account of some of these earlier ideas on this subject. Some of them were most fantastic, as was one advanced by a Fellow of the Royal Society, named Smee, in which electric phenomena were held to play a part, whereas of the more rational ones was that put forward by the great chemist Liebig, who remarked: "In the animal body we recognise as the ultimate cause of all force only one cause, the chemical action which the elements of the food and the oxygen of the air mutually exercise on each other. Cod liver oil furnishes carbonaceous fuel for respiration, and thus protects the tissues from the action of atmospheric oxygen."

It is not surprising to find that others sought for the explanation of the peculiar action of cod liver oil in the chemical differences which can be detected between this and other oils. Of these, the fact that cod liver oil usually contained traces of iodine was soon seized upon and advanced as an explanation of its therapeutic activity about 1830 by a Dr. Kopp (*cf.* Hoppe de l'Orme, *Hufeland's Journal*, 82, 115). That iodine was present was actually keenly contested for some time until finally confirmed by the experiments of Gmelin (*Ann. der Pharm.*, 31, 323), but the opponents of the iodine theory, as we may call it, then argued that so small a trace of iodine as is usually found, *i.e.*, 1 part in 40,000, could scarcely be responsible for the beneficial effects observed (*cf.* Falker, *Heidelbg. Med. Ann.*, 1840, 6). To this supporters of the theory replied that not only did the iodine content run parallel with the potency of the oil, but that the iodine was probably present in some peculiar state of combination that made it physiologically more potent than when given in other forms (Bennett, J. H., "Treatise on the Oleum Jecoris Aselli," London, 1841). Later, with the advance of chemical science came the knowledge that the fatty acids of cod liver oil are more highly unsaturated than those occurring in most other oils, and from the fact that highly unsaturated acids are readily oxidised in the laboratory grew the belief that the mal-nourished organism might assimilate and oxidise such acids when it was too weak to make use of those ordinarily occurring in other oils and fats (Williams, *B.M.J.*, 1912, **2**, 700; *Pharm. J.*, 1913, **89**, 806).

Vitamin Theory

Such was the position when, following Hopkin's discovery of the vitamins in 1912 it was suggested by Funk (*Die Vitamine*, *Wiesbaden*, 1914) that the curative value of cod liver oil is due to the presence of these substances. At the same time it was shown by Osborne and Mendel (*J. Biol. Chem.*, 1914, **17**, 401), that cod liver oil actually contains a growth-promoting substance absent from many other oils the vegetable oils in particular. Even this fact could be reconciled with either of the current theories, but quite a new aspect of the problem was opened up when McCollum and Davis in 1914 (*J. Biol. Chem.*, **19**, 245) reported that the growth promoting principle withstands saponification of the oil in which it is present. Curiously, this important discovery attracted little attention at the time, and was not confirmed until six years later by Steenbock and Boutwell (*J. Biol. Chem.*, 1920 **42**, 121), and by Drummond and Coward (*Lancet*, 1921, ii, 698), who found that the active substance passed into the unsaponifiable fraction. Soon afterwards Zucker, Pappenheimer and Barnett showed that the antirachitic factor also passes into this fraction (*Proc. Soc. Exper. Biol. and Med.*, 1922, **19**, 167). This fraction prepared from cod liver oil appears to possess the whole of the physiological activity of the original oil, and, as it forms usually about 1 per cent., the latter represents a concentration of the active principle a hundred fold.

Scheme of Separation

1 litre cod liver oil.
- Saponification by boiling alcoholic alkali
  - Soaps (inactive)
  - 10 g. unsaponifiable matter (active)
    - Crystallisation and precipitation with digitonin
      - 5 g. cholesterol (inactive)
      - 5 g. active oil I
        - distilled in superheated steam
          - Inactive residue (resins, etc.)
          - Active oil II
            - distilled in high vacuum
              - Fraction 1 b.p. 100
              - Fraction 2 b.p. 220–230/2 mm.
              - Fraction 3 b.p. 250–260/2 mm.
              - Fraction 4 b.p. 260–300/2 mm.

Now, this fraction, if prepared from oils of good quality, contains no trace of iodine, whereas from its method of preparation it can contain no fatty acids. Hence this discovery disposes once and for all of the two theories referred to earlier regarding the nature of the substances responsible for the therapeutic action of cod liver oil.

Chemical Nature of Vitamins in Cod Liver Oil.—What then do we know regarding the nature of the active principle, or principles, for it is likely that there are more than one? In the first place, since they are apparently organic in nature and do not belong to any of the main classes of organic foodstuffs, proteins, carbohydrates and fats, we term them vitamins. Recent work by McCollum and his colleagues make it appear probable that at least two distinct substances of this class are present in cod liver oil. One of these, termed vitamin A, is essential for the normal growth and health of the higher animals, whilst another, the antirachitic vitamin, which can

be labelled vitamin D, plays an indispensable rôle in the normal process of bone formation. Deprivation of both factors causes an animal to show stunted growth with lowered resistance to disease and may induce the condition known as rickets. Chemically, both factors are as yet unidentified, but work is proceeding vigorously in the direction of establishing their nature, as the appended scheme of separation will show (see p. 929).

The vitamins are found in Fraction III. This fraction consists mainly of an unsaturated alcohol of molecular weight about 350. It is too early to say whether the alcohol is one or other of the vitamins, or whether the latter are merely associated with this fraction. The active substance will survive acetylation, benzoylation and hydrogenation of the alcohol present in Fraction III, but they are liable to inactivation by oxidation. They contain only carbon, hydrogen and oxygen. There are reasonable hopes that the nature of the vitamins in cod liver oil will soon be ascertained from the continuation of the chemical studies now in progress.

The mere discovery that there are certain vitamins in cod liver oil would not, however, explain the almost specific action of cod liver oil in benefiting nutrition, for numerous other oils and fats, butter fat, beef fat, etc., have also been shown to contain the same active substances. The reason for the outstanding position of cod liver oil was, however, made clear when Zilva and Muira (*Lancet*, 1921, **15**, 422) demonstrated that it contains the vitamins in far higher concentration than any other types of oil or fat; in some cases examined they found the growth promoting power of cod liver oil to be about 250 times that of butter.

It is interesting in this connexion to read in one of the old treatises on the treatment of rickets published early in the last century, the statement that butter will affect the same improvement as cod liver oil, but to do so very much larger quantities must be employed.

Origin of Vitamins in Cod Liver Oil

It may be asked why cod liver oil should be so rich a source of these vitamins, and why different samples of the oil should show differing potency. Obviously, these questions can only be answered by studying the life history of the cod, and by ascertaining why the vitamins are stored in the liver. To do this, and to study the secondary problem of the influence on the vitamins of the methods employed to extract the oil and refine it, Dr. Zilva and I made an examination on the spot of the cod liver oil industries in Norway and Newfoundland, the two chief centres in the world from which supplies of medicinal oil are derived. As a foundation for our enquiry we know that other species derived the vitamin from their food; thus, the vitamins in the fat of cow's milk had been shown to be derived largely from the green foods eaten by the cow. Now the cod and other fishes of his tribe, the gadoids, are carnivorous, but if you trace back the ultimate origin of their food it is found to be minute marine plants termed diatoms. By obtaining one species of these organisms in fine culture and by growing them in artificial sea water in the laboratory, we were able to show that from simple inorganic substances and the energy derived from sunlight they can elaborate amongst other substances the growth-promoting vitamins (*Biochem. J.*, 1922, **16**, 482). Here, then, would appear to be the origin of the vitamins which one seeks when purchasing a bottle of cod liver oil over the counter of the chemists' shop or drug store. There are, however, many steps between the synthesis of the vitamin by the microscopic green plant in the sea and its storage in the liver of the cod. We have been able to trace the intermediate steps by studying the food of the cod. Cod usually feed on small fish, particularly the capelan (*Mallotus villosus*), crustaceans and squid. The caplin and many other small fish are known as plankton-feeders, that is, they live on the swarms of minute animals of many types which constitute animal plankton. Other species eaten by the cod, whilst not themselves plankton-feeders, are found to live on species which are. Thus indirectly the cod is also nourished on animal plankton, which we have found to be very rich in vitamins. In turn, the minute crustaceans, larvæ, worms and decapods, etc., which constitute plankton, feed largely on diatoms, and thus we link up our chain of vitamin transference from the diatom to the liver of the cod (Drummond and Zilva, *Biochem. Jr.*, 1922, **16**, 518).

Cause of Variations in Vitamin Value of Cod Liver Oil

When samples of cod liver oil are tested for vitamin activity it is soon apparent that considerable variations occur, although the poorest specimens we have examined are generally at least ten times superior in this respect to the best dairy butter. It first occurred to us that the variations might reflect changes caused by the manufacturing processes, particularly in view of the somewhat general belief that the modern almost colourless medicinal oils are inferior in therapeutic value to the dark brown oils which were sold years ago.

Manufacture of Cod Liver Oil

The crude golden yellow or dark brown oils, which are now seldom used except for leather dressing, built up the reputation of cod liver oil. They were prepared by processes centuries old and consisting either of allowing the livers to rot in vats exposed to the air until the oil floated to the surface and could be separated, or of cooking the livers in pans over the open fire until the oil could be skimmed off. Both processes yielded unpalatable products well remembered by many people still alive as associated with sad hours of childhood.

A great advance was made when about 1850 an Englishman introduced the steaming method into Newfoundland, and Peter Möller a similar method into Norway. From this time the preparation of cod liver oil has been made the subject of considerable care. The absolutely fresh sound livers are now cooked by direct or indirect steam heating and the oil separating from the tissues is skimmed off. Second fractions are often prepared by reheating or pressing the residue from the fresh separation.

The colour of the oils thus prepared vary from almost colourless to pale golden yellow.

The separated oils are usually clarified and refined by cooling to 10° C. and filtering off the "stearin" which separates out. This yields the clear, bright, pale oils used generally for medicinal use at the present time. Dr. Zilva and I have ascertained that in the preparation of these oils of high quality there is no appreciable loss of vitamin, and that there is no foundation for the belief that the crude brown oils used so mercilessly by our grandparents were superior to those that the rising generation has to endure. On the other hand there is some evidence that the greater opportunity for oxidative changes which was presented during the older processes may have led to some loss of physiological activity (*J. Soc. Chem. Ind.*, 1922, **41**, 280 T). Furthermore, we have recently found that the careful preparation of emulsions of cod liver oil usually has very little destructive action on the vitamins (*J. Soc. Chem. Ind.*, 1924, **43**, 236 T).

If, then, the variations in vitamin activity are not due to conditions of manufacture, we must assume that they occur in the livers of the fish. Direct trial confirms this assumption. It was necessary, therefore, to investigate how the variations arise.

Life History of the Cod

To do this it was necessary to study the life history of the cod which has been worked out with such care by Hjort for the Norwegian waters. There are two distinct fishing seasons in Norway during which cod liver oil is extensively prepared. The first, lasting approximately from February to May, is centred round the Lofoten Islands and coincides with the time that the mature cod are spawning on the shallow sandy banks round those islands. The fish caught are practically all cod (*Gadus callarius*) and during the spawning period they take little food. As Hjort showed, the ripening of the eggs is marked by the passage of considerable amounts of reserve foodstuffs, particularly fat, from the liver to the developing ova. The eggs of the cod are very rich in vitamins (Hjort, *Proc. Roy. Soc.*, 1922, **93**, 440), and it might be expected that this would materially reduce the concentration of these substances in the liver. Actually we do find the oils prepared during this season tend to be lower in vitamin value than those prepared at other seasons, but we are not yet satisfied that we have the full explanation of the variations.

After spawning, the surviving fish, which are now "spent," migrate northwards to feed after their period of fasting. They are attracted to the north by large shoals of the caplin, a small fish about the size of a sardine, which migrate from the polar seas to the north coast of Norway about May to spawn. Following in their wake and devouring them in enormous numbers come huge numbers of cod, ling, haddock, pollack and other gadoids, and which are reinforced by the "spent" fish arriving from Lofoten. The migration of pursuers and pursued proceeds eastwards along the Finmarken coast until by July or August they reach Murmansk, later turning northwards into polar waters. During the time they are off the coast, active fishing is in progress and much oil is prepared. It is, however, seldom made solely from cod but from the livers of the mixed gadoid fishes caught. This is no disadvantage, however, since we have convinced ourselves that the oils yielded by the livers of the other fish—haddock, ling, pollock, coal-fish—are at least equal to cod liver oil in potency. The average vitamin value of the oil yielded during this period, often termed Finmarken oil, when the fish are actively feeding is higher than that of Lofoten oil, and we are inclined to attribute this to the food. In a recent re-examination of this question (Zilva, Drummond and Graham, *Biochem. J.*, 1924, **18**, 178) we have again been led to conclude that the chief cause of the variation in the vitamin content of cod liver oil lies in changes in the nature of the food supplies.

In Newfoundland the oil is seldom prepared in any quantity from fish caught during the spawning, with perhaps a second and less important spawning period in September, which takes place on the Banks in June, according to the observations of our colleague Mr. Graham, B.A. The fish are usually actively feeding either on caplin or squid when caught and the livers used for oil manufacture. We were not surprised therefore to find that the Newfoundland oils show a high average nutritive value (*J.*, 1923, 185 T).

Role of Vitamin A in Animal Nutrition

The vitamins we have been referring to appear to be necessary for the normal growth and nutrition of animals higher in the evolutionary scale than the amphibia. Certainly in the case of fish the considerable stores laid up in the eggs are utilised during the development of the larval fish (Coward and Drummond, 1920, **16**, 631), and the subsequent growth during the post-larval condition is dependent on adequate supplies of food containing these substances being available. The mammals pass supplies of the essential vitamins on to their young by way of milk, and unless the food supply of the lactating female contains adequate sources of these substances there is danger that the young will suffer from the qualitative deficiency of her milk.

Thus it has been shown that on certain rations deficient in the vitamins A and D, the milk yielded by cows whilst being both adequate in amount and satisfactory when analysed by the usual chemical methods, may, nevertheless, when tested biologically, be found seriously deficient in the growth-promoting and antirachitic powers (Drummond, Coward and Watson *Biochem. J.*, 1921, **15**, 540; Kennedy and Dutcher, *J. Biol. Chem.*, 1922, **50**, 339). This fault may be quickly corrected either by supplementing the deficient ration with fresh green fodder, or by administering a relatively small ration (2—4 oz.) of cod liver oil daily to the cow (Drummond, Coward, Golding, Mackintosh and Zilva, *J. Agric. Sci.*, 1923, **13**, 144; *ibid.*, 1924, in press).

Of the practical employment of cod liver oil as a preventive and curative agent in combating malnutrition and its associated diseases, I do not feel

qualified to speak, as I am not a medical man. The experimental work of Mellanby and of McCollum and the extensive practical studies on rickets and osteomalocia in Vienna carried out by Miss Chick and her colleagues scarcely leave a doubt that in cod liver oil we have a remedy that should enable us to wipe out these disorders.

As yet we are unable to say how the minute amount of certain organic substances present in this oil play a part in bringing about normal bone formation. Many other factors are undoubtedly involved in this complex process amongst which the calcium-phosphorus balance is of obvious importance, but others, such as ultra-violet radiation, play a role which is as yet quite obscure. At one time it was thought that exposure to sunlight or other source of ultra-violet light would cure rickets without the co-operation of the vitamin, but the work of Miss Hume indicates that this is not so, but that the animal can reorganise its calcification with the aid of very much smaller amounts of the vitamin when radiation of the skin is carried out at the same time. Much research is needed to clear up this tangled problem, but whatever fascinating story may ultimately be revealed when the difficulties have been overcome by the workers in laboratory or hospital ward, the fact remains that already our knowledge of the almost specific action of cod liver oil in the prevention and curing of rickets and other diseases which follow in the train of defective nutrition, is sufficient to enable us to reduce enormously the number of lives which are destroyed or damaged by their incidence.

NEW HELIUM PLANT IN WASHINGTON

The U.S. Bureau of Mines semi-commercial helium plant will continue to operate during the time that the Navy's large plant is under construction. This plant, which is to have a capacity of 1,500,000 cb. ft. of gas per day, was designed by the Bureau of Mines, along the lines of the semi-commercial plant. It is estimated that this plant will make possible the production of helium at $30 a 1000 cb. ft. Helium production now is proceeding at a rate in excess of 500,000 cb. ft. per month, the month's output sometimes being as high as 1,000,000 cb. ft. This gas is stored in cylinders, each having a capacity at 1800 lb. per sq. in. pressure of 200 cb. ft. The problem of this type of storage is emphasised when it is considered that 2,150,000 cb. ft. is required to fill the Shenandoah. In view of objections raised to the legislation necessary to the conservation of helium, it is of interest to note that Canada recently adopted a much more stringent leasing act than has ever been proposed in the United States, pending a thorough field survey for helium. The Canadian Government is taking vigorous steps to push its exploration programme.—(*Chem. and Met. Eng.*, Aug. 4, 1924.)

PROGRESS AND PROSPECTS IN CHEMOTHERAPY *

By H. H. DALE, C.B.E., M.D., F.R.S.

INTRODUCTORY

In the mind of every physiologist visiting Toronto to-day one recent advance in our science will certainly be uppermost. We rejoice with our colleagues here in a great achievement which has opened new vistas of knowledge to exploration, has brought relief to unmeasured misery, and has turned the eyes of the world, too often careless of such things, in proper gratitude and well-founded hope to this University and its Medical School. Insulin, and its still marvellous and mysterious action, have held a prominent place in the interest of many of us, myself included, during the past year or two. In one of our meetings, however, we shall have the opportunity of considering the observations and opinions of many who are now working on its properties and their significance, and among them will be some who were associated with its discovery. I have thought it appropriate, therefore, to ask your attention to-day to some recent developments in a widely different field of investigation. The subject which I have chosen presents points of general physiological and biochemical interest, apart from its immediately practical importance for the treatment of disease. It has, further, in one way, a special appropriateness to this year's meeting of the British Association. For our knowledge of an important group of diseases, caused by the parasitic trypanosomes, which have provided the experimental material for a very large proportion of chemotherapeutic investigations, we are in the largest measure indebted to the pioneer work of the distinguished President of the Association, Sir David Bruce.

I THE THEORETICAL ORIGIN OF CHEMOTHERAPY

Chemotherapy may be defined as the specific treatment of infections by artificial remedies. The object of those who study it is to find new remedies which will cure or arrest diseases due to infections, not by alleviating the symptoms or invigorating the patient, but by directly and specifically suppressing the infection. Chemotherapy, in this wide sense, is not entirely of recent growth. When the natives of Peru discovered the value in fevers of the cinchona bark, which the Jesuits brought to Europe in the seventeenth century, they had found a specific remedy for malaria, which is still the best available. Similarly the natives of Brazil had found in ipecacuanha, which reached Europe shortly after cinchona, a remedy for amœbic dysentery better than any other which our modern systematic and scientific efforts have produced. Modern chemistry, indeed, has separated the alkaloids from these drugs, and has made it possible to identify among them the actively therapeutic constituents; Protozoology has revealed the nature of the infections. We know now that cinchona owes its curative action chiefly to

* Presidential Address to Section I (Physiology) of the British Association, Toronto.

quinine and quinidine, and that they act as specific exterminators of the malaria parasites, and not simply as remedies for fevers in general; and we know that ipecacuanha owes its action to emetine and cephæline, and that these act as exterminators of the entamœba causing tropical dysentery, and not simply as symptomatic remedies for dysenteries of any kind. But chemistry has produced no better remedy for malaria than quinine, or for amœbic dysentery than emetine; and the method by which either of these alkaloids cuts short the infection by a particular parasite, the nature of its specific action, remains a fascinating problem.

The modern development of chemotherapy, as a new department in therapeutic science, claiming the co-operation of parasitologists, microbiologists, and synthetic chemists, did not take origin, however, simply from the study of these traditional remedies. It may be regarded rather as an outcome of the study of the natural antibodies. The investigation of these natural antagonists to infection produced a new therapeutic ideal. Not only had they shown themselves to have an intensely specific affinity for the infecting organism of the toxin which caused their production: they were also perfectly harmless to the patient, behaving, in relation to his organism, as normal constituents of his body fluids and tissues. Ehrlich aptly compared them to magic bullets, constrained by a charm to fly straight to their specific objective, and to turn aside from anything else in their path.

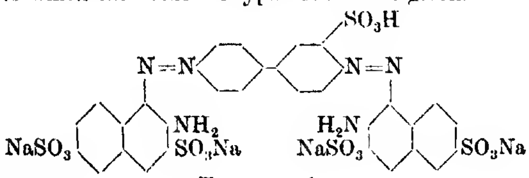
Of the artificial remedies, on the other hand, which man had empirically discovered, even of drugs like those just mentioned as being specific for certain infections, the best that could be hoped was that they would eliminate the parasite before they poisoned the patient. And thus, when the limitations of natural immunity were becoming clearer: when it was realised that to certain forms of infection, several of which had proved to be infections by protozoa, the body was unable to produce antibodies of sufficient potency to eliminate the infection and leave the patient immune; the question arose whether, with the new and growing powers afforded by synthetic chemistry, man could not so far rival Nature's achievements as to produce, in the laboratory, substances specifically adapted to unite with and kill the protoplasm of these parasites, as the natural antibodies united with that of others, and to leave the tissues of the patient similarly unaffected. The ideal of this new and systematic Chemotherapy, as the imaginative genius of Paul Ehrlich conceived it, was to be the production by synthesis of substances with a powerful specific affinity for, and a consequent toxic action on, the protoplasm of the parasites, and none for that of the host—of substances, to use Ehrlich's terminology, which should be maximally parasitotropic and minimally organotropic.

I want to invite your attention to-day to the results which, during the last twenty years, have been produced under the stimulus of this bold conception; not, indeed, to attempt a survey or summary of all that has been done, but, in the light of a few of the suggestive facts which have emerged, to consider how far this hypothesis has justified itself, and whether it can be accepted as a safe guide to future progress, as it has undoubtedly provided the initiative and working basis for much of what has been accomplished hitherto. Before we deal with some of the actual results obtained, it may be well to consider a little more closely what Ehrlich's working hypothesis involved. The problem was to discover, by chemical synthesis, a compound which, in virtue of its chemical structure, should have a maximal affinity for the protoplasm of a microscopic parasite, such as a trypanosome, and a minimal affinity for that of the host's body cells. These affinities were pictured by Ehrlich, in the terms of his side-chain theory, as determined by certain side-chains of the complex protein molecule, or chemoreceptors, which endowed the protoplasm with specific combining properties. When it is remembered that knowledge of the chemistry of the protoplasm of a trypanosome is almost nil, and that what little we do know suggests that it is very similar to that of our own cells, it will be admitted that the enterprise was one calling for scientific courage and imagination in the highest degree. Complete failure would not have been surprising: the matter for surprise, and for admiration, is that so large a measure of practical success should, at the end of two decades, already claim record.

II Trypanosomes and Spirochætes

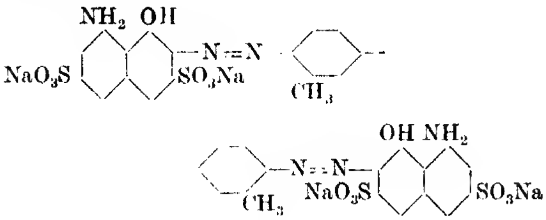
i. *The action of dyes and analogous compounds*

The investigations leading, in the last few years, to a clear promise, at last, of the successful treatment of the diseases in man and animals due to infections with trypanosomes, had at least two different starting-points, the action of dyes and the action of arsenic. Ehrlich's early interest in the synthetic dyes, and his observations of the curiously selective distribution which they often exhibited among the cells and tissues of the body, naturally suggested the possibility of finding, in this group, a substance which would selectively fix itself to the parasite and poison its protoplasm, without injuring that of the host. The technique developed by Laveran and Mesnil, by which a particular strain of trypanosome could be passed through a series of mice or rats, and produce an infection of standardised type and virulence, enabled the effect of a large selection of dyes to be investigated, with the view of finding one which would favourably influence the infection. A starting-point having been obtained, the resources of synthetic dye production were available to produce an indefinitely long series of derivatives and modifications of the active compound, each to be tested in its turn. In this way Ehrlich and Shiga arrived at a substance which gave experimental promise of curative value, a benzidine dye to which the name "Trypan red" was given.



Trypan red

Two years later, Mesnil and Nicolle, proceeding further along the same path, described an even more favourably active blue toluidine dye, "Trypan blue."

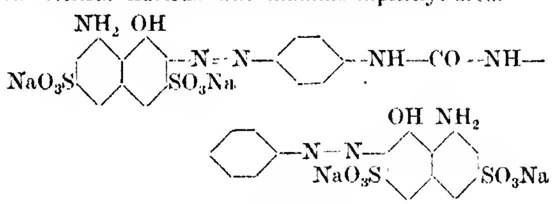


Trypan blue

This is the only one of the dyes which has hitherto had a genuine practical success in the treatment of a protozoal infection, not indeed by a trypanosome, but by an intracorpuscular parasite of the genus Piroplasma, which infects dogs and cattle. This successful application of trypan blue to an animal disease has a special interest for us to-day, in that it resulted from the joint labours of last year's President of this Section, Professor Nuttall, with a Canadian collaborator, Dr. Hadwen.

We may turn aside at this point to enquire how far the results even of these earlier investigations corresponded with the theory which gave them their impetus. Did these dyes really act by selectively staining and killing the parasites, and leaving the host's cells untouched? The evidence was certainly not in favour of such a view. Ehrlich and Shiga themselves observed that Trypan red, even in relatively high concentrations, was practically innocuous to the trypanosomes outside the body. The trypanosomes, like other cells, were not stained by the dye until they died, and there was no clear evidence that they died sooner in the Trypan-red solution than in ordinary saline. Again, Trypan-red cured an infection by the trypanosome of "Mal de Caderas" (*T. equinum*) in the mouse, but not the same infection transferred to the guinea-pig, rat, or dog; nor did it cure an infection with the trypanosome of Nagana (*T. brucei*) in mice. Now, to explain such a difference by stating that the affinity of Trypan red for *Trypanosoma equinum* was much higher than its affinity for the tissues of the mouse, but not than its affinity for those of the rat, would be merely to restate, in terms of the theory, the observed fact that the mouse was cured while the rat was not; and the lack of direct affinity for the dye shown by trypanosomes outside the body made such an interpretation in any case unsatisfactory. One point, however, appeared very significant, and it is met repeatedly in studying the action of effectively chemotherapeutic substances, namely, that the trypansomes treated with the dye *in vitro*, though neither obviously stained nor visibly harmed, had lost their power of infection, and died out promptly if introduced into the body of a mouse. Under such conditions only minimal traces of the dye are introduced into the animal, and we are left with a series of alternative possibilities. It is possible that sufficient dye has been taken up by the trypanosomes to kill them eventually, the period of survival *in vitro* being inadequate to display its action; or that Trypan red is converted by the influence of the body fluids and tissues into something which is effectively lethal for the parasite; or, again, that the effect of the drug is not directly to kill the trypanosomes, but, leaving their individual vitality and motility unimpaired, so to modify them that they have lost the power of rapidly reproducing themselves and invading the fluids and tissues of the mouse's body—in other words, have lost that complex of adjustments to the various factors of the host's natural resistance which we crudely summarise as "virulence." Such possibilities involve either storage or modification of the dye by the host's tissues, or their essential co-operation in its curative effect.

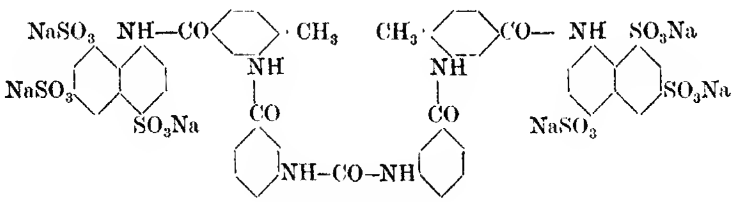
One other active dye must be mentioned as providing the link with a recent, most important advance. Mesnil and Nicolle in 1906 made some promising experiments with a dye, Afridol violet, which differed from any previously tested, in that its central nucleus was diamino-diphenyl-urea.



Afridol violet

From this time onwards there was no further public indication of progress along these lines until 1920, when Händel and Joetten published the results obtained with a remarkable substance which, as the result of some fifteen years of continuous work by their scientific staff, had been introduced by the great dye and chemical firm of Bayer. This substance, which is not a dye, but the colourless, water-soluble salt of a complex sulphonic acid, has hitherto been known as Bayer "205," and, for reasons which need not concern us, the firm decided not to publish its formula. To students of their patent specifications, however, it seemed pretty certain that it would prove to be one of a long series of compounds, formed of chains of aminobenzoyl radicles, united by amide linkages, with a central urea linkage, like the dye last mentioned, and terminal naphthylamine sulphonic acid groupings. A number of these substances, having no diazo-linkages, were not dyes, but there was no indication as to which constitution, out of an immense number possible, would prove to be that of the remarkable substance numbered "205." There is a reasonable probability that its identity has now been settled by the recent work of Fourneau and his co-workers in the Pasteur Institute, who made and investigated an extensive series of compounds of this general type, and found one, which they numbered "309," which conspicuously excelled all others, even those closely related to it, in the favourable ratio which it displayed, between a just toxic dose and that which caused a trypanosome infection in mice to disappear.

As in the case of "205," the ratio, the "chemotherapeutic index" of Ehrlich, was found by Fourneau, in some experiments with his compounds, to be well over 100. At least it may be said that, if M. Fourneau has not identified Bayer "205," he has discovered another compound having very similar, and probably as valuable, properties.



Fourneau's "309" (possibly identical with Bayer 205")

The most remarkable property of "205" is the long persistence of its effect. A dose injected into a mouse, a rabbit, or a rat will not only free the animal, if already infected, from trypanosomes in a few days, but will also render it resistant to such infection for a period of weeks or even months. During that period its serum, or extracts from certain of its organs, exhibit a curative action if injected into another animal infected with trypanosomes.

Though there seems no reason to doubt that this substance has cured a number of cases of African sleeping-sickness in man, even some in which the disease was well advanced and in which all previously known remedies had failed, the mode of its action still presents a number of attractive obscurities. Like many other remedies which are experimentally efficient when injected into the infected animal, it has little or no obvious action when directly applied to trypanosomes *in vitro.* The paradox is, perhaps, less than usually significant in this case, since the action in the animal is delayed, a period of a few days elapsing before the trypanosomes begin to disappear from the blood. We might suppose that the action is too slow to be recognised during the period of survival of the parasites outside the body, or that it affects not the individual vitality of the trypanosomes, but their power of reproducing themselves. The latter idea is supported, as in other cases, by the fact that trypanosomes treated with the drug *in vitro*, or taken from an injected animal before the curative effect has become manifest, fail to infect another animal. It is contradicted, however, by the observation that the trypanosomes, just before the curative action begins, show not a depression, but a stimulation of reproductive activity, division forms becoming abnormally common. Is it that during or immediately after division the parasites become specially liable to the action of the drug? It may be so; but one thing seems perfectly clear, namely, that the action is a very complex one, involving the co-operation, in some way, of the host. For here again it is found that the curative action, on infections by the same strain of trypanosomes, varies enormously with the species infected, a mouse beiug cured with ease, an ox or a horse with difficulty or not at all. A curious fact is that the rapidly progressive and fatal infections produced in mice by certain pathogenic trypanosomes are easily and certainly cured, while the apparently harmless natural infection, seen in many wild rats, by *T. lewisi* is not affected at all. Then there are some curious records of treatment in man, in which the symptoms of sleeping-sickness have disappeared, but the trypanosomes are still found in the cerebro-spinal fluid, suggesting that, though the parasites have not been killed, they have lost their virulence and their power of invading the brain substance.

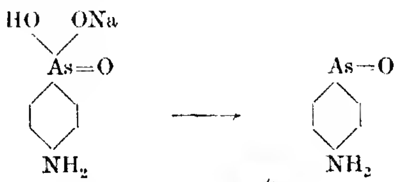
The features of the action of this remedy, however, which have most interest for the physiologist and the biochemist are those related to the long persistence of its effect. "205" has a large molecule, but it is extremely soluble in water, and diffusible through collodion membranes. How, in such circumstances, can we explain the persistence of its sterilising and prophylactic action for months after an injection? At first sight one is tempted to regard it as incredible that a substance with these properties should persist in the body for such a period, and to suggest that the action must be due to its stimulation of the body to form its own protective substances. This possibility, however, seems to be excluded by the fact that the serum of the protected animal does not lose its curative properties if heated. On the other hand, there have recently appeared, some of them only in preliminary abstract, a series of highly suggestive observations, indicating that "205" has properties of entering into a combination of some kind with the serum proteins. After standing for an hour or two in serum, "205" no longer passes into an ultra-filtrate through collodion, and if the proteins are coagulated by heat is not to be found in the filtrate. The proteins of the blood, moreover, are stated to lose many of their characteristic properties by entering into this combination, the blood losing its normal power of clotting, and the serum proteins not being precipitated by mercury salts or tannin.

It would be both useless and presumptuous for a mere onlooker to speculate in detail on the significance, for the curative action of "205," of properties which are only now beginning to be investigated. One conclusion, however, I think, we are entitled to draw. It is sufficiently evident that here is no question of a substance curing simply on

account of its affinity for parasites and lack of affinity for the host's tissues. What direct action on the parasite "205" itself may possess has still to be demonstrated: we may feel reasonably certain, on the other hand, that its affinities for the constituents of the host's blood and tissues play an important part in its remarkable and peculiar curative properties.

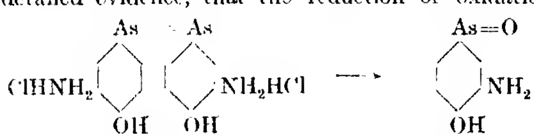
ii. *Derivatives of Arsenic*

In the case of the other series of investigations which I mentioned, that dealing with the organic derivatives of arsenic, we find again many difficulties, in the way of simple theory, of a cure due to distribution by chemical affinities. None of the compounds of this series, which have reached practical trial and success in the treatment of spirochætal or trypanosomal infections, atoxyl, salvarsan, or tryparsamide, has a directly lethal action on the parasites in dilutions at all comparable to those which can be safely and effectively produced in the body of the host. The paradox of this direct inertness of atoxyl, the starting-point of the series, seemed to be explained when Ehrlich showed that its reduction to the corresponding arsenoxide produced a substance with an intense directly lethal action on trypanosomes. Similarly the partial oxidation of salvarsan, to the corresponding arsenoxide, produced a substance having



"Atoxyl" Arsenoxide from "Atoxyl"

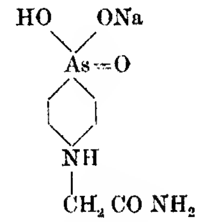
the intensely lethal action on spirochæts or trypanosomes *in vitro*, which salvarsan itself conspicuously and paradoxically lacked. In these cases, we may make the supposition, which Voegtlin and his co-workers, especially, have recently supported by detailed evidence, that the reduction or oxidation



"Salvarsan" Arsenoxide from "Salvarsan"

effected by contact with the tissues is the essential preliminary to the curative action; a supposition which, it will be noted, again introduces the host as an essential participant in the cure. The fact, that the administration of these relatively inactive predecessors is therapeutically more effective than the injection of the directly active oxides derived from them, would then be explained on the assumption that the slow liberation of these latter in the body, at a rate which never produces a high concentration, provides the optimum condition for their persistent action on the parasites, without danger to the host. This slow and persistent liberation of the directly active substance would be favoured by the physical properties of salvarsan, which at the reaction of the body is practically insoluble, and must be rapidly deposited after injection.

In their recent work on the action of Tryparsamide the compound,



Tryparsamide

prepared by Jacobs and Heidelberger at the Rockfeller Institute, which has shared with Bayer "205" the credit of making the eventual conquest of African sleeping-sickness a hopeful possibility, Brown and Pearce find it necessary to introduce yet other considerations to explain its effects. Tested by Ehrlich's therapeutic index—the ratio between the lowest curative and the highest non-toxic dose—it gives a relatively unfavourable figure. Brown and Pearce practically abandon the attempt to account for its action on the supposition that it directly kills the parasites, and attribute its value largely to its power of penetrating easily into the tissues and reinforcing there the processes of natural resistance.

iii. *Action of Bismuth*

Another conception of the mode of action of these arsenical remedies, also involving a direct participation in the host's tissues, was put forward by Levaditi. He found that from atoxyl a directly parasiticidal preparation could be obtained, by incubating it with an emulsion of fresh liver substance. As the first step, therefore, in the curative action of atoxyl, he postulated a combination of its reduction product with some constituent of the liver or other tissue, giving rise to the essential curative complex, which he named "trypanotoxyl." Levaditi's observations were explained by Ehrlich and Roehl as due simply to the reducing action of the liver substance on atoxyl; but it would be difficult to apply this explanation to the quite recently published observations by Levaditi and his colleagues, on the mode of action of bismuth in curing spirochætal infections. A sodium potassium bismuthyl tartrate—a bismuth analogue of tartar emetic—had been found to have valuable curative properties in syphilis and other spirochætal infections. Later, various other bismuth salts, bismuth suboxide, and even finely divided metallic bismuth, were found to produce similar effects. According to Levaditi and Nicolau, these preparations have, by themselves, a relatively weak action, or none at all, on the spirochæts outside the body. If they are mixed, however, with a cell-free extract of liver,

which is itself harmless to spirochæts, the mixture, after incubation, acquires a potent spirochæticidal action. The possibility of a mere reducing action of the liver extract seems here to be excluded, since bismuthous oxide, or metallic bismuth itself, yields a spirochæticidal mixture, containing Levaditi's hypothetical "bismoxyl," when incubated with the liver extract. If these observations are confirmed, there will be a strong indication that some cell-constituent enters into the composition of, or is essential to the formation of, the directly active substance from any of the derivatives of arsenic, antimony, or bismuth, as a preliminary to its action on an infection due to a trypanosome or a spirochæt. Again we have evidence of an organotropic property of the remedy, as an essential condition of its activity.

v. *Resistant Strains of Trypanosomes*

In the phenomena of the acquisition of resistance, by a strain of infecting trypanosomes to a particular curative drug, discovered and largely worked out in Ehrlich's laboratory, we meet again with facts which can only with the greatest difficulty be reconciled with the assumption that the drug directly attacks the parasites. It was found, for example, that if a mouse infected with trypanosomes received an incompletely effective series of doses of atoxyl, the trypanosomes appearing in the blood at each relapse were more and more resistant to the drug, until they could not be caused to disappear by any dose of atoxyl which the mouse would tolerate. The strain, having once acquired this resistance, would retain it, on passage through an indefinitely long series of mice, without further treatment. Mesnil and Brimont, however, made the remarkable observation that, if the strain of trypanosomes was transferred to a rat, it immediately became in that animal susceptible again to treatment with atoxyl, remained so as long as it was kept in rats, to reacquire its old resistance to atoxyl as soon as it was retransferred to mice. Such a fact seems to be not at all explicable on the theory that the directly active agent, to which the trypanosome becomes resistant, is a mere reduction product of atoxyl: it is much more easily reconciled with a mechanism such as that described by Levaditi, in which a constituent of the host's tissues enters into the formation of the trypanocidal substance. We can imagine the trypanosome becoming immune to Levaditi's mouse-trypanotoxyl, and remaining susceptible to the corresponding rat-product.

The whole question of this acquired resistance of the parasites to the action of curative drugs bristles with points of difficulty and interest. Ehrlich attributed the sensitiveness of the parasite, for a particular curative agent, to the possession by its protoplasmic molecule of a special form of side chain, or "chemoreceptor," which determined its affinity for that agent. When the trypanosome became resistant, it was simple to suppose that it did so by losing the appropriate chemoreceptors; an atoxyl-resistant trypanosome, for example, had lost its atoxyl receptors. Apart from the objections already mentioned, this conception met a new difficulty, when in Ehrlich's laboratory it was found that the resistance was by no means as rigidly specific as it first appeared to be. Not only imperfect treatment with atoxyl, but treatment with a particular group of dyes, having no kind of chemical relation to it, was found to produce a race of trypanosomes resistant to atoxyl and to other arsenical derivatives. To suggest that the chemoreceptors for arsenic and for these dyes are identical is merely to restate the fact of this reciprocal action in terms having no definite meaning. Obviously no more precise conception as to its significance can be formed until we know something more of the conditions on which resistance and susceptibility depend. A recent suggestion by Voegtlin has interest in making, at least, an attempt at interpretation in more definite biochemical terms. Voegtlin and his co-workers point out that arsenious oxide and its derivatives readily combine with substances containing a sulphydrile grouping, and find that the toxic action of the organic arsenoxides, on trypanosome and mammal alike, is depressed by the simultaneous injection of excess of various sulphydrile compounds.

$$R{\cdot}As = O + \frac{HS{\cdot}R}{HS{\cdot}R} = R{\cdot}As\begin{matrix}\diagup S{\cdot}R \\ \diagdown S{\cdot}R\end{matrix} + H_2O.$$

III Suggested Reaction of an Arsenoxide with a Sulphydrile Compound

The work of Hopkins, showing the importance of one such sulphydrile compound, reduced glutathione, in the hydrolytic oxidation-reduction processes of the cell, suggests to Voegtlin that a combination with such groups, and consequent suppression of this vital function, may explain the toxic and curative actions of the arsenical derivatives, and that a formation by the trypanosome of the sulphydrile compound, in excess of its vital need, may be the basis of acquired resistance. If certain dyes similarly affect this cellular oxidation system, the production under their influence of strains of trypanosomes resistant to arsenic would also be explained. So stated the suggestion leaves many aspects of the problem still unconsidered: but it may at least be allowed the merit of an attempt to interpret the action of these drugs in terms of known biochemical facts.

IV Emetine and Dysentery

To turn to another example of a chemotherapeutic problem, I may mention briefly some results obtained, some years ago, by Mr. Clifford Dobell and myself, in an attempt to explore the curative action of emetine and the other alkaloids of ipecacuanha in amœbic dysentery, with a view to finding a more effective treatment. At the time when we took up the problem it seemed simple. Rogers had recorded that the amœbæ obtained from a case of amœbic dysentery, and treated *in vitro* with emetine, were rapidly killed by the alkaloid in dilutions as high as one part in 100,000. This seemed to explain the action of emetine as a simple and direct one on the parasites, and to provide a rapid method for testing

a series of compounds for their therapeutic possibilities. We failed, however, as other observers before and since have done, to confirm the observation: on the contrary, we found that the dysenteric amœbæ, obtained from cats secondarily infected, or, in a control observation, directly from man, were surprisingly insusceptible to the action of emetine, living for hours in concentrations much greater than the highest which they would tolerate of other alkaloids, which had no curative action in dysentery. One of the other natural alkaloids of ipecacuanha, methyl-psychotrine, and certain artificial derivatives of emetine, were much more effective in killing the amœbæ in the test tube, and at the same time were practically devoid of the characteristic toxicity of emetine and cephæline for mammals and for man. Here, on the classical assumption of chemotherapy, should have been ideal remedies for amœbic infection—substances much more parasitotropic and much less organotropic than those already known to be effective. Yet each of them in turn when administered to patients suffering from amœbic dysentery, in doses much larger than those in which emetine could be tolerated, produced no effect whatever on the dysentery, which promptly cleared up when emetine was subsequently given. Among the members of this group of alkaloids which were tried, the curative effect seemed to be proportional rather to their toxic and nauseating action on the patient, than to their lethal action on the isolated amœbæ. Yet emetine and cephæline are not mere symptomatic remedies; they definitely stop the progress of infection by the amœbæ, and, properly administered, eliminate them altogether from the body.

Yet another puzzling observation, made by Dobell and myself, was that an amœbic infection which readily yielded to treatment with emetine in man, was entirely uninfluenced by emetine when transferred to the cat. In no way is it possible to account for these facts without admitting a co-operation of the patient's tissues in the curative action; nor, with that admission, can we do more than consider possibilities. We only know that the truly parasitic *Entamœba histolytica*, which cannot live without invading the tissues, can be checked in this invasion and eliminated from the body by administering emetine, while other Entamœbæ, which live on fæcal debris, remain unharmed. Whether the tissues are so altered that the amœbæ cannot invade them, or the amœbæ, without being directly killed, are so weakened in virulence that they cannot invade the tissue and obtain their food, but succumb in face of the normal resisting powers of the host, are possibilities on which we can only speculate, and no method of bringing them to the test of experiment has yet been found.

The work of Morgenroth and his co-workers, extending now over more than a decade, has again led them to emphasise, in connexion with the curative action of substances which they have examined, a fixation to the cells and tissues of the host, a definitely organotropic property, as an important factor in the effect. Two examples may be mentioned.

V Quinine and Malaria

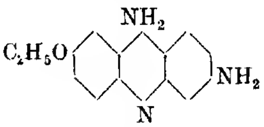
One of the earliest of chemotherapeutic discoveries, that of the cure of malaria by quinine, had never been satisfactorily explained. There was no evidence establishing even a probability that quinine, in such concentrations as can be tolerated in the blood of the living subject, would directly kill the malarial plasmodia, especially if these were partly screened from its action by their position in the interior of the red corpuscles. Morgenroth, from the results of his determination by biological methods of the distribution of quinine in blood, is led to the conception of quinine as acting on malaria, in virtue of its fixation by the red corpuscles, either killing the trophozoites in their interior, or blocking the entry into them of the merozoites of the asexual cycle. On this latter supposition, it will be seen that quinine would act, not by killing the malarial parasites, but by rendering the blood unfitted for their multiplication. They are supposed to fall a prey to the natural defensive substances in the plasma, because a film of quinine denies them access to the red corpuscles, in the interior of which they could continue their development in safety. There are discrepancies between Morgenroth's determinations of the distribution of quinine in favour of the red corpuscles, and those obtained by direct chemical means, which would still need to be reconciled, before either theory of the curative process in malaria could be fully accepted. Meanwhile, these suggestions are of interest, as another example of the need found, more and more, by workers in this field, to regard an organotropic property of a drug, not as detrimental to its curative action, but as an essential factor in the chemotherapeutic process.

VI Remedies for Bacterial Infections

This same property, of fixing themselves to the red blood corpuscles or to the connective tissue, has been observed by Morgenroth and his co-workers with the higher homologues of quinine, ethylhydrocupreine ("optochin"), and octylhydrocupreine ("vuzin"), and with the dyes of the acridine series, with which they have obtained promising results in the treatment of bacterial infections. In the treatment of pneumococcus infections by optochin several factors, other than those of immediately lethal action of the alkaloid on the pneumococci, appear to be concerned. Evidence was obtained by Moore, for example, which suggested that the defensive reaction of the host was an essential factor in the cure, optochin, in doses inadequate to kill the pneumococci, rendering them liable to the action of specific antibodies; and some experiments of Felton and Dougherty suggest that an excessive dose of an alkaloid of this class, by suppressing the natural defensive reaction, may even allow the fatal spread of an infection which a lower dose would cure. Morgenroth, on the other hand, emphasizes the part played by the organotropic properties of optochin and vuzin, in enabling the red corpuscles to act as carriers of the drug to the point of action, and the connective tissues to form local depots of it.

An acridine dye, named Trypaflavin, was under study in Ehrlich's laboratory in 1914 as a trypano-

cidal remedy, and was found during the war, by Browning and his co-workers, to have valuable properties as an antiseptic for infected wounds and mucous membranes, for which, under the name "Acriflavine," it is still used. Since the war, other dyes of this series have been investigated by Morgenroth and his school, and one of them, called "Rivanol," is stated to be particularly effective as a tissue antiseptic, especially in conditions of spreading infection due to streptococci.



"Rivanol" (2-ethoxy 6, 9 diamino acridine)

In the case of "Rivanol" also, evidence has been brought forward that it is fixed by the red corpuscles and the subcutaneous tissues, protected thereby from excretion, or held at the point where its curative action is required. From these body cells it is suggested that the dye is gradually given up to the cocci, on which its action is exerted, by a process called "transgression" by Morgenroth. This is a process by which a substance is passed from one medium to another, when both have strong affinities for it, through a layer of an intervening medium for which it has no affinity, and in which it may be almost insoluble. In this process of depot formation, and gradual liberation of the active substance, we are concerned with a phenomenon which certainly has a widespread importance for chemotherapeutic action. We have earlier seen evidence of such fixation and gradual release in the cases of Bayer "205" and Salvarsan.

Another suggestive feature of the action of "Rivanol" on streptococcal infections, is that such organisms as escape the immediately lethal effect of the dye appear to have lost their hæmolytic properties, and to have been modified into a relatively avirulant strain.

VII Conclusion

We have considered but a few examples of the directions in which chemotherapeutic investigation has proved practically fruitful, including some in which it shows, at the moment, the most hopeful signs of progress. If one considers any one group of investigations by itself, one may easily feel, at the same time, elated by the practical success obtained in the cure of some infection which, but a few years ago, seemed beyond the reach of treatment, and depressed by the disharmony between the results of experiment and the theoretical conceptions, hitherto available, of the nature of the chemotherapeutic process. Some of the most notable practical triumphs in this field have resulted, not from experimental investigations based on the theory, but from an almost empirical trial, on human patients suffering from one type of infection, of a remedy which had experimentally shown promising results in infections of a different and sometimes of a widely different, type. The partial success of tartar emetic in trypanosome infections might have justified a hope that it would have some effect in kala-azar, but hardly a prediction of its really remarkable efficacy in that previously intractable form of infection. Still less would it have justified expectation of the brilliant success of this same drug in infections by the Schistosoma or Bilharzia-worm, which but recently seemed almost beyond the hope of any kind of treatment. With such instances in mind, one might, but a year or two ago, have been tempted to suggest that the attempts at theoretical investigation, of the intimate mechanism of the chemotherapeutic process, had contributed little to the practical achievements, and that a reasonably intelligent empiricism was still the safest guide. I do not think that the suggestion would even then have been defensible, and it would assuredly have been stultified by the results of the past few years. Patient, systematic exploration, by routes of which the initial sections were already mapped in the early days of chemotherapy, has in these recent years again led to results of major importance, both for practical therapeutics and for the theoretical basis of future advance. That the original theoretical framework begins to show itself inadequate for the expanding fabric is good reason for its reconstruction; but we may well beware of hasty and wholesale rejection, remembering that it served the early builders well. I think that it is especially encouraging to note that, though, in the action of almost every remedy which has proved its value in the specific cure of infection, there are features which cannot be interpreted by a strict application of Ehrlich's distribution hypothesis, the discrepancies begin to show a new congruity among themselves. Repeatedly we find phenomena which point to the need of modifying the theoretical structure in the same direction. The conception of a remedy not killing the parasites immediately, but modifying their virulence, or lowering their resistance to the body's natural defences; of a remedy not acting as such, but in virtue of the formation from it in the body of some directly toxic product, either by a modification of its structure or by its union with some tissue constituent; of an affinity of the remedy for certain cells of the host's body, leading to the formation of a depot from which, in long persistent, never dangerous concentration, the curative substance is slowly released; all these conceptions present themselves, again and again, as necessary for our present rationalisation of the effects observed. It can hardly be doubted that they will potently influence the methods by which, in the immediate future, new and still better specific remedies are sought. But though our practical aim, in relation to the affinities of a remedy for the parasite and for the host's tissues, may be radically changed, the meaning of these specific affinities, so delicately adjusted to a precise molecular pattern, remains dark. Ehrlich's chemoreceptors may no longer satisfy us, but we have nothing equally definite to replace them. I have endeavoured to indicate what seem to me hopeful signs of new contacts between biochemistry and chemotherapy. There is promise, in another direction, that at least some aspects of the problem

of immune specificity are being brought within the scope of strictly chemical investigation, as in the recent work of Avery and Heidelberger, on the constituent of a pneumococcus which combines with the specific precipitin. As in Ehrlich's pioneer work in chemotherapy, it can hardly be doubted that an increased understanding of the meaning of immune specificity, which but a short while ago might have seemed hopelessly beyond the range of attack by chemical weapons, will still influence ideas, and help to shape the course of further investigations, on the chemotherapeutic process. As the biological complexity of the problem is realised, it becomes increasingly a matter for wonder and admiration that so much of practical value has already been achieved —the treatment of the spirochætal infections, syphilis, yaws and relapsing fever, revolutionised; Leishmania infections, kala-azar and Baghdad boil, and Bilharzia infections, which crippled the health of whole populations in countries such as Eygpt, now made definitely curable; trypanosome infections, such as the deadly African sleeping-sickness, after years of alternating promise and disappointment, brought now at last within the range of effective treatment. And if such results have already been attained, in a period during which practice has often and inevitably outrun theory, we may well be hopeful for a future, in which fuller understanding should make for more orderly progress.

FORTHCOMING EVENTS

Oct. 1. SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1, at 8 p.m.

The following papers will be read:—"The Determination of Coconut Oil and Butter Fat in Margarine," by G. D. Elsdon and P. Smith. "A Preliminary Note on the Composition of the Fat of Goat's Butter," by F. Knowles and J. C. Urquhart. "The Quantitative Estimation of the Degree of Hydrolysis of Gallotannin by Tannase," by Miss W. N. Nicholson and D. Rhind. "The Pemberton-Neumann Method for the Estimation of Phosphorus," by Miss M. B. Richards and W. Godden. "Application of 'Formal Titration' to the Kjeldahl Method of Estimating Nitrogen," by W. S. Shaw. Informal Dinner will be held for Members and their friends at St. James' Restaurant, 178 Piccadilly, at 6.30 p.m.

Oct. 2. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section*, the Chemical Department of the University (Woodland Road), Bristol, at 7.30 p.m. "Combustion Control in Boiler Houses," by H. T. Ringrose.

WORK has begun on the construction of a plant for the manufacture of pulp from straw, to the north of Selkirk, Manitoba. M. Dolphus, representing the De Vains interests in Great Britain, has completed arrangements, and W. R. Allan, president of the Union Bank of Canada, will be on the directorate.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

A circular letter with further particulars and a form of application for tickets has been sent out to the members.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

OTTAWA SECTION

On September 4 a joint meeting was held with the Ottawa Branch of the Engineering Institute of Canada, Dr. A. E. Macintyre in the chair.

In opening the meeting the chairman exhibited a map prepared by the natural resources and intelligence branch of the Department of the Interior, which showed the production, importation and consumption of coal in the various provinces of Canada.

Prof. W. A. Bone, F.R.S., then read a paper on "The Brown Coals and Lignites of the British Empire. Why Coals Coke." Prof. Bone expressed his great appreciation of the hospitality extended to the British Association during the Canadian visit and hoped that the visit would strengthen the bonds of unity within the Empire. Co-operation was necessary in all parts of the Empire in order that the great natural resources in brown coals and lignites might be exploited to the best advantage. The coalfields from Saskatchewan to the Rockies were unique and appeared to have been laid late in the earth's history. There was a gradual maturing of the coal from Saskatchewan westward. This field, perhaps, offered the best opportunity for chemists to determine how coals were formed, and it would be of great value if Canada would so investigate it.

An outline was then given of coal formation and after this the scheme was described for developing electric power at the Morwell brown-coalfields in Australia, where the coal is burned in water tube boiler furnaces after being dried with the waste gases. The drying increased the rates of combustion and of evaporation more than threefold. The heat units might be concentrated with advantage by heating to 375° C. The Saskatchewan lignites were heated to 350° C. to increase their burning efficiency in his experiments with them. The yield of coal tar in the low temperature carbonisation of these coals was generally below 4 per cent., so they could not be considered a source of oily hydrocarbons.

The thanks of the meeting was expressed by Mr. F. J. Hambly for the chemists and Mr. J. L. Rannie for the engineers.

CORRESPONDENCE

CHEMICAL AND PHYSICAL UNITS

Sir,—Some little time ago I resigned my membership of the Joint Committee for the Standardisation of Scientific Glassware, so I may be permitted to criticise their report.

Their resolution to the effect that "volumetric glassware *shall be graduated* in terms of "the millilitre, involves metaphysical rather than physical considerations. They do not make it sufficiently clear that the difference involves an error of the order of 1 part in 35,000, which is far outside the limit of error of manufacture, and indeed, no ordinary laboratory would have the means of determining whether an article should really be marked c.c. or ml. What the Committee really has done is to show the weakness of the suggestion put forward by another representative committee of chemists to the effect that the Mohr unit should be adopted as the basis of standardisation of chemical glassware. The N.P.L. could well have dealt with this suggestion without the aid of a second committee.

While referring to units it is an extraordinary fact that a very large number of chemists consistently refer to "normal pressure" as being represented, in London, by 760 millimetres of mercury. As a matter of fact the international unit refers to sea level in Lat. 45, which is equivalent to 759·55 millimetres in London. It is upon this basis that we reckon the mass of a litre of oxygen at 1·4290 grams. Taking the normal pressure at 760 millimetres an error of 1 in 1700 is involved. It is not of much use reading a barometer to 0·1 mm., applying a correction for temperature reckoned to be of the same order of accuracy, and then neglecting the gravity correction of about half a millimetre.

In technical work standard pressure is often taken to be 30 in. of mercury at 0° C. This is equivalent to 762·98 millimetres. This involves a departure of about 1 in 300 from normal pressure, but the difference is often ignored.—I am, Sir, etc.,

M. W. TRAVERS

147, Queen Victoria Street,
London, E.C. 4

THE EARLY HISTORY OF CHEMICAL INDUSTRY

Sir,—According to Parkes, a workman who had absconded from Roebuck's employ started a works for the manufacture of sulphuric acid at Bridgenorth (Salop) in 1736. The writer will be grateful for any confirmation of this statement, and further particulars, if known.

Roebuck's works are stated by Prosser to have been in Steelhouse Lane, Birmingham. They eventually passed into the hands of Messrs. Alston and Armitage, and were continued under the name of Alston and Sons down to the year 1825, or perhaps later. Presumably these were the works at which the first leaden vitriol chamber was erected. It would be of great interest to hear if any drawings or other illustrations of early chemical works or plant are in existence at the present date, or indeed, portraits of some of the early pioneers of chemical manufacture. The following names of those who have shared in laying foundations of the heavy chemical industry, occur to me at random—Drebbel, Ward, Dossie, La Follie, Roebuck, Garbett, Holker, Clement, Desormes, Gay Lussac, Glover. The list could doubtless be considerably extended. Illustrations of early chemical plant, the result of their efforts would form an interesting series of considerable historical value.—I am, Sir, etc.,

H. A. AUDEN

120, Whitehedge Road
Garston
September 13, 1924

PERSONAL AND OTHER ITEMS

His Royal Highness Prince Arthur of Connaught has graciously consented to undertake in November the formal opening of the Ramsay Laboratory of Chemical Engineering at University College, instituted in 1923 as part of the Memorial to the late Sir William Ramsay, K.C.B., F.R.S. A full course of study in chemical engineering will be provided in the laboratory in the coming session, leading to the degrees of M.Sc. or Ph.D. in Chemical Engineering. The Course is designed to meet the demands of the manufacturing industries for men trained in the application of scientific methods to the design and operation of industrial chemical processes and plant. Special facilities are provided for research.

Mr. W. J. U. Woolcock, C.B.E., president of the Society of Chemical Industry, has been elected an Honorary Member of the Chemical, Metallurgical and Mining Society of South Africa, for the year ending June 30, 1925.

During the recent autumn meeting of the Institute of Metals, Prof. T. Turner, the president, announced that £1600 had been given anonymously to the endowment fund of the Institute.

Dr. J. S. Haldane has succeeded Sir John Cadman as president of the Institution of Mining Engineers.

The Ministry of Agriculture announces that the Government has decided to provide a further sum of £500,000 for agricultural education and research, in addition to the funds available for the same object amounting to £1,000,000 under the Corn Production Acts (Repeal) Act, and about £400,000 a year from other Government funds.

The following awards for the year 1924-25 have been made by the Salters' Institute of Industrial Chemistry and approved by the Court of the Company: Fellowships are renewed to Dr. W. G. Sedgwick, Armstrong College, Newcastle-on-Tyne, and Oxford, Fellow, 1923-24, and to Mr. W. Randerson, Imperial College of Science and Technology, Fellow, 1922-23, and Hon. Fellow, 1923-24 (during tenure of Albert Kahn Travelling Fellowship). Fellowships are awarded to Mr. H. H. Evers, University of Liverpool; Mr. K. Knight Law, University College, Nottingham; Mr. H. S. Pink, University College, Nottingham, and Oxford; and Mr. V. E. Yarsley, Birmingham University. The Salters' Institute has also awarded 72 Grants in Aid to young men and women employed in chemical works in and near London to facilitate their further studies.

We greatly regret to announce the death of Mr. Otto Hehner whilst on a visit to South Africa. An obituary notice of Mr. Hehner, who was an original member of the Society of Chemical Industry, will appear in a later issue.

The death is announced, at the age of 80, of Mr. John Allen, chairman of Frederick Allen & Sons, Ltd., chemical manufacturers, Poplar, and an original member of the Society of Chemical Industry.

Empire Motor Fuels

The report of the Empire Motor Fuels Committee set up by the Imperial Motor Transport Council has been published by the Institution of Automobile Engineers. The report constitutes a remarkably complete review of practically every motor fuel whether commercial or not, from the points of view both of chemical and physical properties and of efficiency in actual use. The possibilities of alcohol alone or in admixture with other fuels are shown to be very promising, and interesting results have been obtained in the prevention of "knocking" by adding very small amounts of pyridine, diethyl and tetraethyl compounds to the fuel. The results are given of tests with 90, 95 and 99 per cent. alcohol and with mixtures of alcohol and ether. The reports of sub-committees on denaturation and excise restrictions have been published separately.

Fur Dermatitis

The Ministry of Health has issued a report (Reports on Public Health and Medical Subjects, No. 27, pp. 31. H.M. Stationery Office, Price 9d.) of an enquiry into the occurrence of dermatitis attributed to the wearing of fur collars. Examination showed that the disease was caused by furs consisting of rabbit skins dyed to resemble beaver. The dyes used were found to be paraphenylenediamine and metaphenylenediamine, which have to be developed by oxidation, hydrogen peroxide being generally used. When oxidation is incomplete, owing to carelessness or from motives of economy, actively irritant bodies such as quinone di-imide are produced, and these products set up dermatitis. It is concluded that defective or careless technique in the use of potentially dangerous dyes is, in all probability, the cause of fur dermatitis.

"Antiknock" Compounds

It is well known that the presence of a minute quantity of tetraethyl lead in motor fuel will prevent knocking in internal-combustion engines, but no explanation has been given of the mechanism of this curious phenomenon. An explanation has, however, been suggested by G. L. Wendt and F. V. Grimm (*Ind. & Eng. Chem.*, Sept., 1924). According to these workers, the energy released in the reaction of the hydrocarbon with oxygen serves in part to liberate electrons from the reacting molecules, and the electrons, propelled at high velocity from the flame front, ionise the molecules in the gas in front of the flame, this ionisation being regarded as the cause of the acceleration of the flame. It is thus suggested that the function of the lead atoms in tetraethyl lead is to attract these electrons, and form highly-charged lead ions, thus preventing the ready ionisation of the unburned hydrocarbons. In addition, the lead, it is considered, will attract the positively charged hydrocarbon ions and thus render them momentarily inactive. Experiments made by the authors provide evidence in favour of their theory, and the work is being extended to other antiknock compounds.

Italian Mineral Production in 1923

The following table shows the output of the various minerals and their products in 1923 as compared with 1922 :—

	1922 Metric tons	1923 Metric tons
Mines—		
Iron ore	311,214	295,450
Ferromanganese	3,196	10,050
Manganese ore	4,694	9,190
Copper ore	7,863	7,230
Lead ore	30,617	36,804
Zinc ore	94,956	136,881
Antimonial ore	607	700
Iron pyrites	486,000	493,412
Anthracite	26,423	9,42[illegible]
Coal	168,929	159,50[illegible]
Lignite	745,402	938,22[illegible]
Bituminous schist	5,476	2,52[illegible]
Peat	56,687	56,1[illegible]0
Raw sulphur	167,339	248,[illegible]16
Ground sulphur ore	22,706	15,[illegible]00
Rock salt	49,802	53,[illegible]59
Medicinal salt	86,572	1[illegible]0,197
Petroleum	4,290	4,810
Asphalt and bituminous rock	67,895	140,250
Bauxite	66,646	98,222
Leucite	18,000	8,720
Boric acid	2,448	2,500
Graphite	4,546	5,584
Quarries—		
Pumice stone	21,036	30,000
Asbestos	540	1,510
Steatite and talc	26,485	31,140
Barytes	21,300	26,300
Coloured earths	6,505	10,000
Quartz and felspar	39,864	40,770
Porcelain clay	7,687	9,885
Magnesium earths	8,700	13,250
Refractory material	48,779	58,250
Silicious sand	216,540	241,000
Fluorspar	[illegible]	3,362
Metallurgical Industries—		
Pig iron	143,198	229,100
Synthetic pig iron	14,400	18,060
Steel and iron in ingots	981,419	1,121,912
Metallic alloys	20,214	28,180
Lead	10,709	17,059
Silver	6,367 kilos	9,536 kilos
Zinc	3,082	3,700
Zinc white	715	1,009
Copper cement	409	397
Antimony	209	175
Asphalt	41,920	38,400
Refined bitumen	993	900

In ferro-alloys, the production of which was insignificant before the war, considerable progress has been made. Steel production in 1923 was greater than it was before the war (933,500 tons in 1913), but less than the 1,331,641 t. recorded in 1917, the record year. The facilities of the Italian plants were greatly enlarged during the war and at the present rate of production it is estimated that they are working at only about two-thirds of their capacity. The production of metallic zinc in Italy is very small, most of the ore being exported to Belgium, France and Germany. The zinc industry

is new to Italy, and no production of metallic zinc is recorded for 1913, 1914 or 1915. Italy's zinc resources were materially increased during the war owing to the existence of important mines in the annexed Austrian territory. The production of metallic lead, although considerably greater, is still elow the pre-war average of 21,674 t. The present esources of copper are very limited, having declined rom 86,953 t. in 1914 to 7230 t. in 1923. No metallic opper was produced in 1922, but 150 t. was recorded or 1923. Imports of copper in 1923 were 46,983 t., of which 26,539 t. was supplied by the United States. In 1923, 1500 t. of nickel ore was mined, as compared with 22 t. during the previous year, but no production of metallic nickel is recorded. The output of bauxite in 1923 was approximately 50 per cent. greater than in 1922, whilst that of aluminium remained practically stationary around 800 t.

Practically the entire output of fuel consisted of lignite, although 159,500 t. of coal, which is actually a high-grade lignite produced in Istria, is also recorded. It is interesting to note that after having shown a decline from a maximum of 2,117,145 t. in 1918, the production of lignite is again increasing and reached 938,229 t. in 1923. The agreement between the Sicilian sulphur consortium and the American producers, concluded in March, 1923, resulted in a considerable increase in the Italian production of raw sulphur, but there was a small decline in the output of ground sulphur ore.—(*U.S. Com. Rep., May* 19, 1924.)

Shock resisting glass in Czechoslovakia

The Prague Glass Works, organised in 1919 with a share capital of 12,000,000 crowns, is engaged principally in the manufacture of laboratory glass and other special glass products, and has lately come to an agreement with the owners of the patent for the production of a shock-resisting glass under the trade name "Resista," whereby "Resista" glass shall be produced as soon as the plant can make the necessary technical preparations.

The World's Production of Fertilisers

In 1923 the output of ammonium sulphate was as follows:—France, 88,000 m.t.; Germany, 900,000 m.t.; United States, 420,000 m.t.; Britain, 360,000 m.t., and Japan, 70,000 m.t. In the same year, France produced 50,000 m.t. of cyanamide, Germany, 400,000 m.t., and Japan 40,000 m.t. Imports of Chilean nitrates into France amounted to 268,000 t. as compared with 322,000 t. in 1913. Notwithstanding the reduced output of natural phosphates elsewhere, Algeria, Tunis and Morocco steadily developed their production. In Northern Africa the progress of extraction has been as follows:—Algeria, 402,000 t. in 1921; 615,000 m.t. in 1923; Tunis, 1,418,000 m.t. in 1921, and 2,261,000 m.t. in 1923; Morocco, 80,000 m.t. in 1922, and 190,000 in 1923. Whilst the world's output of superphosphates decreased to 9,094,000 t. in 1923, against 12,222,000 t. in 1913, French production has increased from 1,979,000 m.t. in 1913 to 2,215,000 m.t. in 1923. The output of dephosphorising slags is decreasing, France producing 617,000 m.t. in 1913, and 585,000 in 1923; Luxembourg, 282,000 m.t. in 1913, and 235,000 in 1923; Germany, in 1913, 2,029,000, and 480,000 m.t. in 1923; and Belgium, 482,000 m.t. in 1913, as against 275,000 in 1923. The production of potassium salts has risen from 146,355 t. in 1921, to 230,000 t. in 1922, and 248,528 t. in 1923. Whereas 42,437 t. was imported in 1913, about 167,000 m.t. was exported in 1923, about 10,000 m.t. going to Great Britain.

COMPANY NEWS

UNITED INDIGO AND CHEMICAL CO., LTD.

The report for the year to June 30, 1924, shows a gross profit of £41,587, which includes excess profits duty previously reserved and was struck after providing an unstated amount for depreciation. General charges absorb £4669, leaving a net profit of £36,918. A further dividend is proposed on both the preference and ordinary shares, making 15 per cent. for the year (compared with 10 per cent. last year, and 12½ per cent. for 1921–22), carrying forward £11,262, against £9969 brought in.

BRITISH ALUMINIUM CO., LTD.

The directors announce a dividend at the rate of 5 per cent. per annum, less tax, on the ordinary shares for the six months ended June 30, 1924, payable October 1.

BURT, BOULTON, AND HAYWOOD, LTD.

Since the last report 92,000 ordinary shares have been issued, and also £300,000 6 per cent. first mortgage debenture stock. The latter will take the place of the Bank loan (for £244,000) appearing in the balance sheet. Net profits of £72,928 were earned in the year to June 30 last, after writing off £20,000 for depreciation. The balance of £10,163 brought forward is added. The preference dividends, the interim ordinary dividends, and distribution on the workers' certificates absorbed £16,908. A final dividend of 4 per cent. is proposed on the ordinary shares, making 8 per cent. free of tax for the year (the same as for the preceding twelve months), together with a final distribution of £302 on the workers' certificates. In addition £30,000 is to be carried to reserve, and there will be a balance of £17,241 to be carried forward.

LEYLAND AND BIRMINGHAM RUBBER CO.

Profits for the year ended June 30, 1924, amounted to £78,739, a decline of £5064 on the previous year's figure. Depreciation, reserve for discounts, bad and doubtful debts and directors' remuneration absorb £20,456 (against £19,332), leaving a net profit of £58,283, compared with £64,470. The directors recommend a final dividend of 7½ per cent. on the ordinary shares, again making 10 per cent., placing £5000 to the reserve account (against £7000), leaving £31,074 to be carried forward, compared with £30,791 brought in.

NEW TAMARUGAL NITRATE CO., LTD.

An interim dividend of 10 per cent. is announced on account of profits for the year to July 31 (the same as the interim dividend for 1922–23).

REPORTS

REPORT ON THE INDUSTRIES AND COMMERCE OF SPAIN. Dated March, 1924. By Capt. U. DE B. CHARLES, C.B.E., H.M. Commercial Secretary, Madrid. Department of Overseas Trade. Pp. 78. H.M. Stationery Office. 1924. Price 2s. 6d.

Little advance was made either commercially or industrially during 1923 (cf. *Chem. and Ind.*, 1923, 991). The two main problems are Morocco and transport, still awaiting solution. The most acute stage of the industrial crisis occurred in 1923, but is now considered to be past, and better results are hoped for during 1924.

In the mining and metallurgical industries the year opened with good prospects which were, however, not fulfilled. The protection given by the Conservative Government to the coal industry was much modified. The output from the Asturian mines was 2,500,000 t., and 1,500,000 t. of British coal were imported, the total consumption being 5,684,000 t. Owing to reduced British demands the output of iron ore was low. Exports of cupreous pyrites fell and price-cutting by the larger producers placed many small concerns in difficulties. The lead industry remained about the same, 64 183 t. being exported in 1923; the present high prices are leading to the opening of fresh workings. Zinc output was slightly improved, but that of mercury fell somewhat, though an improvement is hoped for this year. Cement production increased considerably in 1923, the output being estimated at 600,000 t.

Harvests in general were above the average, but prices fell owing to reduced purchases: the sugar crop was abundant.

The total value of imports in 1923 was 2708 million pesetas (nominally £1=25·22 pesetas, 1923 average about 32) against exports 1117 mill. pesetas. There were increased imports of oils, natural earths, phosphates of lime and window-glass, and decreased imports of coal, coke and briquettes, lime, cement, asbestos, tar and pitch, and glass other than window-glass. Among metals and manufactures of metals there was some change in the products in demand, steel in hoops and rough iron bars showing a big increase for example, whilst pig-iron imports fell considerably. The United Kingdom holds a fairly good position here with Belgium, Germany and the United States as the chief competitors. Among chemicals, dyestuffs are obtained but little from this country, which, however, holds the lead in oils, fats and waxes, glycerin, alkali borates, copper sulphate, ammonium sulphate and other ammonium salts, and cream of tartar. Among textile imports Great Britain has a strong competitor in France. The total imports from Great Britain in 1923 were valued at £11,333,512.

REPORT ON THE FINANCIAL, COMMERCIAL, AND INDUSTRIAL SITUATION OF AUSTRIA. Revised to July, 1924. By O. S. PHILPOTTS, O.B.E., H.M. Commercial Secretary, Vienna. Department of Overseas Trade. Pp. 50. H.M. Stationery Office, 1924. Price 1s. 6d.

The League of Nations scheme for the reconstruction of the country has met with much success, and the budget is due to balance by the end of this year. The improvement in national finance is not, however, reflected in the general economy of the country; a financial crisis in the spring of this year led to a number of failures. On the other hand unemployment has recently decreased. Politically, the country has been undisturbed and relations with neighbouring countries are excellent.

The agricultural industry still has far to go before reaching pre-war standard, though a steady improvement has been noticeable since 1919. Coal consumption in 1923 was again lower than in the previous year: unemployment in various industries offers some explanation, but the development of water-power is also beginning to make itself felt; the decrease, too, is mainly in lignite. There is strong competition between Czechoslovakia and Poland for the Austrian market in black coal; 72,000 tons of coal and 24,000 tons of coke were imported from Great Britain.

The country is highly industrialised and has a large surplus of manufactured goods for export. The industrial crisis which followed the stabilisation of the crown in 1922 lasted throughout 1923, but has diminished in intensity and unemployment has decreased considerably, largely owing to the occupation of the Ruhr and the collapse of Germany as a competitor. Production of pig-iron in Austria in 1923 amounted to 323,172 t. and of steel to 499,442 t.; the latter part of the year was the more favourable. The percentage of full production in February, 1924, was estimated as follows:—Leather 60, boots 50, rubber 100, cotton 75-80, wool rather higher than cotton, hemp and flax 60, knitted goods 66, glass 20. The stagnation of Austrian industries is likely to last some time, both on account of the loss of pre-war markets and also the high rates of transport.

In 1923 imports into Austria amounted to £77,122,000 against £73,220,000 in 1922, whilst exports were valued at £43,238,000, against £46,369,000. The rise in imports was mainly in articles of food and drink and in finished goods, rather than in materials and machinery for the improvement of industrial and agricultural production. The principal source of imports is Czechoslovakia, with 23·2 per cent. of the total in 1923, Germany coming next with 16·6 per cent., followed by Hungary with 11·4 per cent. The most important exports from Britain to Austria are leather, textiles, iron, and raw and semi-manufactured materials.

A HOT SPRING AT ARCACHON

This spring, which was mentioned by our special correspondent in his account of the Fourth Congress of Industrial Chemistry at Bordeaux, was discovered as the result of borings put down to 464 m. in the Abatille Forest by the Société de Recherches d'Hydrocarbures. The water, at a temperature of 25° C., springs 10 m. into the air, flowing at a rate of 60,000 m. per hour, and its radio-activity is similar to that of the mineral waters at Vichy. The water is alkaline, contains free carbonic acid, nitrogen and sulphide, and is slightly magnesium.

REVIEWS

The Action of the Beater. By Dr. S. Smith. Translated by Major R. Marx, M.C., B.Sc. Pp. xi+212. London: The Technical Section of the Papermakers' Association of Great Britain and Ireland, 1923. Price 15s.

The important part which the beater occupies in the manufacture of paper is well known, and the statement that "the sheet is made in the beater" is in many instances justified. Mr. C. F. Cross in the Foreword quite correctly describes the beater as the pivot of the mill, and the beating preparation of the fibrous raw material as *the* papermaking operation.

"The Action of the Beater" is a particularly valuable addition to the literature, because in it the author discusses the results of a very large number of systematic experiments which he has carried out under mill conditions.

In the introduction the author draws attention to the widely different views held by papermakers on the question of beating and of makers of beaters on their construction, and everyone will agree with him that "any reliable theory on the beating operation must be largely based on detailed investigation of all the factors concerned."

Both in the Introduction and in Chapter VI, "Comparative Beating Tests," the work carried out by previous investigators is fully, and in many cases, critically discussed.

In Chapter I the author deals with the effect of beating on the character of the stuff with regard to physical changes, such as shortening of the fibres and of "wet beating" which may result in both physical and chemical changes of the fibres.

Chapter II, "The Mechanics of the Beating Tackle"; Chapter III, "The Theory of Beating"; Chapter IV, "The Beating Pressure"; Chapter V, "Influence of Pressure and Consistency on the Beating Action," contain a mass of detail which will be found of the utmost interest to all concerned with the manufacture of paper.

In Part II, Chapter I to IV, the author discusses the results of exhaustive experiments into the power consumption of beaters.

The study of the "Conditions Governing the Formation of Fibrages" dealt with in Part III, to which hitherto but little attention has been paid, will be found of special interest. Dr. Smith has made a careful study of this subject, which is one of the most important factors in determining the efficiency of a beater.

We are indebted to Mr. C. F. Cross for the "simple descriptive word" Fibrage, which means "the fibre attaching itself to the bars and brought under the direct milling action between the bars of the roll and bed plate."

Those who are unable to follow the mathematical treatment of the subject will find a very useful summary at the end of the book, in which the author's conclusions are set out in non-mathematical terms.

The book should be carefully studied by every papermaker and papermaking engineer.

The industry is greatly indebted to the Technical Section of the Papermakers' Association of Great Britain and Ireland for publishing this work in English, and last, but not least, to Major Marx for his excellent translation.

J. Huebner

The Design and Working of Ammonia Stills. By P. Parrish, A.I.C., M.I.Chem.E. Pp. xvii+283. London: Ernest Benn, Ltd., 1924. Price, 40s. net.

Mr. Parrish's book should receive a hearty welcome from all who are connected with the working of plant for the recovery of ammonia from any form of ammoniacal liquor, for though there are other books containing general descriptions of ammonia-plant, there are none within the reviewer's knowledge dealing with the matter in detail from the point of view of working the plant in such manner as to obtain from it the greatest efficiency and economy in manufacturing costs. This book well fills the gap, as would be expected in view of Mr. Parrish's extended experience in the working of these plants and the long and careful study he has made of the different processes involved, and of the principles on which they depend. Whilst it is probable that there will not be universal agreement with every one of Mr. Parrish's conclusions, even those who differ from him on some points will gain much from a study of the book whether they are concerned with the daily working of the plant or the design of new and better apparatus for the purpose.

What may be termed the leading "motif" of the book is economy in steam, and consequently in fuel consumption, a matter very largely neglected in the past. This neglect was chiefly due to the fact that the users of such plant were, for the most part, gas undertakings or coke oven installations, which happened to have available supplies of poor fuel suitable for the purpose which were barely saleable, and, in consequence, economy of such fuel made but a small showing in reducing manufacturing costs. The great rise in the commercial value of even such low-grade fuels, has, however, entirely altered the position, and a reduction in fuel consumption is now realised as imperative, even by those who formerly regarded this as unimportant. But, although steam and fuel economy may be regarded as the main theme, adequate consideration is also given to the underlying principles of the still and the accessory parts of the plant, such as preheaters, dephlegmators liming apparatus and coolers; the manufacture of concentrated gas liquor, concentrated ammonia liquor, and liquor ammonia are all dealt with, as well as the difficult problems associated with the satisfactory handling of the waste gases and waste liquor produced in the process, and directions are indicated in which these are capable of improvement. The most noticeable omission in the book is that nothing is included with regard to the manufacture of ammonium sulphate from the gases given off from the stills, although (except for the ammonia-soda process, where the

ammonia from the stills is, for the most part, used over and over again and only losses having to be made good) by far the greatest amount of ammonia evolved from the stills is made direct into sulphate.

The book is well printed on good paper, and the illustrations are numerous and, for the most part, good and clear. There are, however, some defects which should be remedied in future editions. For example, in Fig. 167, representing diagrammatically the still used in the ammonia-soda process, the arrangement is not very clear, and part of the figure seems to have wandered into Fig. 168 on the next page. Further, where the illustrations are numerous, these sometimes get separated by several pages from the descriptions, which is somewhat exasperating to the reader, and though probably to some extent unavoidable, might be made less extensive. The number of typographical errors is also rather large, though these are, for the most part, confined to transposition of figures, and especially to the chemical formulæ and equations, which suffer rather severely in places.

H. G. COLMAN

1. CHEMISCHE REAKTIONEN IN GALLERTEN. By R. ED LIESEGANG. Pp. 90. Dresden and Leipzig: Theodor Steinkopff, 1924. Price \$0.85 net.

2. LICHT UND FARBE IN KOLLOIDEN. By WOLFGANG OSTWALD. Pp. XIV. + 556. Dresden and Leipzig: Theodor Steinkopff, 1924. Price \$7.60 net.

1. The study of reactions in jellies is one of the most fascinating lines of colloidal research, owing partly to the beauty of many of the results, and partly to the hope, remote and tantalising though it is in many instances, of their throwing light on the origin of natural structures. The subject bears on so many different disciplines that the literature is even more widely scattered than that on other branches of colloid chemistry, and the author has done a service to students by presenting a brief but quite adequate account of our present knowledge. A short introduction is followed by a description of the experimental technique of diffusion and precipitation experiments, a discussion of Pringsheim's rule for the direction in which the reaction proceeds, and chapters dealing with apparent *actio in distans*, the degree of dispersity and crystallographic peculiarities of the precipitates formed in jellies. The rest of the volume is devoted to the phenomenon of periodic precipitation now generally associated with the author's name, the closely related "rhythmical crystallisation," and their bearing on natural structures. Few readers, unfamiliar with the literature, would gather from these chapters how important have been the author's own contributions; wherever possible, he describes the work of other investigators rather than his own. Even the illustrations, which are well chosen and reproduced, are largely taken from the papers of other authors.

The work should be useful to a large circle of readers and will probably tempt most of them to make at least one set of "Liesegang rings."

2. This large volume is described as the first part of a treatise on the optical properties of colloidal or, more generally, disperse systems. A comparison with standard works, such as Freundlich's "Kapillarchemie," which devotes a total of about 25 pages to these properties, is all that is necessary to impress the reader with the magnitude of the task accomplished by the author. An immense range of literature has been drawn upon, and the material has been marshalled so as to exhibit the two aspects which the author emphasises in his other works; the continuity of phenomena, from coarse dispersions to molecular solutions, and the variation of any one property with the degree of dispersity. The matter is treated under five principal headings: I. Turbidity and the Tyndall phenomenon; II. The ultra-microscope and the qualitative and quantitative ultra-microscopic investigation of disperse systems; III. Polarisation and optical activity; IV. Absorption and colours, and V. Refraction and dispersion in disperse systems.

In the first section the factors which cause turbidity in disperse systems, viz., refraction, reflection and diffraction at the interface, and their relative share with varying degree of dispersity, are discussed at great length for both dielectric and metallic particles. The chapter on ultra-microscopy is by far the most exhaustive treatment which this subject has received in a textbook so far, and it is illustrated by a number of very beautiful and instructive plates. The third section gives the theory, as far as it has developed, of polarisation by metallic and by non-conducting particles, and a very full account of the variation of the specific rotation of gelatin, tannin, etc., with age and concentration. In the fourth section the validity of Lambert's and Beer's absorption formulæ for disperse systems is discussed, as well as the production of colour by the three factors which cause turbidity. The final section deals with the problem of expressing the refractive index of disperse systems in terms of the indices of the phases, their ratio and degree of dispersity.

The book is written throughout with that obvious and lively joy in the subject which is characteristic of all the author's works and sometimes tempts him into an almost epic breadth of treatment. The plan of the work—or, perhaps the nature of the subject—involves a considerable amount of repetition, some of which seems avoidable; thus it is not quite easy to see why opalescence should be treated quite separately from turbidity, and why Lord Rayleigh's formula should thus be discussed very amply in two places. A number of minor points, on which differences of opinion are possible, might be made, but they would exceed the scope of this review and do not materially affect the value of this pioneer work. The volume will have to have a place in every library of colloid chemistry, and the purchaser may find some consolation for the high price (which, no doubt, is partly justified by the expensive illustrations) in the thought that very little of it is spent on information already available in the other volumes on his shelves.

EMIL HATSCHEK

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst. ..	£45 per ton.
Powder..	£47 per ton.
Acid Hydrochloric ..	5s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric ..	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali..	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal ..	£25 per ton.
Powder..	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Copper Sulphate ..	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial ..	3s 1d.—3s. 5d. per gallon, according to quantity.
Mineralised ..	4s. 2d.—4s. 6d.
Nickel Sulphate .. / Nickel Ammon. Sulphate	£38 per ton d/d. Normal business.
Potash Caustic ..	£30—£33 per ton.
Potass. Bichromate ..	5¼d. per lb.
Potass. Chlorate..	3d.—4d. per lb.
Salammoniac ..	£32 per ton d/d.
Salt Cake..	£3 10s. per ton d/d.
Soda Caustic, solid ..	Spot lots: delivered, £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals ..	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton, carr. paid.
Sod. Bichromate..	4½d. per lb.
Sod. Bisulphite Powder 60/62%..	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate ..	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst. ..	£9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden ..	5¼d.—1s. 4d. per lb., according to quality.
Antimony sulphide—	
Crimson ..	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes ..	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide ..	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide ..	£30—£33 per ton, according to quantity. Again dearer.
Carbon Black ..	7d.—7½d. per lb. ex wharf. Dearer.
Carbon Tetrachloride ..	£60—£65 per ton, according to quantity, drums extra. Again dearer.
Chromium Oxide, green..	1s. 3d. per lb.
Indiarubber Substitutes White and Dark ..	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black ..	£48 per ton, barrels free. Advanced.
Lead Hyposulphite ..	7½d. per lb.
Lithopone, 30% ..	£22 10s. per ton.
Mineral Rubber "Rubpron" ..	£16 5s. per ton f.o.r. London.
Sulphur ..	£10—£12 per ton, according to quality.
Sulphur Precip. B.P. ..	£56—£57 per ton, according to quantity.
Sulphur Chloride ..	4d. per lb., carboys extra. Dearer.
Thiocarbanilide ..	2s. 6d. per lb.
Vermilion, pale or deep ..	5s. 1d. per lb. dearer.
Zinc Sulphide ..	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

"Summer conditions" prevail in this as in most industries.

Acetate of Lime—	
Brown ..	£12 per ton.
Grey ..	£16 per ton.
Liquor ..	9d. per gall. 32° Tw.
Charcoal ..	£7 15s.—£9 5s. per ton, according to grade and locality. Market brisker.
Iron Liquor ..	1s. 7d. per gall. 32° Tw. 1s. 2d. ,, ,, 24° Tw.
Red Liquor ..	10d.—1s. per gall. 14/15° Tw.
Wood Creosote ..	2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible ..	4s. 10d. per gall. 60% O.P.
Solvent ..	5s. 3d. per gall. 40% O.P.
Wood Tar ..	£4 5s. per ton.
Brown Sugar of Lead ..	£43 per ton. Cheaper.

TAR PRODUCTS

Acid Carbolic—	
Crystals ..	6½d. per lb. Quiet.
Crude 60's ..	1s. 9d.—1s. 11d. per gall, according to district. Still quiet.
Acid Cresylic, 97/99 ..	2s.—2s. 1d. per gall. Demand fair.
Pale 95% ..	1s. 9d.—1s. 10. per gall.
Dark ..	1s. 9d.—2s. per gall. Quiet.
Anthracene Paste 40% ..	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained ..	7½d.—9d. per gall. Quiet.
Unstrained ..	6½d.—7½d. per gall.
Benzole—	
Crude 65's ..	7½d.—9d. per gall. ex works in tank wagons.
Benzole—	
Standard Motor ..	1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.

Benzole—

Pure	.. 1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole 90% ..	.. 1s. 5d.—1s. 5½d. per gall. Small demand.
Pure ..	.. 1s. 8d.—2s. per gall. Small demand.
Xylol coml. ..	.. 2s. 3d. per gall.
Pure ..	.. 3s. 3d. per gall.

Creosote—

Cresylic 20/24%	.. 8½d. per gall. Not much business.
Middle Oil .. .. / Heavy Oil .. .. / Standard Specification	5d.—6½d. per gall., according to quality and district. Small export inquiry. Market quiet but fairly steady.

Naphtha

Solvent 90/160	.. 11d.—1s. 5d. per gall., according to district. Fair demand.
Solvent 90/100	.. 11d.—1s. 4d. per gall. Fair demand.

Naphthalene Crude—

Market dull. Not much export inquiry. Cheaper in Yorkshire than Lancashire.

Drained Creosote Salts £1—£6. Quiet.

Whizzed or hot pressed £7—£9 per ton.

Naphthalene—

Crystals and Flaked	.. £13—£16 per ton in Yorkshire and London respectively.
Pitch, medium soft	.. 55s. 60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160	.. 19s. per gall. Again dearer. Market firm.
Heavy ..	.. 12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

There has been a considerable falling off in business in Aniline Dyes. Orders are now being received for day to day requirements only. The outlook is not very promising.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 7d. per lb.
Acid H.	.. 3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic	.. 2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	.. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic	.. 9¼d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil ..	.. 7¾d.—8½d. per lb. naked at works.
Aniline Salts ..	.. 7¾d. 9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base ..	.. 4s. per lb. 100% basis d/d.
Benzyl Chloride 95%	.. 1s. 1d. per lb.
p-Chlorphenol ..	.. 4s. 3d. per lb. d/d.
p-Chloraniline ..	.. 3s. per lb. 100% basis.
o-Cresol 19/31° C.	.. 4½d. per lb. Demand steady.
m-Cresol 98/100%	.. 2s. 1d. 2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline ..	.. 3s. per lb.
Dichloraniline S. Acid	.. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .	.. £85 per ton.
Diethylaniline ..	.. 4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline ..	.. 2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene ..	.. 10d. per lb. naked at works.
Dinitrochlorbenzol	.. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine ..	.. 2s. 10d. per lb. d/d.
Monochlorbenzol ..	.. £63 per ton.
*β*Naphthol ..	.. 1s. per lb. d/d.
*α*Naphthylamine	.. 1s. 4d. per lb. d/d.
*β*Naphthylamine	.. 4s. per lb. d/d.
m-Nitraniline ..	.. 4s. 3d. per lb. d/d.
p-Nitraniline ..	.. 2s. 3d. per lb. d/d.
Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene	.. 10½d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 3s. 11d. per lb. d/d.
p-Phenylene Diamine	.. 10s. 2d. per lb. 100% basis d/d.
R. Salt	.. 2s. 5d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 3d. per lb. 100% basis d/d.
o-Toluidine ..	.. 8½d. per lb.
p-Toluidine ..	.. 4s. 2d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £47 per ton.
Acid, Acetyl Salicylic	.. 3s. 1d.—3s. 3d. per lb., according to quantity.
Acid, Benzoic B.P.	.. 3s. per lb.
Acid Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric ..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 4½d.—1s. 5d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic ..	.. 3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	.. 6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm; increasing demand.
Acid, Salicylic ..	.. 1s. 6d.—1s. 9d. per lb., according to quantity. Demand rather easier.
Acid, Tannic B.P.	.. 2s. 10d. per lb. Market quiet.
Acid, Tartaric ..	.. 1s. 1½d. per lb. less 5%.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 2s. 1d.—2s. 3d. per lb. fc quantity. Demand slow.
Amidopyrin ..	.. 13s. 3d. per lb. Neglected. Stock low.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone	.. 15s.—15s. 6d. per lb. Quiet market.
Benzonaphthol ..	.. 5s. 3d. per lb. Small inquiry.
Bismuth Salts ..	.. Prices reduced by about 1s. 3d.—2s. 3d. per lb. on account of the fall in the price of the metal.
Bismuth Carbonate	.. 10s. 6d.—12s. 6d. per lb.
,, Citrate ..	.. 10s. 3d.—12s. 3d. ,,
,, Salicylate	.. 9s.—11s. ,,
,, Subnitrate	.. 8s. 8d.—10s. 8d. ,,
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Market firm, and Continental prices fully maintained with upward tendency.
Ammonium ..	.. 1s. 6d.—1s. 9d. per lb.
Potassium .	.. 1s. 4d.—1s. 7d. per lb.
Sodium .	.. 1s. 5d.—1s. 8d. per lb.
Calcium Lactate	.. 1s. 5d.—1s. 9d., according to quantity. Fair demand and steady market.
Chloral Hydrate ..	.. 4s.—4s. 3d. per lb. Very firm and scarce.
Chloroform ..	.. 2s. per lb. for cwt. lots. Very steady
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Formaldehyde ..	.. £59 per ton.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.

Glycerophosphates—	
Iron	.. 8s. 9d. per lb.
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. ,,
Guaiacol Carbonate	.. 10s. 6d.—11s. 3d. per lb.
Hexamine ..	.. 3s. 6d. per lb. for English make —market steady.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor ..	English make offered, 120s. per oz.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £25 per ton, less 2½%. Price reduced.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 57s. 6d. per lb.
Synthetic ..	.. 26s.—31s. per lb., according to quantity. English make.
Mercurials ..	.. Market very quiet.
Red oxide ..	.. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. ,,
White precip. ..	.. 4s. 7d.—4s. 8d. ,,
Calomel ..	.. 3s. 11d.—4s. ,,
Methyl Salicylate	.. 1s. 10d.—2s. 1d. per lb. Keen competition.
Methyl Sulphonal	.. 26s. per lb.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 2s. 10½d.—3s. per lb. Not very active.
Paraldehyde ..	.. 1s. 5d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin ..	.. 6s. per lb. Price and demand steady.
Phenazone .	.. 7s. 2d. per lb.
Phenolphthalein ..	.. 5s. 6d.—5s. 8d. per lb. in cwt. lots.
Potass. Bitartrate—	
99/100% (Cream of Tartar) ..	.. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Good steady demand.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	.. 7¼d. per lb.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz tins. Steady market.
Resorcin	.. 5s. 6d. per lb.
Saccharin ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. 6d. per lb.
Silver Proteinate ..	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb. Ample supplies. B.P. quality available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—	
Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	.. 75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate ..	.. Market rather easier. Powder 2s. 1d.—2s. 3d. per lb. Crystal at 2s. 3d.—2s. 5d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	.. 15s. per lb. Easier.
Thymol	.. 20s. per lb. nominal. Very scarce indeed.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.
Aubepine	.. 15s. 3d. ,,
Amyl Acetate ..	.. 2s. 6d. ,,
Amyl Butyrate ..	.. 6s. 9d. ,,
Amyl Salicylate ..	.. 3s. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,
Benzyl Alcohol free from Chlorine ..	.. 2s. 9d. ,,
Benzaldehyde free from Chlorine ..	.. 3s. 6d. ,,
Benzyl Benzoate ..	.. 3s. 6d. ,,
Cinnamic Aldehyde—	
Natural ..	.. 17s. 6d. ,,
Coumarin ..	.. 19s. 6d. ,,
Citronellol ..	.. 17s. ,,
Citral	.. 8s. 6d. ,,
Ethyl Cinnamate	.. 12s. 6d. ,,
Ethyl Phthalate ..	.. 3s. 3d. ,,
Eugenol	.. 10s. 6d. ,,
Geraniol (Palmarosa)	.. 35s. ,,
Geraniol	.. 11s.—18s. 6d. per lb.
Heliotropine ..	.. 7s. 3d. ,,
Iso Eugenol ..	.. 15s. 9d. ,,
Linalol ex Bois de Rose	.. 26s. ,,
Linalyl Acetate ..	.. 26s. ,,
Methyl Anthranilate	.. 9s. 6d. ,,
Methyl Benzoate ..	.. 5s. ,,
Musk Ambrette ..	.. 45s. ,,
Musk Xylol ..	.. 14s. ,,
Nerolin	.. 4s. 9d. ,,
Phenyl Ethyl Acetate	.. 15s. ,,
Phenyl Ethyl Alcohol	.. 16s. ,,
Rhodinol	.. 60s. ,,
Safrol	.. 1s. 10d. ,,
Terpineol	.. 2s. 4d. ,,
Vanillin	.. 26s. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. ..	.. 15s. 6d. per lb.
Anise Oil	.. 2s. 6d. per lb.
Bergamot Oil ..	.. 17s. 6d. per lb.
Bourbon Geranium Oil	.. 36s. 0d. per lb.
Camphor Oil ..	.. 65s. per cwt.
Cananga Oil Java	.. 10s. 6d. per lb.
Cinnamon Oil, Leaf	.. 6¼d. per oz.
Cassia Oil, 80/85%	.. 10s. per lb.
Citronella Oil—	
Java 85/90% ..	.. 5s. 8d. per lb.
Ceylon	.. 3s. 5d. per lb.
Clove Oil	.. 7s. 6d. per lb.
Eucalyptus Oil 70/75%	.. 2s. 5d. per lb.
Lavender Oil—	
French 38/40% Esters	27s. 6d. per lb.

Lemon Oil ..	.. 3s. per lb.
Lemongrass Oil ..	.. 3d. per oz.
Orange Oil, Sweet	.. 11s. per lb.
Otto of Rose Oil—	
Bulgarian ..	.. 37s. 6d. per oz. Production below average.
Anatolian ..	.. 18s. per oz.
Palma Rosa Oil ..	.. 17s. per lb.
Peppermint Oil—	
Wayne County	.. 30s. per lb. Market very active and prices rising.
Japanese ..	.. 18s. 6d. per lb. Market very active and prices rising.
Petitgrain Oil ..	.. 9s. 3d. per lb.
Sandal Wood Oil—	
Mysore	.. 26s. 7d. per lb.
Australian ..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Nov. 10th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on Sept. 25th.

I.—Applications

Crowe and Mills. Precipitating and filtering. 20,832. Sept. 3.

Fothergill. Evaporators. 20,888. Sept. 4.

Heyl. Heating and distillation of liquids and solids, etc. 20,750. Sept. 3.

Synthetic Ammonia and Nitrates, Ltd. Carrying out catalytic reactions. 20,572. Sept. 1. (U.S. 1.9.23.)

I.—Complete Specifications Accepted

14,371 (1923). Fahim. Crushing-mills. (221,001.)

26,714 (1923). Shores, Towers, and United Alkali Co., Ltd. Means for closing, or sealing, glass or like containers, more especially adapted for use in the transport of chemicals. (221,107.)

26,918 (1923). Hunter. Settling or precipitation tanks. (221,109.)

29,996 (1923). Lake. (Furnace Engineering Co.). Pulverizers. (221,121.)

II.—Applications

Caspari. Distillation of bituminous substances. 20,704. Sept. 2. (Ger., 24.10.23.)

Freeman. Treating oil-bearing shales. 20,903. Sept. 4.

Heyl. 20,750. *See* I.

Holden. Manufacture of water-gas. 20,824, 20,825. Sept. 3.

Jones. Manufacture of combustible gas. 21,071. Sept. 6.

Melamid. Process of liquefying carbon. 21,019. Sept. 5. (Ger., 17.6.24.)

Sauer. 20,793. *See* XIX.

Sauer. 20,905. *See* XX.

Trumble. Producing gasoline from solid material. 20,697. Sept. 2.

II. Complete Specifications Accepted

14,493 (1923). Lamplough. Destructive distillation apparatus. (221,009.)

18,107 (1923). Trumble. Treating carbonaceous materials. (221,052.)

IV.—Application

Compagnie Nationale de Matières Colorantes et Manufactures de Produits Chimiques du Nord, Réunies, Etablissements Kuhlmann. 20,693. *See* XX.

IV.—Complete Specifications Accepted

14,489 (1923). Sokal (Kalle & Co.). *See* XX.

27,219 (1923). Meister, Lucius, und Bruning. Manufacture of acid azo-dyestuffs. (206,831.)

V.—Application

Textilpatentges. Improving vegetable fibres. 21,09[illegible] Sept. 6. (Ger., 8.9.23.)

V.—Complete Specification Accepted

13,769 (1923). Soc. Indus. pour l'Application de Breve[illegible] et Procédés. Treatment of hydrated celluloses to diminis[illegible] their absorptive capacity. (201,526.)

VI.—Applications

British Dyestuffs Corporation, Ltd., Blackshaw, Horsfa[illegible] and Lawrie. Dyeing etc. wool and fur. 21,086, 21,0[illegible] Sept. 6.

VII.—Applications

Crowe and Mills. Recovering cyanogen from soluti[illegible] 20,833. Sept. 3.

Norsk Hydro-Elektrisk Kvaelstofaktieselskab. Appara[illegible] for synthetic production of ammonia. 20,689. Sept.[illegible] (Norway, 28.9.23.)

Phillipp and Sutherst. Manufacture of colloidal sulp[illegible] 20,998. Sept. 5.

Synthetic Ammonia and Nitrates, Ltd. Productio[illegible] nitric acid from ammonia. 21,066. Sept. 6. (U.S. 6.9.[illegible]

Synthetic Ammonia and Nitrates, Ltd. Produ[illegible] ammonium nitrate. 21,067. Sept. 6. (U.S., 6.9.23.)

VII.—Complete Specifications Accepted

14,295 (1923). Koritschoner and Hansgirg. Manufa[illegible] of pure alumina. (199,017.)

24,023 (1923). Metallbank und Metallurgische [illegible] Furnaces for burning sulphur. (210,734.)

VIII.—Applications

Dynamidon Werk Engelhorn & Co., Ges. Productio[illegible] fireproof magnesite. 21,105. Sept. 6. (Ger., 14.9.23[illegible]

Hancock. Manufacture of pottery. 20,557. Sept. [illegible]

VIII.—Complete Specification Accepted

26,714 (1923). Shores, Towers, and United Alkali Co., Ltd. *See* I.

IX.—Complete Specification Accepted

14,872 (1923). Schmidt and Hahnle. Producing hydraulic cement and artificial stones. (221,017.)

X.—Applications

Coley. Manufacture of zinc. 20,920. Sept. 4.

Debuigne. Production of carbon-free metals of low silicon content. 20,621. Sept. 1. (Ger., 31.8.23.)

Poldihütte. Steel alloy. 21,022. Sept. 5. (Czecho-Slovakia, 5.9.23.)

X.—Complete Specification Accepted

22,565 (1923). Mond (Goldschmidt Akt.-Ges.). Production of aluminium alloys. (221,082.)

XI.—Applications

Burgess Battery Co. Dry batteries. 20,606. Sept. 1. (U.S., 1.9.23.)

Soc. Anon. Le Carbone. Electric batteries. 21,015. Sept. 5. (Fr., 12.7.24.)

XI.—Complete Specification Accepted

25,279 (1923). Casale. Apparatus for the electrolysis of water. (221,102.)

XII.—Complete Specifications Accepted

14,363 (1923). Technical Research Works, Ltd., and Lush. Preparation and reactivation of metallic catalysts used in the hydrogenation of oils etc. (221,000.)

16,164 (1923). Meulen. Vulcanising oils or fats. (201,531.)

XIII.—Applications

Heyl. Mineral pigments. 20,749. Sept. 3.

Latex Developments, Ltd., and Russell. Waterproof paints. 20,786. Sept. 3.

XIII.—Complete Specifications Accepted

13,753 (1923). Wade (Karpen and Bros.). Manufacture phenolic condensation products. (220,985.)

18,929 (1923). Pollak. Manufacture of condensation products from formaldehyde and urea, thio-urea, or their derivatives. (201,906.)

IV.—Applications

Bamber. Treatment of rubber. 20,802. Sept. 3.

Clute. Curing rubber. 20,711. Sept. 2. (U.S., 18.9.23.)

V.—Complete Specification Accepted

[illegible]6,161 (1923). Meulen. *See* XII.

[illegible]—Applications

Marris, Ross, and Walker and Sons. Process of removing [illegible]ir from skins. 20,556. Sept. 1.

Rack. Manufacture of liquid glue. 21,042. Sept. 6.

[illegible]—Complete Specification Accepted

[illegible]2 (1923). Lloyd, Pickard, and British Leather [illegible]facturers' Research Association. Soaking-liquors for [illegible] hides and the like. (221,058.)

[illegible]III.—Application

Bendixen, Harrison, and Stapley. Apparatus for propa[illegible] pure cultures of bacteria, yeast, etc. 20,759. Sept. 3.

[illegible]—Applications

[illegible]bs and Lane. Preserving etc. meat. 21,089. Sept. 6.

[illegible]les and McDougall. Manufacture of insecticides etc. [illegible] Sept. 2.

[illegible]er. Activated carbon for purification of water etc. [illegible] Sept. 3.

[illegible]—Applications

[illegible]ompagnie de Béthune. Production of ethyl-sulphuric [illegible]id. 21,032. Sept. 5. (Fr., 7.9.23.)

Compagnie Nationale de Matières Colorantes et Manufac[illegible]res de Produits Chimiques du Nord, Réunies, Etablisse[illegible]ents Kuhlmann. Process for manufacture of perylene. 20,693. Sept. 2. (Fr., 20.12.23.)

Sauer. Activated carbon for medicinal purposes. 20,905. Sept. 4.

XX. Complete Specifications Accepted

14,189 (1923). Sokal (Kalle and Co.). Producing perylenetetracarboxylic acids or their monoimides. (221,008.)

[illegible]5 (1924). Mendel Akt.-Ges., and Wolffenstein. Producing halogen albumin compounds. (213,536.)

XXI.—Complete Specification Accepted

18,665 (1923). Lilienfeld and Jahoda. Fluorescent screens for X-rays. (201,519.)

XXII.—Application

Tagliabue. Manufacture of explosives. 20,936. Sept. 4.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number: *Argentina*: Interior paints (299). *Canada*: Soap (280). *Egypt*: Paints, linseed oil (297). *France*: Oils, fats for soap-making, chemical manures, nitrate of soda, sulphate of ammonia (284). *Greece*: Steel tubes (287). *Japan*: Dyestuffs (B.X./1215). *Poland*: Chemicals rubber and surgical goods (295). *South Africa*: Paraffin oil (B.X./1222); Disinfectant fluid (B.X./1226); Red oxide paint in paste (B.X./1225). *Uruguay*: Camphor (300); Iron (A.X./1295).

Trade Information

Pyrex Glassware is now being made in England by James A. Jobling & Co., Ltd., at the Wear Flint Glass Works, Sunderland. Pyrex glass is a borosilicate glass which resists sudden cooling and is claimed to be superior to other glasses in its resistance to water, acid, ammonia and phosphoric acid, and equal to other high-grade glasses in resistance to alkali carbonates and caustic alkalis. The coefficient of linear expansion is very low, 0·0000032, compared with 0·0000092 for lead glass. All the usual forms of laboratory glassware are made in Pyrex glass, which is also used for making ovenware.

Sutcliffe Bros. & Bryce, Ltd., Globe Works, Hyde, have acquired the old-established boiler-covering business of W. J. Hockey & Co., of Cardiff. Mr. W. J. Hockey has joined the Board of Sutcliffe Bros. & Bryce, Ltd., and will manage this branch of the business as heretofore. The acquisition of these works and offices will afford Sutcliffe Bros. & Bryce, Ltd., greater facilities for carrying out their South Wales and District contracts than they have enjoyed hitherto. The address of the new branch will be Sutcliffe Bros. & Bryce, Ltd., W. J. Hockey & Co., Branch, Hodges Row, Docks, Cardiff.

Science and the Baker

Baking is a process that ultimately concerns everyone, but scientific control is, unfortunately, not yet a feature of standard practice. An interesting attempt is now being made to establish the science of baking by the *Arkady Review*. Although this new publication is really devoted to the merits of "Arkady," a yeast food for which valuable qualities are claimed by its makers, the British Arkady Co., Ltd., Manchester, advertising matter is not too conspicuous, and articles are given explaining, in simple language, common words such as salts and sugars, the use of the thermometer, malt and malting, yeasts and starch, science and bread-making. Mention must be made of the excellent photomicrographs reproduced in each issue. The inclusion of educational matter deserves commendation and will, it is hoped, make the baking industry realise the power of science and the invaluable help it can give. The editors of the *Arkady Review* are to be congratulated on their attempt to bridge the gap between the technologist and the working baker. The inclusion, in the third number, of a supplement containing a lecture on the Colloid Chemistry of Bread-making, by Mr. R. Whymper, is a feature that augurs well for the new *Review*.

Gas Undertakings in Great Britain

Part I of the Return relating to Authorised Gas Undertakings in Great Britain for the year 1923 (H.M. Stationery Office; price 5s. net) has been issued by the Board of Trade. This part contains particulars of the manufacture and supply of gas by 790 undertakings. Finance and the prices charged for gas will be dealt with in Part II.

The quantity of gas made in Great Britain in the year 1923 by these undertakings was 259,850

million cb. ft., of which nearly 84 per cent. was coal gas and nearly 15 per cent. water gas. Excluding the gas consumed at gasworks, 241,627 million cb. ft. was sold, compared with 232,603 million cb. ft. in 1922 and 229,077 in 1921. The residual products in 1923 included 11,098,000 tons of coke and breeze and 181,963,000 gallons of tar. These consumption figures, combined with the following figures of number of consumers and length of mains, illustrate the continued extension of the use of gas :—

	1923	1922	1921
Number of consumers—			
Prepayment	4,231,243	4,137,009	4,071,220
Ordinary	3,579,107	3,535,137	3,488,090
Length of mains, in miles	40,981¼	40,231½	39,547¾

The Return gives particulars of the make of gas materials used, quantities of residuals made, numbers of consumers, etc., for each of the 790 undertakings. For concerns authorised to charge for heat units supplied, the quantities of gas made and sold are shown in therms as well as in cubic feet.

PUBLICATIONS RECEIVED

ANILINE AND ITS DERIVATIVES. By P. H. Groggins. Pp. vii+256. London: Chapman and Hall, Ltd., 1924. Price 18s.

MODERN CEREAL CHEMISTRY. By D. W. Kent-Jones, B.Sc. With a foreword by W. Jago, F.I.C. Pp. ix+324. Liverpool: The Northern Publishing Co., Ltd., 1924.

COAL CARBONIZATION. By H. C. Porter, M.S., Ph.D., American Chemical Society Monograph Series. Pp. 442. New York: The Chemical Catalog Co., Inc., 1924. Price $6·00.

THE STRUCTURE OF CRYSTALS. By R. W. G. Wyckoff. American Chemical Society Monograph Series. Pp. 462. New York: The Chemical Catalog Co., Inc., 1924.

REPORT OF THE ECONOMIC CONDITIONS IN FRANCE. By J. R. Cahill. Department of Overseas Trade. Pp. 221. H. M. Stationery Office, 1924. Price 6s.

THE NATIONAL PHYSICAL LABORATORY REPORT FOR THE YEAR 1923. Department of Scientific and Industrial Research. Pp. 228. Price 13s. 6d.

THE RUBBER MANUFACTURERS' HANDBOOK. TABLES AND FORMULÆ. By W. G. Pinkney and P. Watkins. Pp. 89. London: The Rubber Age, 1924. Price 12s. 6d.

THE NEW THEORIES OF MATTER AND THE ATOM. By A. Berthoud. Translated by Eden and Cedar Paul. Pp. 259. London: G. Allen and Unwin, Ltd., 1924. Price 10s. 6d.

THE BOOK OF RECEIPTS. By E. W. Lucas and H. B. Stevens. Twelfth edition. Pp. 473. London: J. and A. Churchill, 1924. Price 10s. 6d.

A CATALOGUE OF OLD AND MODERN MEDICAL AND SCIENTIFIC BOOKS. No. 25. Pp. 12. London: Bligh and Co., 1924

—Complete Sy... (1923).

SYLLABUS OF CLASSES AT SIR JOHN CASS TECHNICAL INSTITUTE, ... STREET, ALDGATE, E.C. Session 1924-25.

... azo-dyes Pp. ...

PROSPECTUS OF UNIVERSITY COURSES IN THE MUNICIPAL SCHOOL OF TECHNOLOGY, UNIVERSITY OF MANCHESTER, FACULTY OF TECHNOLOGY. Session 1924-25. Pp. 229.

L'ECONOMISTE ROUMAIN. BULLETIN MENSUEL DE L'INSTITUT ECONOMIQUE ROUMAIN ET DE L'ASSOCIATIO DES BANQUES ROUMAINES. No I. Pp. 24. Bucarest: 1924.

PUBLICATIONS OF THE DEPARTMENT OF THE INTERIOR, BUREAU OF MINES, WASHINGTON: GOVERNMENT PRINTING OFFICE, 1924:—

SILVER IN CHLORIDE VOLATILIZATION. By C. M. Bonton, W. C. Riddell and L. H. Duschak. Technical Paper 317. Pp. iv.+56. Price 10 cents.

TESTS OF MARINE BOILERS. By H. Kreisinger, J. Blizard, A. R. Mumford, B. J. Cross, W. R. Argyle and R. A. Sherman. Bulletin 214. Pp. xiv.+303. Price 55 cents.

PUBLICATION OF THE DEPARTMENT OF THE INTERIOR, U.S. GEOLOGICAL SURVEY, WASHINGTON: GOVERNMENT PRINTING OFFICE, 1924:—

PLATINUM AND ALLIED METALS IN 1923. By J. M. Hill, No. 1: 2. Pp. 9—22. Mineral Resources of the United States, 1923. Part I.

UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR OLIVE DRAB PAINT (SEMIPASTE AND READY-MIXED). Circular No. 165. Department of Commerce, Bureau of Standards. Federal Specifications Board Specification No. 137. Pp. 11. Washington: Government Printing Office, 1924. Price 5 cents.

WEIGHTS AND MEASURES, DEPARTMENT OF COMMERCE, BUREAU OF STANDARDS, SIXTEENTH ANNUAL CONFERENCE OF REPRESENTATIVES FROM VARIOUS STATES HELD AT THE BUREAU OF STANDARDS IN MAY, 1923. MISCELLANEOUS PUBLICATIONS No. 55. Pp. 153. Washington: Government Printing Office, 1924. Price 30 cents.

MASLAMA AL-MAJRĪTĪ AND THE RUTBATU'L-HAKĪM. By E. J. Holmyard. Reprint from Isis, No. 18, Vol. VI. (3), 1924. Pp. 293—305. Bruxelles: Société Anonyme M. Weissenbruch, 1924.

A REFERENCE LIST OF BIBLIOGRAPHIES, CHEMISTRY, CHEMICAL TECHNOLOGY AND CHEMICAL ENGINEERING PUBLISHED SINCE 1900. Compiled by J. A. Sohon and W. L. Schaaf. Pp. x+100. New York: The H. W. Wilson Co., 1924. Price $6.

TAGESFRAGEN. Edited by Prof. Küster. Stuttgart. Biochemische Wissenschaftliche Verlagsgesellschaft m.b.H., 1924:—

(1) VOM CHEMISCHEN WESEN UND DER BIOLOGISCHEN BEDEUTUNG DES EIWEISS. By Prof. W. Küster. Part III. Pp. 18.

(2) DIE BEZIEHUNGEN ZWISCHEN PFLANZE UND TIER IM LICHTE DER CHEMIE. By Prof. Tschirch. Part II. Pp. 22.

DIE FERMENTE UND IHRE WIRKUNGEN. By Prof. C. Oppenheimer, with a section on Physical Chemistry and Kinetics by Dr. R. Kuhn. Lieferung II. Pp. 161—320. Leipzig: Georg Thieme, 1924. Price $1·90.

DIAGNOSTISCHE UND THERAPEUTISCHE IRRTÜMER UND DEREN VERHÜTUNG. INNERE MEDIZIN. By Prof. J. Schwalbe. Part 15. Vergiftungen. By Prof. H. Zangger. Pp. 226. Leipzig: Georg Thieme, 1924. Price $1·45.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry
which consists of Representatives from
The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

VOL. 43 NEW SERIES — LONDON, SEPTEMBER 26, 1924 — NO. 39

EDITORIAL

NEARLY thirty years ago Röntgen discovered X-rays; twelve years ago Laue, Friedrich and Knipping used crystals as diffraction gratings to produce interference effects of X-rays and Sir William Bragg and Professor W. L. Bragg devised the method of interpreting the structure of crystals and the position of the atoms in them by measurement of the angles of incidence of X-rays which showed maxima and minima of interference in the reflected rays. The photographic recording of these is largely due to the skill of Moseley, Siegbahn and de Broglie. During these last twelve years our knowledge of crystals and how they are built up from molecules, atoms, ions, protons and electrons has been increased very considerably, and Sir William Bragg has been responsible for a large part of this extension of knowledge. Men are continually struggling to explain highly-complicated phenomena, some of which are imperfectly known, by simple signs capable of being expressed on a printed page. Popular journals expound to a non-mathematical body of readers Einstein's theory of a four-dimension system which seems to involve at least some algebra and conic sections in its elementary essentials. Chemists are continually trying to express by the fewest possible printed symbols the interaction of electrical forces of extreme complexity, so complex that our most skilful mathematicians cannot calculate the combined effect of them. The formulæ and equations of the chemists have been singularly ingenious and useful, so useful that, to many, they appear to be accurate diagrams of the changing facts. The capital letters of the alphabet and a few short straight lines have enabled us to express a sort of approximation to the truth in a very convenient way. The addition of a plus and a minus sign and a few dotted lines enables a little higher degree of complexity to be indicated. But it is like trying to represent a football match, a battle or the flux of European politics by means of a few diagrams. Sir William Bragg's address on the Analysis of Crystal Structure by X-rays shows how impossible it is to draw rigid distinctions between unit cells, atoms and ions, between agglomeration, cohesion, chemical attraction, electrostatic attraction and so on. We get on to the borders of metaphysics and logic, and the discussion of some of these topics is akin to an investigation of the relations between the different parts of a Highland tartan; we may easily fix the smallest unit which enables us to describe the Mackenzie tartan or the Hunting Stuart but there is no obvious boundary to this unit. If the tartan were in three dimensions we should have an exact parallel to the crystal. So, too, in our representations of molecules we try and make a few brackets and lines such as $Be_4O(CO_2CH_3)_6$ represent the combined effect of some 47 different atoms most of which include several electrons each with attractions, repulsions, orbits and eccentricities of its own. Bragg and Morgan last year showed us that this beryllium compound is built up round one central oxygen atom, four beryllium atoms are tetrahedrally connected to it by a set of electrical attractions, with six acetate groups arranged symmetically round the edges of the imaginary tetrahedron. We have here a further degree of approximation to the truth, but when we consider how little we know of the electron, whether we are to consider it as fixed in space, as revolving round a nucleus, or a couple of nuclei, whether electricity in these minute quantities and at such minute distances obeys the law of inverse squares and so on, we know that such a description is only an approximation. Nevertheless, each further degree of approximation takes us nearer and nearer to the truth. A proper understanding of planes of symmetry and spatial distribution of atoms and other disturbing entities is essential to modern work, and Sir William Bragg's able treatment of these makes an important address.

* * *

We published on August 8 an account of a rapid method of drying glue and gelatin adopted in the laboratory of Messrs. Scheidemandel. Our esteemed contemporary *The Chemical Age* has mildly suggested in the past that we should not have embarked on the stormy voyage of a business career; one of the reasons we did this was the belief that scientific information could be more promptly and accurately dispensed by the Society in weekly numbers than by any other method. *The Chemical Age* in its issue of September 20 gives an account, which it acknowledges is taken from *Industrial and Engineering Chemistry*, of a method of preparing lime and gelatin in pearls by squeezing lime or gelatin through a set of fine openings. *Industrial and Engineering Chemistry* has been engaged, we think, in playing a practical joke on its readers. There is a German word "Leim" which means glue or gelatin, and we suspect that this word was found in the original

memoir from which the legend of lime in pearl form originated. The glue pearls, a sample of which lies before us, should prove useful. Every father, whose family includes a few young boys, knows the disadvantages of glue as usually sold; he may break it with a hammer but the bits fly all over the carpet; the large lumps take so long to melt properly that the church bell rings before the mending can be commenced; Milton, or someone else, says that the worst of the amateur carver is that the gravy so seldom matches the wallpaper: the worst of the amateur joiner is that the glue so seldom matches the linoleum. Pearls of glue in the house should prove a well-spring of joy; we wish we knew where they could be purchased.

* * *

A certain amount of discussion goes on in the daily press and over the walnuts and wine which still adorn the tables of our wealthier acquaintances, as to the possibility of opening the Wembley Exhibition again next year. In spite of a wet summer, Wembley has always been well attended, and no one has visited the Exhibition without wishing to go again many times. We do not know whether grown-up people or children have derived the most pleasure and benefit. As an outward and visible sign of the British Empire it has been unique; its political consequences are bound to be of the utmost importance, for our Empire is held together very largely by common sentiment and common interest; it is essential in these circumstances that the more we all know of its far-flung parts the more we shall appreciate the good features, innumerable as they are, of the Empire. Let us look on some of these and rejoice, *video meliora proboque*. From the point of view of trade and commerce, we imagine that a considerable number of firms have sold their wares so fast that their delivery organisation has been strained to its uttermost. We have given long accounts in this journal of the chemical exhibits and still have additional notes to publish. The chemical exhibit has been conspicuously successful; it has brought home to chemists and to the general public the enormous importance of chemistry in very many industries; it has demonstrated to the world a fact, which required demonstration, that British chemistry is first-class. It has evoked Chemistry in the Twentieth Century, which has sold in thousands and a set of pamphlets which have been sold in tens of thousands. As to the finances of the Exhibition, these are not known to us, but it is reported that about fifteen or sixteen million visits have been recorded at the turnstiles; this is less than was originally expected by the sanguine promoters, so it is probable a loss has been incurred. The chemical exhibit, valuable as it has been both from a scientific and industrial point of view, will be very valuable next year if the Exhibition can be again opened then. It has by no means outlived its usefulness; its lessons are not yet fully appreciated. We hope that some means may be found of opening the Exhibition again next year, and we are sanguine enough to think that next year might easily provide a considerable profit as a set-off against this year's expected deficit.

THE ANALYSIS OF CRYSTAL STRUCTURE BY X-RAYS *

By SIR W. H. BRAGG, K.B.E., D.Sc., F.R.S.

In this address I propose to consider the new methods of analysing the structure of materials by means of X-rays, considering especially the stages by which they move towards their objective. It is convenient to recognise three such stages, of which the first comprises the simplest and most direct measurements and the last the most indirect and complex.

The fundamental measurement of the method is the angle at which rays of a given wave-length are reflected by a set of planes within the crystal. The planes of a "set" are all exactly like one another: an imaginary observer within the crystal could not tell by any change in his surroundings that he had been moved from one plane to another. Sometimes there is no reflection of the first order from a set so defined, because the planes may be interleaved by other planes so spaced and of such strength as to annul the true reflection; but this can always be allowed for. When the wave-length of the X-rays is known, the angular measurement can be used to find the spacing of the set of planes, and in this way a linear dimension of the crystal is measured. The spacing is the distance between any plane and its nearest like neighbour on either side. If the spacings of three different sets of planes are found, the volume of the unit cell is found. The crystal unit cell is bounded by six faces, each set of planes furnishing a pair. The pair consists of two neighbouring planes of the set. The cell may have a great variety of forms, but has always the same volume. The specific gravity of the substance being known, it is possible to find the number of atoms of various kinds which the cell contains: the proportion of the various kinds is necessarily the same as in the molecule of the substance. The cell is in practice found always to contain a small integral number of molecules, one, two, three, or four, rarely more. This assemblage of molecules is fully representative of the crystal; by the mere repetition of the cell, without the addition of any new features, the crystal with all its properties is produced.

There are, therefore, three types of assemblage. The simplest is that of the single atom, as in helium in the gaseous state, in which the behaviour of every atom is on the whole the same as the behaviour of any other. The next is that of the molecule, the smallest portion of a liquid or gas which has all the properties of the whole: and lastly, the crystal unit, the smallest portion of a crystal (really the simplest form of a solid substance) which has all the properties of the crystal. There are atoms of silicon and of oxygen: there is a molecule of silicon dioxide, and a crystal unit of quartz containing three molecules of silicon dioxide. The separate atoms of silicon and oxygen are not silicon dioxide, of course: in the same way the molecule of silicon

* **Presidential Address before Section A (Mathematical and Physical Science) of the British Association, Toronto.**

dioxide is not quartz; the crystal unit consisting of three molecules arranged in a particular way *is* quartz.

The final aim of the X-ray analysis of crystal is to determine the arrangement of the atoms and the molecules in the crystal unit, and to account for the properties of the crystal in terms of that arrangement.

The first step is the determination of the dimensions of the crystal unit cell: any one of the possible ways in which the cell can be drawn will do. When this has been completed it is a simple calculation in geometry to find the distance between any atom and any other atom in the crystal of like kind and condition, or, in other words, the distance an observer would have to travel from any point within the crystal to any other point from which the outlook would be exactly the same and would be similarly oriented. This is the only measurement which the X-rays make directly: any other measurement of distance is made indirectly, by aid of some additional physical or chemical reasoning. It is not possible by direct X-ray measurement to determine the distance between any two points—atom centres, for example—within the same cell.

Let us take an example. The crystal unit of naphthalene has the dimensions defined in the usual way by the statement:—

$$a=8{\cdot}34\text{Å} \quad b=6{\cdot}05\text{Å} \quad c=8{\cdot}69\text{Å}$$
$$\beta=122^\circ\ 49' \quad \alpha=\gamma=90^\circ.$$

It contains two molecules: an integral number, as always. These facts are given directly by the X-ray measurements. But there is no direct determination of the distance between any carbon atom and any other carbon atom contained within the same cell: the measurements given are those of the distances between any atom and the nearest neighbours, in three principal directions, which are exactly like itself, these distances being the lengths of the edge of the cell. There is not even a measurement of the distance between the two molecules in the same cell, because they are not similarly oriented. In fact, there is no clear meaning in the term "distance" in this case, just as we cannot state the distance between an object and its image in a mirror, unless the object is a point of no dimensions. If the molecule of naphthalene has a centre of symmetry, as is indeed indicated during the development of the results of the X-ray analysis, it is possible to state the distance between the centres of symmetry of the two molecules in the same cell, but this does not define the distance between any atom in one of the two molecules and any atom in the other. All such distances, if they are to be defined and measured, can only be found by the aid of fresh considerations.

Or again, let us take the case of rock-salt. The crystal unit cell of rock-salt contains one molecule: one form of the cell has for its eight corners the six middle points of the faces of a certain cube (edge=5·62 A.U.) and two of the opposite ends of any diagonal of the cube. The so-called face-centred cube is four times as large as the cell, and contains four molecules. The dimensions of the cell are determined directly by the X-rays, which measure the distance between each of the three pairs of parallel faces that contain it. The cell may be placed so that each corner of it is associated in the same way with a molecule of sodium, let us say: and, of course, the knowledge of the dimensions of the cell is equivalent to a knowledge of the distance between any two sodium atoms in the crystal, which atoms are all alike in every respect. But we have no direct measurement by the X-ray methods of the distance between a sodium and a chlorine atom. We infer that the chlorine atom lies at the centre of the sodium cell, or *vice versâ*, from considerations of symmetry. Crystallographic observations of the exterior form of the cell assign to the crystal the fullest symmetry that a crystal can possess. If the cell that has been described is to contain the elements of such full symmetry, the chlorine atom must lie at the centre of it. It cannot lie anywhere else, for every cell would contain a chlorine atom similarly placed. There would then be unique directions in the crystal; that is to say, polarities. Moreover, both the sodium and the chlorine atoms must themselves contain every symmetry of the highest class: the full tale of planes of symmetry, axes of rotation, and so on. They both have centres, and we can state the distance between a chlorine atom and a sodium atom because we can state it as between centre and centre, and put it equal to half the distance between two sodium atoms on either side of the chlorine. The structure of sodium chloride is then determined completely.

It may possibly be a difficulty that the cell so described does not at first appear to have all the symmetries of the rock-salt cube, but it is to be remembered that we are to expect the full display of symmetries only when the cell has been repeated indefinitely in all directions. We may take a simple case, as follows:—

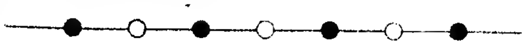


FIG. 1

Suppose sodium and chlorine atoms were to be arranged in a line as in the figure, just as they are in any of the three principal directions in the crystal. A plane of symmetry perpendicular to the line of atoms indefinitely prolonged may be drawn through the centre of any atom. The unit cell is one molecule: one chlorine and one sodium. The unit by itself has not this symmetry, but the repetition of the same molecule in either direction on either side provides the symmetry. Moreover, each sodium and each chlorine must itself have a plane of symmetry, and the planes are equally spaced. We can state the distance between a sodium and a chlorine atom as half the distance between two sodiums.

Let us take one more instance, the diamond. The crystal unit cell contains two atoms of carbon: as in the case of rock-salt, it may be so chosen that, of its eight corners, six are the middle point of the faces of a certain cube and two are the ends of any diagonal of the cube. The sides of this cell are

determined by the X-rays, and are all equal to 2·52 A.U. This is the distance between any carbon atom and the nearest carbon atom which is exactly like itself. The distance between the two carbon atoms in the same cell is not measured directly, but can be inferred after it has been defined. This we are able to do because the carbon atom is tetrahedral; a tetrahedron has a centre, and we can state the distance between the centres of two tetrahedra, no matter how the tetrahedra are oriented. We know that the carbon atom, as built into the crystal, is tetrahedral, because the X-ray observations show that four trigonal axes meet in it. The two atoms in the cell are oriented differently; one may be said to be the image of the other, if translation shifts are ignored, in each of the faces of the cube. Considerations of symmetry or X-ray observations show that the centre of an atom of the one orientation lies at the centre of a tetrahedron formed by four atoms of the other orientation. The edge of this tetrahedron is the edge of the unit cell, and its length is 2·52 A.U. It may then be calculated that the distance between the one atom and the others, its nearest neighbours, is 1·54 A.U. We may call this distance the diameter of the carbon atom, but we must remember our original definition of the meaning of the term. Thus the 2·52 A.U. is the result of a direct unaided X-ray measurement, but the 1·54 A.U. is not, and has no meaning except after special definition.

Only such distances between atoms as can be calculated from the dimensions of the unit cell can be measured directly and without qualification. The determination of these distances may be looked on as the result of the *first stage* of the analysis by X-rays.

We now come to a *second stage*. It is possible to make other statements of the relative positions of atoms and molecules which, though less complete and informative than those of distances, and their orientations, are necessary to the solution of the crystal structure problem. These also are deduced by means of the X-ray methods.

It often occurs that the atoms or molecules in one cell can be divided into two portions which are the reflections of one another across some plane, or can be brought to be the reflection of each other by a shift parallel to the plane. In that case the orientation of the plane and the amount of the shift can be stated definitely, the former by inspection of the crystal or by X-ray observations, the latter by X-ray observations alone. So also it may happen that the atoms or molecules in the same cell may be divided into portions which can be made to coincide with each other by a rotation round some axis with or without a shift parallel to that axis. The direction of the axis can be found by inspection of the crystal or by X-ray observations; the amount of the shift can be found by X-ray observations alone.

In these cases the distances that are found by the X-ray method are all that can be stated without special definition. It is not possible to state the distance between an object and its image in a mirror, if the object has any extension in space; but it is possible to state the magnitude of a shift.

Measurements of this sort constitute a characteristic feature of the X-ray analysis, for which reason I would like to discuss them briefly.

We know that it is possible to separate crystals into thirty-two classes, according to the kind of external symmetry which they display. As we have hitherto been unable to look into the interior of the crystal, we have been obliged to be content with this imperfect classification by outer appearance.* It has been shown, however, that there is a classification by inner arrangement which is perfect and includes the other. It is beyond the limits of ordinary vision: out of the range of the lens and the goniometer. The interior arrangements of the crystal, of which the outer form is one consequence, are so varied as to furnish 230 different modes. With very few exceptions the X-rays now allow us to carry the classification to this higher degree. If the modes are grouped according to the external features of the crystals that follow them, we come to the well-known thirty-two classes, there being several modes in every class. I may be permitted to illustrate this important point by examples, although it is familiar to those who have studied crystallography. Let us consider first a two-dimensional example, which is much easier to describe than the three-dimensional actuality, and contains all the essential ideas.

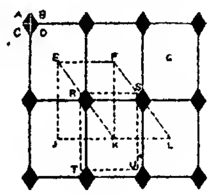


Fig. 2

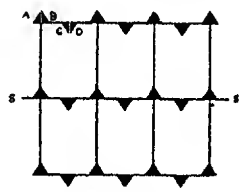


Fig. 3

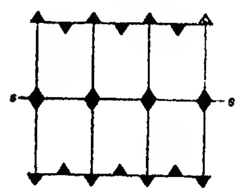


Fig. 3A

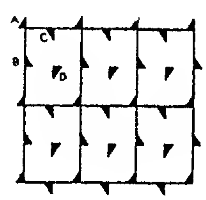


Fig. 4

Consider an arrangement of figures in a plane which displays symmetry across two planes at right angles to one another. Such arrangement may be exhibited diagrammatically, as in Fig. 2. The unit cell may be drawn in various ways, EFKJ, EFLK, RSUT, and so on. The cell contains, however it is drawn, either a whole diamond or enough parts to make up a whole diamond. Each diamond can be divided into four parts: B and D are the reflections of A and C across a plane; C and D are the reflection of A and B across a plane at right angles to the first plane. Unless the diamond, the content of one cell, could be divided in this way there could not be the

double symmetry. But, granted this division into four portions, it is not necessary that the four should be arranged as in the figure in order that the double symmetry may be obtained. There are two alternatives (Figs. 3 and 4).

In Fig. 3 the lower half of each diamond—that is to say, the portions C and D—are shifted, whether to right or to left is immaterial, by an amount equal to one-half of one side of the cell EFKJ. The symmetry about a vertical line in the plane of the paper is obviously retained. It is not so obvious that there is still any symmetry about the horizontal line until we realise that we mean only "observable symmetry": that which is to be seen in the outer form of the indefinitely extended figure, corresponding to the crystal. Clearly, the whole figure will present the same appearance from below as from above. In fact, we can see that as a whole the lower part of the figure is symmetrical with the upper part by imagining the upper and the lower to be further shifted relatively as in Fig. 3A: the two parts sliding on one another along the line SS. The two parts are then the image of each other across SS in the full sense of the word.

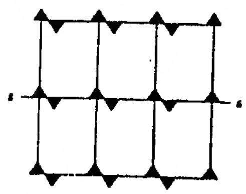


Fig. 5

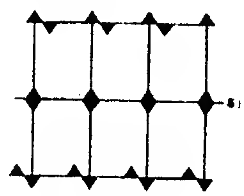


Fig. 5A

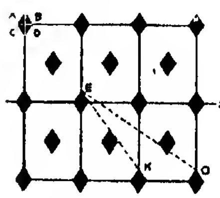


Fig. 6

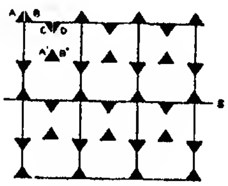


Fig. 6A

From Fig. 2A we may also realise that the amount of the original shift must be equal to one half of EF: no other shift will give the symmetry which Fig. 3A shows. In Figs. 5 and 5A a different shift has been given, and the failure is clear.

In Fig. 4 not only are C and D shifted parallel to the horizontal line, but also B and D are shifted parallel to the vertical; this time the amount of shift is one-half of the side EJ.

The three modes of Figs. 2, 3 and 4 all lead to the same external symmetry. There is one more which is based, as we should say, on a different lattice and is symmetrical, like the others, about two lines at right angles to each other. It is shown in Fig. 6. There are no variations of Fig. 6, as of Fig. 2, to be obtained by the introduction of shifts. If in Fig. 6 we shift C and D relatively to A and B, as we did in Fig. 3A, we find that they can now be described as the direct reflection of A′B′ into CD and of A′C into B′D, and the mode of Fig. 6A is the same as that of Fig. 6.

There are therefore four *modes* in one *class*: four varieties of internal arrangement which all lead to the same external appearance of symmetry.

Our example is two-dimensional, and the crystal has three dimensions. But there are no new ideas to be added: it is only the numbers of symmetries, modes, and classes that are increased. If, for example, we continue the study of the modes of arrangement that lead to an external symmetry of reflection across two planes at right angles to each other, we find that there are four lattices instead of two, and twenty-two modes instead of four. The class containing crystals that possesses this particular form of symmetry is generally called the "hemimorphic class in the orthorhombic system." Its symbol is C_{2v}: the symbols of the four lattices are $\Gamma_0\ \Gamma_0'\ \Gamma_0''\ \Gamma_0'''$. In every case the content of the unit cell is divisible into four parts, corresponding to the ABCD of Figs. 2 to 6. The ten modes in the Γ_0 lattice are shown in Fig. 7, which will serve to show the numerical increase due to the introduction of the third dimension. Under each separate figure is given, beside the crystallographic symbol, another symbol which describes the shifts: D^x means a direct reflection across a plane parallel to yz; E^x_y a reflection across a plane parallel to yz, together with a shift parallel to the axis of y equal to half the y edge of the cell, and M^x a reflection across a plane parallel to yz, together with a shift parallel to the diagonal of the yz face and equal to half that diagonal.

Let us now see how the X-ray analysis distinguishes the mode. Let us imagine that Fig. 2 represented a number of pits in a plane reflecting surface. The surface could be used as a grating having many spacings instead of one. If, for example, we so placed it that the horizontal lines of the figure were parallel to the slit of the spectroscope the spacing would be equal to EJ: if the vertical, the spacing would be equal to EF. Again, if the grating were so placed that EK, for example, were vertical, the spacing would be the perpendicular distance between EK and FL. If the surface is pitted as in Fig. 3, the spacing when the horizontal line is parallel to the slit is the same as before: but when the vertical is parallel to the slit the effective spacing is only half what it was in Fig. 2. This follows from the fact that if we divided the surface into a number of vertical narrow strips, the diffracting effect of each such strip, for this position, depends on the total amount of reflecting surface contained in the strip, but not on its distribution along the slip. It does not matter that C and D are upside-down as compared to A and B. The strata consisting of C and D portions have interleaved the strata of A and B portions. This halving of a spacing of Fig. 3 as compared with Fig. 2 occurs only when the grating is placed so that the slit is parallel to the vertical line of Fig. 3, and not when any other line is vertical, except by some odd chance connected with the shape of the pits. In this way it is possible to distinguish between Fig. 2 and Fig. 3. The mode shown in Fig. 4 is distinguished by the halvings of both the horizontal and vertical spacings, and of no others. In the case of Fig. 6, as compared with Fig. 1, the spacing is halved when the slit is parallel to the

horizontal or the vertical line of the figure, and also whenever the grating is so placed that the parallel to the slit passing through one of the corners of a cell does not pass through the centre of that or any other cell, as, for example, if EO but not EK is parallel to the slit. It is therefore easy to distinguish each of the four modes.

If such a difference exists it may be expected to show in the external characteristics of the cell, giving it polarity. A good example is to be found in zinc blende. Layers of zinc and of sulphur atoms alternate with one another as in Fig. 9, all of them being perpendicular to a trigonal axis of the crystal. The distance between a zinc atom in the

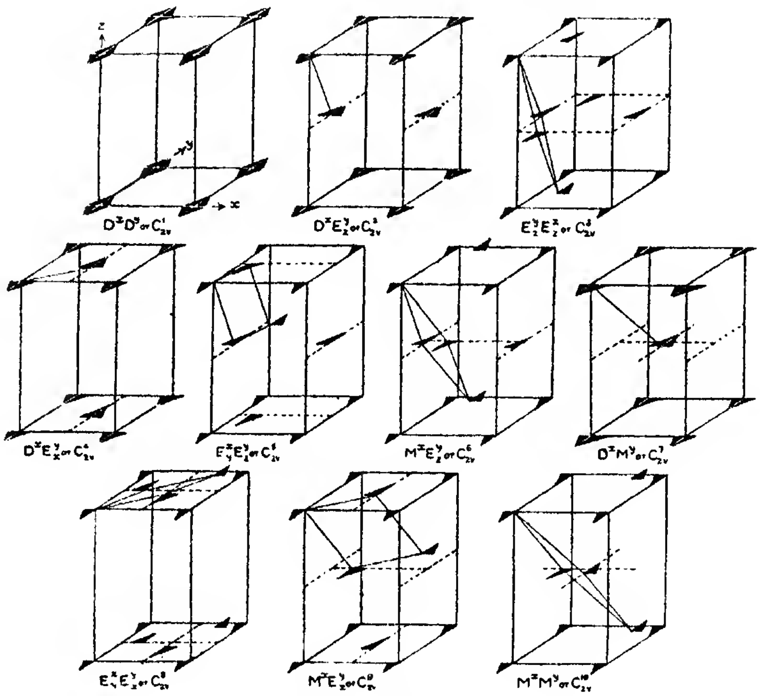


FIG. 7

Similar methods are applicable to the three-dimensional crystal. If, for example, we consider the case of C^2_{2v} or $D^x E^y_z$ we can show that, whereas in general the spacings of planes are such as are proper to a cell of the dimensions and form drawn in the figure, all planes of the form $lx/a + mz/c =$ an integer, show halved spacings, unless l is odd and m is even: which is sufficient identification of the mode of arrangement. The symbols a and c denote edges of the cell.

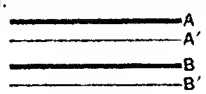


FIG. 8

If we follow this line of reasoning through all the thirty-two classes, we end, of course, with the discovery of the 230 modes which are known to exist: and with the identification marks of each, with certain qualifications. These last are of two kinds. One of them is general in nature and is a consequence of the fact that the X-rays can measure only the distance between two like points in neighbouring cells, say A and B. But they do not indicate any difference that may exist between AB and BA.

layer A to a zinc atom in the layer B is found without question by the X-ray method. Now we know from observation of the crystal that there is a difference between AB and BA: the crystal is polar. A crystal plate cut so that its faces are perpendicular to the axis shows different properties on its two sides: if heated, one face becomes positively and one negatively electrified. Whichever face we use in the X-ray spectrometer we obtain the same value for the spacing, and we find ourselves unable to detect any difference between the two aspects by means of the spectrometer observations.

We may see this point in another way. Suppose that Fig. 9 represents a section of a crystal consisting of two kinds of atoms, indicated respectively by full and empty circles. The arrangement clearly has no symmetry about a vertical line in the plane of the paper. But if X-rays were incident from above, as shown there would be equal reflections from the planes 11′ and 22′. If the incident rays were heterogeneous and a photographic plate were placed to receive the Laue reflections in the usual way, there would be a symmetry distribution of spots on either side of A, although there is no symmetry in the crystal to correspond.

It is only when we have taken other considerations into account and have determined the structure that we can establish the polarity of the crystal. We may take, for example, the fact that zinc blende is cubic, and therefore has four trigonal axes, a fact which we may discover from X-rays as well as from the external form. Also, the unit cell contains only one molecule of zinc sulphide, and may be drawn of the same form as in diamond: that is to say, its eight corners can consist of the six centres of cube faces and the two ends of a diagonal. If we put zinc atoms at the corners of the unit cell, the sulphur atom must lie either at the centre of the unit cell or at the centre of the regular tetrahedron formed by four of the corners of the cell: only by the adoption of one of these alternatives do we get the four trigonal axes. The former gives the rock-salt structure and is distinguished by the fact that the (100) and (110) spectra decrease regularly in intensity from lower to higher orders, whereas in the (111) spectrum the even orders are relatively greater than the odd.

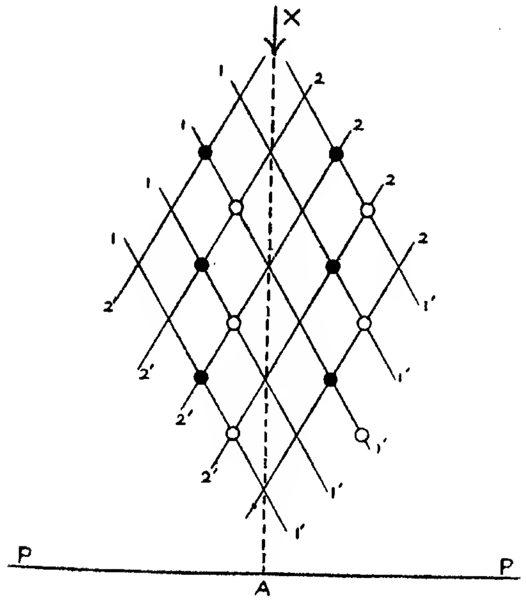


Fig. 9

In the latter alternative the even orders of (100) are relatively greater than the odd, (110) spectra are normal, and the second order of the (111) is abnormally small. It is easy to distinguish between the two cases. The latter is adopted by zinc blende. Each atom has the symmetry of Class 31, to which the crystal belongs, there being only one atom of each in the unit cell.

In this case we are successful from X-ray measurements alone in determining the mode of arrangement of the crystal, although the crystal is polar and the X-rays cannot detect polarity directly. We have been able to determine the structure completely, and the polarity then appears.

When the determination of structure cannot be carried far enough, the X-rays may fail to decide between the presence and absence of polarity. For example, resorcinol is an orthorhombic hemihedral crystal: this is known by its external form. The X-rays show that, this being so, its internal arrangement must be that of $M'M^{y}$ or C^{10}_{2v} in Fig. 7. If we had no help from the study of external form, or from any other source, we should not be able to decide between C^{10}_{2v} and the more symmetrical mode known as Q^{12}_{h}: the symmetry of the latter is obtained by adding a centre of symmetry to the elements of symmetry, possessed by C^{10}_{2v}: that is to say, by removing the polarity of the crystal. As a matter of fact the external form of resorcinol clearly shows polarity: or, if we could be sure that the molecule had no symmetry, we could infer that the crystal was unsymmetrical about the *xy* plane, there being only four molecules in the cell and all these being wanted to give the symmetry observed by X-rays. Thus there are cases where the X-rays cannot decide between two modes, one of which can be derived from the other by the addition of a centre of symmetry. As, however, the existence of a centre of symmetry can generally be decided by other means —for example, by such means as I have described above in the case of zinc blende or of resorcinol— this incapacity of the X-ray method is of no great consequence.

The addition of a centre of symmetry moves a structure from one class to another—Class 1 to Class 2, Class 31 to Class 32. Consequently, the X-ray methods are by themselves sometimes in doubt between two modes in different classes when they are rarely in doubt as to the mode within a class. It will readily be understood that the doubt as to class may be of far less importance than the doubt as to mode; though hitherto the former kind of difference has been given all the attention because it has been the only kind that could be observed. A very slight relative movement of the atoms would be sufficient to reduce the symmetry of the crystal from one class to another: but the change from one mode to another within the same class would mean a complete rearrangement of the molecules.

There are two cases in which the X-rays cannot distinguish between two modes in the same class. These are Q^{8} and Q^{9} in the enantiomorphous class of the orthorhombic system, and T^{3} and T^{5} in the tetratohedral class of the cubic system. The ambiguity disappears, however, if there are only two molecules in the unit cell, when the former alternative is alone permissible in each case: it would disappear also in any case in which the structure could be determined completely by any other means.

It has been known for many years, thanks to the work of Fedorow, Schonflies and Barlow, that the 230 modes of arrangement represent all the possible forms of internal crystal structure. In each mode of arrangement there is a relative disposition of planes, axes and centre of symmetry, which is characteristic of the mode, and the mode may be described in terms of these symmetries. This was the language used in the original work on

the subject, and the term space group was used, instead of the term mode of arrangement, in reference to the particular group of symmetry planes, axes and centre in space. When the subject is approached from the point of view of the X-ray worker, the language of the mode of arrangement has its special conveniences. A list of the 230 modes, and of the X-ray tests for each mode, has recently been published in the *Transactions of the Royal Society* by Astbury and Yardley. Lists of the same 230 space groups have already been published in different terms by writers on crystallography: recently a list by Wyckoff has been published by the Carnegie Institution of Washington, in which each space group is expressed in terms of the coordinates of the arrangement of points required to give each space group its special characteristics.

It may be of interest to look at these matters from a somewhat different point of view, which takes in the question of the permanence of the chemist's molecule when built into the solid structure.

In every crystal the unit can be divided into a certain number of parts, each of which has no symmetry of its own, but may be made to coincide with any other part by some combination of reflections, rotations and shifts. The number is always either one, two, three, four, six, eight, twelve, twenty-four, or forty-eight. The division into 230 modes of arrangement refers to the arrangements of these parts. In the case of a crystal of the rock-salt type both the positive and negative portions of the cell can be so divided. Very often the part in question is the chemical molecule. For example, the cell of the monoclinic prismatic class can be divided into four such parts. The X-ray measurements show that the unit cell of benzoic acid which belongs to this class contains four molecules. Also they detect the existence of the four parts, and determine the mode of their arrangement. It is natural to make the assumption that each part is a molecule. This, it may be noted, involves the existence of right- and left-handed molecules, as built into the crystal.

Sometimes the division into parts involves the division of the molecule. The molecule then consists of two or three or more parts, and therefore possesses a corresponding symmetry. For example, the naphthalene molecule in the naphthalene crystal contains two parts, and has a centre of symmetry. The molecule of FeS_2 in the crystal of iron pyrites consists of six parts, and has a centre of symmetry and a trigonal axis. Each of the two atoms in the rock-salt cell, sodium and chlorine, has—that is to say its relations to its neighbours have—forty-eight parts, and therefore the full symmetry of the crystal.

Much more rarely a part consists of more than one chemical molecule. So far a few instances have been met with. The "part" in the crystal cell of sulphur certainly contains two, perhaps more, atoms. Miss Yardley finds that the "part" in the fumaric acid crystal contains three, perhaps six, of the molecules as ordinarily defined $(COOH.CH:)_2$. In the cell of α-naphthylamine at least three molecules go to a part. The part has no symmetry, so that the molecules that compose it differ from each other. These are really examples of polymerisation in the crystal.

Is the grouping of the atoms in the molecule as displayed in chemical reactions maintained without change? When the first results of the new methods were published, with their determinations of diamond and rock-salt structure, there was some unnecessary alarm as to the apparent disappearance of the molecule. If there had been anything to suggest a complete disruption of all the alliances in the molecule, which had been so long and so successfully studied by the chemists, the alarm would have been justified. Atomic bonds would have been annoyingly variable and dependent on conditions, and we should have been put back to the starting-point in the investigation of the solid. This condition of things appears, fortunately, to have no existence. The conclusions of chemistry are carried into the solid, with only such modifications as might reasonably be expected. Our new science is in full and close alliance with chemical science already established: it is in fact a constant and delightful experience to find some direct confirmation or illustration of an inference already drawn from other sources. So far as experience has to tell us, the chemical molecule generally takes its place as such in the crystal structure with little change.

To sum up, we are now able to replace the rough division into thirty-two by the finer division into 230. This is advancing a whole stage towards the final solution of the structure problem. We carry the analysis right up to the limits which can be foreseen by the mathematical investigation of the geometry of space. We require only a sufficient number of X-ray measurements; if these can be obtained, the crystal then—with certain additional information as to polarity—can be assigned to its particular mode or space group, with one or two exceptions as already noted. It may be that the structure of the crystal is so simple that having got so far the full solution is already in sight. In the vast majority of cases this is not so; we have only come to the end of the second stage of the work.

The first stage was complete when we had found the dimensions of the crystal unit cell: the second is completed when we know which of the 230 possible arrangements of molecules, or, in other words, space groups, the crystal structure follows.

If the structure of the crystal is not yet obvious—and in the great majority of cases this is far from being the case—we enter on a third stage, in which the mode of procedure is less stereotyped and more difficult, perhaps all the more interesting. We have now to find if we can, the arrangement of the atoms within the cell, to which task the knowledge already gained is an indispensable though, it may be, a quite insufficient contribution.

As I have said already, the X-rays do not tell us directly the relative positions of the atoms within the unit cell. They have, however, much to tell us as to the relative intensities of the different orders of reflection by each plane, and these must depend on the atomic arrangements. It is to be admitted, however, that we are as yet unskilled in the interpretation of this evidence. We do not completely understand how varying conditions affect intensities of reflection, though we have learnt a great deal through the work of W. L. Bragg, Darwin, Compton,

and others. And, of course, when the cell contains many molecules, their positions being as yet unknown and their separate contributions to the intensities in any case doubtful, the observations of intensity are very difficult to make use of, though they can be accurately measured. We can only avail ourselves of such bold indications as that a very strong reflection implies the location of many atom centres on or near the plane in question, particularly if there are higher orders: or we may find ourselves able to show that an especially strong second or third or other order implies the adoption of some particular alternative arrangement. A very interesting example of a general influence of form upon intensity is to be found in the reflections from the fatty acid layers which have been investigated by Muller and Shearer. The first, third and other odd orders are much more intense than the second, fourth, and other even orders. A simple explanation is found in the fact that these long chains face opposite ways alternately, and that the number of scattering centres is distributed fairly evenly along their length. At the ends, however, the uniformity of distribution is interrupted; at one end, probably the carboxyl end, there is an excess per unit length: at the other, the methyl end, a deficiency. Thus we may say that the effect on an odd order of the spectrum due to a single layer, the thickness of a layer being twice the length of a molecule, contains a factor :—

$$A \sin(\omega t - a) - B \sin(\omega t - a - \overline{2n+1}\pi) = (A+B) \sin(\omega t - a).$$

The factor for an even order is :—$(A-B) \sin(\omega t - a)$. If at both ends there had been an excess of scattering centres, we should have found the even orders stronger than the odd: the effect we find, for example, in the (111) planes of rock-salt. In the case of the simpler inorganic crystals like rock-salt, diamond, and so on, intensity observations are conclusive as to the structure: in the case of iron pyrites or calcite they are very nearly so. But in the case of quartz, where the cell contains nine atoms, still more in the case of an organic compound, they do not carry us very far. We hope that greater experience will give us in the future the power of using them to better advantage.

In what other direction then shall we look for additional means of approaching more nearly to the final solution of the problem of structure?

The answer to this question will take account of all the store of physical and chemical knowledge which we already possess. Having solved, wholly, or in great part, the structure of some of the simpler crystals, and being able to proceed in all cases, even of the most complicated crystals, to the determination of the number of molecules in the cell, and of their mode of arrangement, we must try to correlate what we have found with the properties of the crystal. By that means we shall become gradually more certain of the general connexion between the structure and its physical and chemical properties; we shall become able to settle further structural details in various cases, and so, by alternate and mutually supporting advances, we may hope to reach our goal.

Let us consider what is being done in this direction. First of all there is the question of the distribution of the atoms in space. Given so many atoms, to be packed into a cell of known dimensions, what information have we as to the space that each must occupy? The answer to the question cannot be simple, because we may not expect that the atoms are always to be treated as spheres, still less as spheres of constant radius. It is as generally difficult to state the distance between one atom and another as to state the distance between a table and a chair. Nevertheless, the atom-radius is a useful conception, especially when its dependence on the nature of combination is taken into account. The question has been considered by W. L. Bragg, Wyckoff, Davey, and others, and it appears that an atom does make a definite contribution to the distance between its centre—when it can be assumed to have a centre—and the centre of a neighbour, so long as the nature of the bond remains the same. This is a valuable contribution to the study of structure. It is proved by the examination of simple structures like those of the alkaline halides, and we may assume its reliability in our attempt on more complicated problems. And, of course, it is interesting from the point of view of atomic structure itself, and atomic linkages.

The radius seems to depend on the tightness of the bond as in bismuth or in graphite, where there are two kinds of bonding, and the plane of cleavage cuts across all the longer distances from centre to centre. In calcium fluoride the centres of calcium atoms are closer together than they are in the metal itself in spite of the interposition of the fluorine atoms; and in calcium oxide they are still closer. The change in the type of the bonding has altered the value of the radius.

There is also the very interesting but still more unsettled question of the mutual orientation of the bonds between an atom and its neighbours. It is, of course, the carbon atom which is the occasion of this problem in its most pressing form. In the diamond the exactly tetrahedral arrangement of bonds is associated with great rigidity, which implies great stiffness of orientation. The analysis of the structure of graphite has lately been carried by Bernal to a stage very near completion, but the only point in any doubt is unfortunately the very one as to which certainty would be welcome. Has the great weakening of one bond interfered with the realtive orientation of the other three? Debye thought that the structure was trigonal, and that the atoms were arranged in layers which were like the layers of diamond, except that they were flattened out without a sideways extension of the network. This would involve a closer approach of carbon atom centres from 1·54 A.U. to 1·45 A.U.; against which no obvious objection can be offered, but it would be interesting to know how it happened. Hull believed the structure to be hexagonal, and that the layers remained as in the diamond. Bernal, having found some good graphite crystals to which the single crystal methods could be applied, finds that Hull is correct as to the hexagonal structure, but inclines to the belief that the layer is flattened.

In the latter case, we must suppose that the carbon atom has three very strong bonds almost coplanar with the carbon, and one weak bond at right angles to this plane.

The question arises in another form in the investigations of the long carbon chains by Piper and others, and especially by Muller and Shearer. If the chains are formed by the linking of carbon atoms together in such a way that the junctions of one atom to its two carbon neighbours are inclined to one another at the tetrahedral angle of 109°28′, as in diamond, then there are three possible forms of chain. In one of them, each two carbon atoms imply an increase of 2·00 A.U. in the length of the chain, and, in a second, an increase of 2·44 A.U. In these two cases the carbon atoms of a chain can lie in a plane. With one exception, all the cases examined show one or other of these two rates of increase. The third form of chain is a spiral, for which the growth of each single atom added is 1·12. In one case this rate of increase is found to hold: it is that in which the chain contains a benzene ring. This agreement between the calculation and experiment shows with some force that the relative orientation of the bonds is maintained. Even when two or four hydrogens are stripped from the chain at various points, so as to leave a double or triple bond between consecutive carbon atoms, to adopt the ordinary chemical language and theory, no reasonable change is found in the length of the chain. This does not mean that there is no change in the distance between neighbours: such a change would be small and might escape detection. But it does mean that there is no great change in the general straightness of the chain, such as might be expected from any large change in the mutual orientation of the bonds between the carbon atom and its neighbours.

In calcite the three oxygens which surround a carbon atom must lie in one plane. It is supposed, however, that in this case the bonds are electrostatic: the carbon atom has lost its four valency electrons, and with them its powers of tetrahedral orientation.

Now if we can discover the extent to which an orientation is maintained under different conditions, we are provided with one more guiding principle in our attempt to discover the structure of the crystal which contains carbon atoms. And, of course, the organic compounds centre round the carbon atom and its tetrahedral structure.

The question of orientation in respect to other atoms is more obscure, but it is clearly one of importance. There must be some reason why ice has such an open structure, and here the oxygen atom is largely concerned. In the ruby the oxygen atom has no plane of symmetry in relation to its neighbours. In organic substances the great emptiness of the structure implies that atoms are attached to one another at points which have definite positions on the surfaces of the atoms and are limited in number. And, generally speaking, the consideration of organic crystal structure is against any idea that atoms and molecules are to be treated as spheres surrounded by uniform fields of electric force, except in certain cases where by loss or gain of electrons an atom has been reduced to the outer form of one of the rare gases. They must have highly irregular fields, having forms which more or less resist any change. The weak bonds which hold molecule to molecule in the organic substance are not due to electron sharing as in diamond, or to ionisation as in rock-salt, but to an intermingling of stray fields belonging to definite positions on the surfaces of the molecules.

Our attempt to discover the effect of orientation is part of a general attempt to discover the field of force of the atom, which is naturally a very difficult matter. But if we can learn only a few rules, even empirical rules, we are so much the further on our way.

Yet another obvious and most important source from which help may be obtained is to be found in chemistry itself. Although the chemist has had no means until now of measuring distances and angles, he has been able to build up a wonderful edifice of position chemistry. An atom A of a molecule is certainly linked, it may be to B, and not to C; or again, of a number of atoms of the same nature and contained in the same molecule, so many must be alike, and so many may be different.

The chemist has, for example, come to the conclusion that the naphthalene molecule is a double benzene ring, and the anthracene a triple benzene ring. The X-ray observations show that one of the sides of the unit cell of the latter crystal is longer by 2·5 A.U. than the corresponding side of the other, all other dimensions of the two cells being very nearly the same. The width of the hexagonal ring in the diamond is 2·5 A.U., so that on the one hand the chemical evidence suggests that the length of the molecule is parallel to that edge of the two cells which shows differing values, and on the other the X-ray conclusions give material support to the chemical view. Let us take another example from basic beryllium acetate $Be_4O(C_2H_3O_2)_6$. The substance is remarkable for the case with which it sublimes into a vapour consisting of whole molecules, from which we may infer that the molecule does not suffer much change in the process. The relative positions and mutual alliances of the atoms are nearly the same when the molecule is free as when it is built into the solid. From the X-ray evidence we learn that the molecule has four intersecting trigonal axes. We must place the unique oxygen at the centre of a regular tetrahedron, and the four beryllium atoms at its corners. Each of the six acetate groups must be associated with one of the tetrahedron edges, and in such a way that the four trigonal axes are maintained. This necessitates, as crystallographic theory shows, the existence of a dyad axis through the middle points of each pair of opposite edges of the tetrahedron. The $C_2H_3O_2$ groups must be added so as not to interfere with the existence of these axes. If they are placed correctly for the trigonal axes, each of them has a dyad axis of the kind mentioned. All this agrees with the chemical evidence as partly stated in the formula, which implies :—

1. That there is one oxygen differently situated to the rest.
2. That the four beryllium atoms are all alike.
3. That the acetate groups are all alike.

Further, chemists would say that the carbon atoms

are not alike; in that case, they must both lie on the dyad axis, since if they did not they would necessarily be symmetrically placed with respect to that axis and would be equivalent. On the other hand, the oxygen atoms in the acetate group cannot lie on the axis if, as is probable, they are equivalent to one another. They must be placed symmetrically with respect to the dyad axis. As to the hydrogens, we must assume either that they do not count, which is not at all unlikely, or that they are not all alike. It is impossible to place eighteen hydrogen atoms so that the group has four intersecting trigonal axes and that every hydrogen is like every other. The molecule has no plane of symmetry, the fault lying with the oxygens. It could not be due to the hydrogens because there are marked differences in the intensities of reflection of pairs of planes, which differences would not exist if there were planes of symmetry, and would be small if due to dissymmetry in the positions of hydrogens only. It is by reasoning along such lines as these that X-ray evidence and chemical evidence can help each other. Many other instances might be given; indeed, no complex crystal can be studied with success without calling in the assistance of chemical arguments.

A fourth example of the connection between arrangement and properties is to be found in the recent work by W. L. Bragg on the indices of refraction of crystals. It has been found possible to calculate the indices of refraction of calcite, given the dielectric capacities of calcium, carbon and oxygen atoms separately. The difference between the two principal refraction indices is almost entirely due to a difference between the dielectric capacities of a set of three oxygen atoms, at equal distances from one another, when placed :—

1. So that the plane in which they lie contains the direction of the field.

2. So that this plane is perpendicular to the field.

If we are able to calculate the refractive indices on these data, then it must be possible to find conditions governing the arrangement of the atoms, when we know the composition of the crystal and its refractive indices. For instance, the near equality of the refractive indices of potassium sulphate implies that the dielectric capacity of the SO_4 group is much the same in all directions, and this is in agreement with the hypothesis that the oxygen atoms are grouped in some sort of tetrahedral fashion about the sulphur atom.

There are still other connexions between structure and properties which we begin to understand, and can use in proportion to our understanding. The cleavage plane and the occurrence of certain faces in preference to others are connected with the nature of the bonds and the size of the spacings. We are not surprised to find that in bismuth, or graphite or naphthalene the cleavage plane cuts across the ties which we should expect to be the weakest of those that bind the molecules together; or again, that natural faces follow the planes that are richest in atoms or molecules and may be assumed to contain relatively large numbers of linkages. In naphthalene the cleavage plane passes between the ends of the molecules, where the β hydrogens are, and where there is a deficiency in the number of scattering centres, as the X-rays indicate by the strengths of several orders of the (001) reflection. The other faces found on the crystal cut across the ties at the positions of the α hydrogens.

There are many other connexions between the structure and other properties of a substance, such as dielectric capacity, rigidity, and compressibility, conductibility both thermal and electric, magnetic constants. In fact, the only properties of solid bodies which are not directly and obviously related to crystal structure are those, few in number, that depend on atomic characteristics alone, such as weight; and the absorption coefficients for α, β, γ and X rays, all the rays which involve high quantum energies. With few exceptions every aspect of the behaviour of a solid substance depends on the mode of arrangement of its atoms and molecules. We have, therefore, an immense field of research before us, into which the X-ray methods have provided an unexpected and welcome entrance.

They tell us directly, as I have said, the number of molecules in the crystal unit cell, and the mode of their arrangement with such determination of lengths and angles as are required to define the mode of arrangement in full. They leave us then to ally our new knowledge to all that we possess already as to the physical and chemical properties of substances. By this comparison we hope in the end to determine the position of every atom, and explain its influence through its nature and position upon the properties of the substance. It is the chemistry of the solid that comes into view, richer in its variety even than the chemistry we have studied for the past century, and possessing an importance which is obvious to us all. Every side of scientific activity takes part in this advance, for all sciences are concerned with the behaviour of matter.

CHEMISTRY IN HERODOTUS

In the *Chemiker Zeitung*, 1924, No. 1, p. 1; No. 7 pp. 29-31, and No. 8/9, p. 38, Prof. E. O. von Lippmann has an interesting article, entitled *Technologisches und Kulturgeschichtliches aus Herodot.* Herodotus (489-429 B.C.) included a large number of observations of scientific interest in his great work, but hitherto they have attracted very little attention, probably because they are not gathered together in one place, but are scattered throughout the book and often introduced only incidentally. Prof. von Lippmann has been industrious enough to collect these isolated details, and the material he has thus accumulated will prove of great assistance to those who are engaged upon the study of early chemistry. The article—of which it is scarcely possible to make an abstract—is divided into four sections, which deal respectively with (i) the Elements, (ii) Mineral Substances, (iii) the Metals, and (iv) Organic Substances. The annotations are as scholarly and as enlightening as would be expected from the learned author of *Die Entstehung und Ausbreitung der Alchemie.*

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

The Autumn Dinner, which will be under the auspices of the Society of Chemical Industry and the Chemical Industry Club, will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, on Friday, November 14, at 7 for 7.30 p.m., and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

A circular letter with further particulars and a form of application for tickets has been sent out to the members.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

FORTHCOMING EVENTS

Oct. 1. SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS, in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1, at 8 p.m.

The following papers will be read:—"The Determination of Coconut Oil and Butter Fat in Margarine," by G. D. Elsdon and P. Smith. "A Preliminary Note on the Composition of the Fat of Goat's Butter," by F. Knowles and J. C. Urquhart. "The Quantitative Estimation of the Degree of Hydrolysis of Gallotannin by Tannase," by Miss W. N. Nicholson and D. Rhind. "The Pemberton-Neumann Method for the Estimation of Phosphorus," by Miss M. B. Richards and W. Godden. "Application of 'Formal Titration' to the Kjeldahl Method of Estimating Nitrogen," by W. S. Shaw. Informal Dinner will be held for Members and their friends at St. James' Restaurant, 178 Piccadilly, at 6.30 p.m.

Oct. 2. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section*. Joint Meeting with the Institute of Chemistry, the Chemical Department of the University (Woodland Road), Bristol, at 7.30 p.m. "The Present Position of the Catechin Chemistry," by Dr. Nierenstein.

Oct. 3. SOCIETY OF CHEMICAL INDUSTRY, *Manchester Section*, at the Textile Institute, 16, St. Mary's Parsonage, Manchester, at 7 p.m. "Chemistry and Industry," by W. J. U. Woolcock, C.B.E., President of the Society of Chemical Industry.

Oct. 22. THE FARADAY SOCIETY, in the Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1, at 5 p.m. Discussion on "The Physical Chemistry of Igneous Rock Formation," with an introduction by Dr. J. S. Flett. Papers are expected from Prof. C. H. Desch, Dr. J. W. Evans, Prof. J. W. Gregory, A. F. Hallimond, Prof. P. Niggli, Dr. A. Richardson, Dr. A. Scott, Mr. G. W. Tyrrell, and Prof. W. E. S. Turner.

CORRESPONDENCE

ARSENIC AND THE OYSTER

Sir,—Why, I venture to ask, do you single out the innocent but succulent oyster and accuse it of a base predilection for arsenic? Surely a humble mollusc cannot be expected to be as fastidious in its diet as its more highly cultured neighbours—the fishes. Three parts per million is not excessive for an animal condemned to feed on the bottom of the sea; why, even the plaice, which has two eyes, and the whiting which feeds not on the ocean bed, may contain this much, and the aristocratic cod, so says Prof. Bang, on occasion contains more than four parts. Pray, Sir, acquit the oyster and let us enjoy it in peace.

In conclusion I beg you to inform me whether the "Walrus" and the "Carpenter," either or both, died of arsenical poisoning after their lament over the gentle oysters they decoyed and betrayed?—I am, Sir, etc., "ARSENICUM"

September 19, 1924

THE CHEMIST IN THE PROVINCES

Sir,—Now that we have reached the end of our English summer, the time will soon be upon us when we shall receive demands for Annual Subscriptions. The typical young chemist in the provinces, who, anxious to keep up-to-date has joined several societies, may be faced with a bill of anything up to £10. He is entitled to ask himself whether he is receiving value for money?

The young chemist emerges from the University with a degree. Urged by his professor he probably joins the Chemical Society. He then finds that although he possesses his degree he is not considered a genuine chemist unless he joins the Institute, so if he is sufficiently enthusiastic he takes the A.I.C. He now goes forth into chemical industry a "pukkha" chemist. Still anxious to keep abreast of knowledge he enters the Society of Chemical Industry, and, if a super enthusiast, he joins a fourth society connected with some specialised branch of his profession.

Let us consider the case of the chemist who lives away from London. What does he get in return for his hard-earned cash? Let us take the various societies separately.

(*a*) *Chemical Society*

All that the provincial chemist receives for his £3 per annum is the monthly journal, consisting entirely of papers on "pure" research, *e.g.*, Isomerism in the Timbuctoo acids. If the young chemist is honest with himself he finds that 99 per cent. of the contents do not interest him, and that 50 per cent. cannot be properly understood by him. If he remains a member for many years, he finds himself landed with a collection of hefty tomes which he cannot dispose of.

He learns that the Chemical Society has a fine library of which he can make very little use. It might just as well be in Jericho.

(*b*) *Institute of Chemistry*

This society for 30s. per annum registers the young aspirant as a genuine chemist. It bestows

upon him every two months a journal which he may or may not find interesting. It makes him a member of a local section, at which on certain evenings in the winter he can meet perhaps a dozen other chemists and discuss such absorbing topics as "Should the Institute have an Academic dress?" etc.

(c) *Society of Chemical Industry*

For £2 15s. per annum the young chemist receives a weekly *Journal*. This *Journal* is certainly a very good one, though occasional articles by prominent professors make him wonder if he knows any chemistry.

This Society also makes him member of a local section. Once in two or three years, perhaps, the young chemist hears of a paper which interests him and attends a meeting. The question: "What becomes of all the old chemists?" is supplied with a full and complete answer.

So much, then, for the various Societies. Is there any genuine reason why the young chemist should be called upon to pay several annual subscriptions? Surely one single Society alone could do the work at present done by three.

The function of a chemical society is simply to look after the status of the chemist, keep a register, and enable its members to keep abreast of chemical knowledge both pure and applied. It should publish a weekly journal and have occasional local meetings, and establish a library in every local section.

The journal, in addition to matters of topical and professional interest, should be modelled on the lines of "Chemistry in the Twentieth Century," *i.e.*, the articles should consist of general accounts of progress in various fields of chemistry, and should be written by specialists. These articles enable the ordinary chemist, who is really a specialist himself, to obtain a good knowledge of progress in other branches of chemistry, without overwhelming him with a mass of indigestible detail. The consulting of original papers is then optional.

The Society should, as now, receive accounts of original researches from its members, but only the titles of such papers should be published in the *Journal*.

If the chemist finds that one of these papers is of particular interest to himself, he should be able to obtain a full copy from the Secretary of the Society, or copies of all papers communicated to the Society should be kept at the libraries of the local sections.

Whether there should be meetings of local sections is a matter of opinion. If held, they should certainly be much wider in scope and of a definitely social character. The topics should be as broad as possible, with the object of enabling the chemist to take the widest possible view of his profession. The average chemist is deeply interested in his work, and is not above attending meetings if they are worth it. At present we chemists suffer from too many meetings, and too narrow a view of our profession.

To sum up, my points are these:—(1) The young chemist cannot afford to be a member of several societies.

(2) There is no valid reason why all the interests of the chemist should not be looked after by one single society at a reasonable fee.

(3) The chemist in the provinces should be catered for equally with the chemist in London.

(4) The literature of chemistry should be given a wider scope and should have a more general appeal. —I am, Sir, etc., "YORKIST"

Leeds

BENZOL RECOVERY

SIR,—In the issue of September 12, Vol. 43, No. 37, B. 739, you published an extract from a paper read by Monsieur Edouard Urbain at the Centenary Congress of the Société Technique on "Activated Carbon and Silica Gel."

From this paper one would naturally draw the inference that the benzol-recovery plant at the Grenoble gasworks was erected to the designs of Monsieur Edouard Urbain.

I should, therefore, like to prevent any misunderstanding, and state the facts regarding this plant verified by two independent experts from this country, who visited Grenoble to see the plant in operation.

The erection was carried out by the Société Anonyme pour l'Utilisation des Combustibles, of Paris, to the design of Friedr. Bayer and Co., Leverkusen, and under their guarantees. The installation of steam coils in the filters to reduce the steam consumption (specially mentioned in Monsieur Urbain's paper) was carried out during the course of the erection of this plant on the instructions and to the design of the Friedr. Bayer Co. after their experimental filters at Leverkusen had been fitted and tried out with these special coils and data obtained therefrom as to the resulting economy. These experiments were carried out at Leverkusen during 1923.

Further, since the plant has been put in operation, a prefilter has been added in order to minimise the risk of fouling the highly active "T" carbon with foreign bodies which cannot be driven out by means of highly super-heated steam, or only with great difficulty. This pre-filter is again to the Friedr. Bayer Company's design and filled with their prefilter carbon. This would have been embodied in the original design for the Grenoble plant, but it was assumed that the gas would be clean enough to be dealt with directly in the benzol carbon filters.

In my paper read before the Chemical Engineering Group of the Society of Chemical Industry on March 7, 1924, the Grenoble plant was described, and a diagrammatic slide of the arrangement thereof shown. However, figures as to plant operation could not be given at that time, as it had only been in operation for some five to six weeks.

I feel it only right and fair to Messrs. Friedr. Bayer and Co. that I should draw your readers' attention to these facts as, although the Société Anonyme pour l'Utilisation des Combustibles have the sole exploitation of this Bayer process in France, my firm, Messrs. Simon-Carves, Ltd., 20, Mount Street, Manchester, has its exploitation for the United Kingdom, and we work in the closest co-opera-

tion with Messrs. Friedr. Bayer and Co., all information being pooled for our common use.

Owing to the French occupation of the Ruhr, there was difficulty in obtaining delivery of the active carbon from Messrs. Friedr. Bayer and Co.'s Leverkusen works, and apparently one of the three filters at the Grenoble plant was filled with carbon manufactured according to Monsieur Edouard Urbain's process. The Grenoble plant is one of the many solvent extraction plants using the Bayer process and carbon, amongst which there are in operation and in course of construction plants extracting over 2000 tons of benzol per annum.—I am, Sir, etc

Knutsford VIVIAN F. GLOAG

September 19, 1924

PERSONAL AND OTHER ITEMS

Prof. Alex. Findlay has accepted an invitation to visit Stanford University, California, as Acting-Professor of Chemistry for the three quarters of the academic year, January to August, 1925.

Sir Ernest Rutherford, Prof. Donnan and Sir Charles Parsons have arrived in Philadelphia for the celebration of the centenary of the Franklin Institute.

Mr. E. Craig Porter, B.Sc., Ph.D., who has been appointed works chemist at the factory of Lotus Ltd., Stafford, graduated in technical chemistry at Manchester University, and gained the degree of Ph.D. for research work on hide substances in the leather department of Leeds University under Prof. Procter.

Mr. J. G. A. Skerl, research assistant to Prof. P. G. H. Boswell, of the University of Liverpool, has been appointed by the British Cast Iron Research Association to direct an investigation on moulding sands in the Refractories Department of Sheffield University and in the foundries of members of the Association.

Prof. B. I. Slorzov, a Russian biochemist whose death is announced, had done much work on tissue enzymes.

The British Research Association for the Woollen and Worsted Industries has awarded research fellowships for 1924-25 to Mr. R. Burgess to enable him to continue investigations on the bacteriology and mycology of wool at University College, Nottingham, and to Mr. J. E. Nichols to investigate the wool fibres of various breeds of sheep at the Animal Breeding Research Department of the University of Edinburgh. An advanced scholarship, tenable at the Scottish Woollen Technical College, Galashiels, has been awarded to Mr. H. Maldwyn Williams.

The University of Pennsylvania announces that honorary degrees of D.Sc. are to be conferred on, amongst others, Sir W. H. Bragg, Sir C. Parsons and Prof. Pieter Zeeman, of the University of Amsterdam.

It is officially announced that the British Empire Exhibition will be closed on November 1. The question of reopening the Exhibition next year is still in abeyance.

The late Mr. W. H. Revis has left £10,000 and a share in £35,000 to the University College of Nottingham. The bequest will probably be utilised to provide scholarships and short-term fellowships at the University.

Sir George Thomas Beilby, F.R.S., LL.D., D.Sc., who died on August 1, aged 73, left estate of the gross value of £163,689, with net personalty £154,248.

A tablet to the memory of Henry Fox Talbot, the founder of modern photography, was unveiled in the library of the Royal Photographic Society on September 13.

Mr. H. K. G. Bamber, for many years a director of the Associated Portland and British Portland Cement Companies, has been killed in a motor accident.

We regret to announce the death of Mr. E. H. Brown, an old member of the Society of Chemical Industry, who had lived some years in Russia and was latterly executive officer of the Pembroke, Ontario, branch of the McGuire, Patterson and Palmer Co., match manufacturers.

Smokeless Fuel

The Corporation of Glasgow is installing a five-unit battery of Maclaurin producers to manufacture smokeless fuel and supply industrial gas to the Dalmarnock electricity station. The plant will be at work in a few weeks and will supply gas for firing boilers at the station at 1·01d. per therm.

Arsenic, Calcium Arsenate and the Boll Weevil

The supply of arsenic compounds for the control of the boll weevil pest of the cotton crop has of late received much attention in the United States, owing to the great fluctuations of prices and the difficulty, at times, of obtaining supplies. A contribution to the study of the problem has been made by Mr. H. W. Ambruster, who has reprinted, under the above title, various papers and addresses from technical and trade papers. The pamphlet (pp. 42, price 50 c., Barr-Erhardt Press, New York), which discusses the supply of arsenic, the manufacture of calcium arsenate, phases of the state of supplies of arsenic and its use for controlling the boll weevil, provides a useful summary of certain aspects of the question.

BRITISH INDIA

First Sugarcane Forecast, 1924—1925

According to reports received from provinces, which contain, on an average, 93 per cent. of the total area under sugarcane in India, the total area planted with the sugarcane is estimated at 2,566,000 acres, as against 2,715,000 acres at the corresponding date of last year, or a decrease of 5 per cent. Weather conditions at the time of planting were not generally favourable, and the present condition of the crop is, on the whole, fair, but much depends on the future course of the monsoon.

First Forecast of the Sesamum Crop, 1924–25

A memorandum based on reports received from provinces which comprise 80 per cent. of the total sesamum acreage of India states that the area under crop, so far reported, is 2,115,000 acres, as compared with 2,100,000 at this time last year, or an increase of 1 per cent. Sowings still continue in many places. The weather at sowing time was not quite favourable, but the present condition of the crop, on the whole, is reported to be fair.

REVIEW

Charts of the Chemical Reactions of the Common Elements. By John A. Timm, Ph.D., Pp. ix + 81. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924, Price 10s.

This book reviews the chemistry of the common elements, arranged alphabetically in the form of charts of their occurrence and reactions, and of equations related thereto.

The charts are ingenious, and present a bird's-eye view of the chemistry of each element, including reactions employed in analysis and manufacture. Small numerals attached to formulæ in these charts refer to equations for the elements which follow. The equations offer no ground for criticism from the point of view of accuracy; and the method by which they are built up is no doubt the one commonly employed, apart from the ionic notation—*e.g.* :—

$$2HNO_3 \rightarrow H_2O + 2NO + 3O$$
$$3O + 3Cu \rightarrow 3CuO$$
$$\underline{3CuO + 6HNO_3 \rightarrow 3Cu(NO_3)_2 + 3H_2O}$$
$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O.$$

Yet it is necessary to warn the student that this procedure is a means of arriving at a result rather than a plan of nature's footsteps; otherwise he may ask why three atoms of oxygen are shown to be liberated, and then to produce three molecules of copper oxide, since these things are not known to occur. One doubts, therefore, the wisdom of presenting the student with lists of equations in the bald fashion of this book—there are no fewer than sixty "sulphur equations"—without a word of explanation as to their limitations as expressions of facts. If it is said that this is not a textbook but merely a review, then the question arises whether the good student should not prepare his own review, and whether the indifferent student will ever become a good student by having his review prepared for him.

One might prophesy that piles of these books will be found left upon the doorsteps of examination halls in America, and perhaps in this country, but whether the comprehension of nature and the advancement of chemical science will be promoted by their use is another question.

R. M. Caven

COMPANY NEWS

NOBEL INDUSTRIES, LTD.

At the fifth ordinary general meeting, Sir Harry McGowan, K.B.E. (chairman and managing director), said that despite a continuance of uncertain commercial conditions throughout the world, the hope expressed last year that the results for 1923 would not fall short of those for 1922 had been amply realised. During the past few years, the Company had been rapidly consolidating its position in the production of its chief line of manufacture, blasting explosives and accessories. The home trade formed an important part of the business, and he believed that customers were satisfied both with the service and selling prices, which latter compared most favourably with those ruling prior to the war. This had only been made possible by the policy of concentration of manufacture and scientific research adopted by the company. The company possessed large interests in many foreign companies, including Canadian Explosives, Ltd., and Chilian Explosives Co. The Cape Explosives Works in South Africa, and Nobel's interests in South Africa had been merged into a new company, the African Explosives and Industries, Ltd., the shareholders being De Beers and Nobel Industries, Ltd. Interests had also been acquired in explosives and fuse factories in Czechoslovakia, Hungary and Rumania, and business in the Far Eastern countries, such as India and China, was well established. By application of scientific factory administration, the company was now producing a superior quality of goods as compared to pre-war days. The board was quite satisfied with the year's trading and saw no reason to suppose that the complete year's figures for 1924 would be less satisfactory than those for 1923, in which circumstances the directors would consider whether the time was not opportune to adopt the policy of paying an interim dividend on the ordinary shares, and it was hoped to make a declaration on the subject towards the end of this year.

GAS LIGHT AND COKE CO.

An agreement for amalgamation with the Brentford Gas Company has been made, with effect, subject to parliamentary sanction, from January 1, 1926. The amalgamation will be the largest in the history of the British gas industry, giving the Gas Light & Coke Co., already leading in the world's gas supply, an area nearly 40 miles long by, in places, 15 miles wide. The Gas Light & Coke Co. has an issued capital of £23,165,280 and the Brentford Company a capital of £2,058,545. The latter company has already absorbed the Richmond, Harrow and Stanmore gas companies.

BRITISH CELANESE

During the year ended February 29, 1924, there was a loss on trading of £34,478 and a total loss, allowing for debenture interest, and losses on cancellation of erection contracts, of £74,048, without providing for depreciation. The special propaganda programme has been charged to revenue and had the expenditure been capitalised, there would have been a trading profit. The total deficit now stands at £565,827. Sales during the last few months have been satisfactory.

ASSOCIATED PORTLAND CEMENT MANUFACTURERS

The reconstruction of the board of this company has now been completed. The Hon. F. C. Stanley, and Messrs. A. White, H. Holt, W. F. Roch and A. Brooks have resigned from the board and Lord Meston, Sir J. A. Horne, Mr. W. J. Firth and Mr. P. J. Pybus have been elected directors. Economies have been made in administration and an intensive campaign of propaganda is to be carried out.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	.. £45 per ton.
Powder	.. £47 per ton.
Acid Hydrochloric	.. 3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	.. £21 10s.—£27 per ton makers' works, according to district and quality.
Acid Sulphuric ..	.. Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	.. £6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	.. Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	.. £7 per ton, packages extra.
Borax, Commercial—	
Crystal	.. £25 per ton.
Powder	.. £26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	.. £5 17s. 6d. per ton d/d.
Copper Sulphate ..	.. £25 per ton.
Methylated Spirit 64 o.p.—	
Industrial ..	.. 2s. 7d.—2s. 11d. per gallon, according to quantity.
Mineralised ..	.. 3s. 8d.—4s. per gallon, according to quantity.
Nickel Sulphate .. / Nickel Ammon. Sulphate	.. } £38 per ton d/d. Normal business.
Potash Caustic ..	.. £30—£33 per ton.
Potass. Bichromate	.. 5¾d. per lb.
Potass. Chlorate ..	.. 3d.—4d. per lb.
Salammoniac ..	.. £32 per ton d/d.
Salt Cake	.. £3 10s. per ton d/d.
Soda Caustic, solid	.. Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals ..	.. £5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	.. £24 per ton.
Sod. Bicarbonate	.. £10 10s. per ton, carr. paid.
Sod. Bichromate ..	.. 4½d. per lb.
Sod. Bisulphite Powder 60/62%	.. £18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate ..	.. 3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	.. £9 per ton d/d.
Sod Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide— Golden	.. 5¾d.—1s. 4d. per lb., according to quality.
Antimony sulphide— Crimson ..	.. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic, Sulphide, Yellow	1s. 11d. per lb.
Barytes	.. £3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	.. 3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	.. £30—£33 per ton, according to quantity. Again dearer.
Carbon Black ..	.. 7d.—7½d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	.. £60—£65 per ton, according to quantity, drums extra. Again dearer.
Chromium Oxide, green ..	1s. 3d. per lb.
Indiarubber Substitutes White and Dark ..	{ 5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black ..	.. £48 per ton, barrels free. Advanced.
Lead Hyposulphite	.. 7½d. per lb.
Lithopone, 30% ..	.. £22 10s. per ton.
Mineral Rubber "Rubpron"	.. £16 5s. per ton f.o.r. London.
Sulphur	.. £10—£12 per ton, according to quality.
Sulphur Precip. B.P.	.. £56—£57 per ton, according to quantity.
Sulphur Chloride	.. 4d. per lb., carboys extra. Dearer.
Thiocarbanilide ..	.. 2s. 6d. per lb.
Vermilion, pale or deep ..	5s. 1d. per lb. dearer.
Zinc Sulphide ..	.. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	.. £12 per ton.
Grey	.. £16 per ton.
Liquor	.. 9d. per gall. 32° Tw.
Charcoal	.. £7 15s.—£9 5s. per ton, according to grade and locality. Market brisker.
Iron Liquor ..	.. 1s. 7d. per gall. 32° Tw. 1s. 2d. " " 24° Tw.
Red Liquor ..	.. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote ..	.. 2s. 9d. per gall. Unrefined.
Wood Naphtha—	
Miscible ..	.. 4s. 10d. per gall. 60% O.P.
Solvent ..	.. 5s. 3d. per gall. 40% O.P.
Wood Tar ..	.. £4 5s. per ton.
Brown Sugar of Lead	.. £43 per ton. Cheaper.

TAR PRODUCTS

Acid Carbolic—	
Crystals ..	.. 6½d. per lb. Quiet.
Crude 60's ..	.. 1s. 7d.—1s. 11d. per gall, according to district.
Acid Cresylic, 97/99	.. 2s.—2s. 1d. per gall. Demand fair.
Pale 95% ..	.. 1s. 9d.—2s. 1d. per gall. Not much enquiry.
Dark	.. 1s. 9d.—2s. 1d. per gall. Quiet.
Anthracene Paste 40% ..	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained ..	.. 7½d.—9d. per gall. Quiet.
Unstrained ..	.. 6½d.—7½d. per gall.

Benzole—	
Crude 65's	7½d.—9d. per gall. ex works in tank wagons.
Standard Motor	1s. 1½d.—1s. 3d. per gall. ex works in tank wagons.
Pure	1s. 5½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5d.—1s. 5½d. per gall. Small demand.
Pure	1s. 8d.—2s. per gall. Small demand.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	8½d. per gall. Better demand.
Middle Oil Heavy Oil Standard Specification	5d.—6½d. per gall., according to quality and district. Small export inquiry. Market quiet but fairly steady.
Naphtha—	
Solvent 90/160	11d.—1s. 2d. per gall., according to district. Steady market.
Solvent 90/100	11d.—1s. per gall. Not much demand.

Naphthalene Crude—

Market dull. Not much export inquiry. Cheaper in Yorkshire than Lancashire.

Drained Creosote Salts £4—£6. Quiet.

Whizzed or hot pressed £7—£9 per ton.

Naphthalene—	
Crystals and Flaked	£12—£13 per ton.
Pitch, medium soft	55s.—60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160	19s. per gall. Steady demand.
Heavy	12s. per gall. Market dull.

INTERMEDIATES AND DYES

There has been some slight improvement in the business passing for Aniline Dyes.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb.
Acid H.	3s. 11d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 2d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1d. per lb. Improved demand.
Acid Sulphanilic	9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	8d. per lb. naked at works.
Aniline Salts	8½d. per lb., naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4½d. per lb. Rather quiet.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene	9d.—10d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
Monochlorbenzol	£63 per ton.
βNaphthol	1s. per lb. d/d.
αNaphthylamine	1s. 4d. per lb. d/d.
βNaphthylamine	4s. per lb. d/d.
m-Nitraniline	4s. 3d. per lb. d/d.
p-Nitraniline	2s. 3d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. 11d. per lb. 100% basis d/d.
Nitronaphthalene	10½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	3s. 11d. per lb. d/d.
p-Phenylene Diamine	10s. 2d. per lb. 100% basis d/d.
R. Salt	2s. 5d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 3d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 3d.—4s. 2d. per lb. naked at works.
m-Toluylene Diamine	4s. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£45 per ton.
Acid, Acetyl Salicylic	3s. 1d.—3s. 3d. per lb., according to quantity.
Acid, Benzoic B.P.	3s. per lb.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 4½d.—1s. 5d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	6s. 9d. per lb. Resublimed quality 8s. per lb. Market firm; increasing demand.
Acid, Salicylic	1s. 5d.—1s. 8d. per lb., according to quantity.
Acid, Tannic B.P.	2s. 10d. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
Amidopyrin	13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s.—15s. 6d. per lb. Quiet market.
Benzonaphthol	5s. 3d. per lb. Small inquiry.
Bismuth Salts	Prices reduced by about 1s. 3d.—2s. 3d. per lb. on account of the fall in the price of the metal.
Bismuth Carbonate	10s. 6d.—12s. 6d. per lb.
„ Citrate	10s. 3d.—12s. 3d. „
„ Salicylate	9s.—11s. „
„ Subnitrate	8s. 8d.—10s. 8d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Market firm, and Continental prices fully maintained with upward tendency.
Ammonium	1s. 6d.—1s. 9d. per lb.
Potassium	1s. 4d.—1s. 7d. per lb.
Sodium	1s. 5d.—1s. 8d. per lb.
Calcium Lactate	1s. 5d.—1s. 9d., according to quantity. Fair demand and steady market.
Chloral Hydrate	4s.—4s. 3d. per lb. Very firm and scarce.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Formaldehyde	£59 per ton.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	7s. per lb.

Glycerophosphates—	
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. ,,
Guaiacol Carbonate	10s. 6d.—11s. 3d. per lb.
Hexamine	3s. 1d. per lb. and upwards. Market weaker.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£25 per ton, less 2½%. Price reduced.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	56s. per lb.
Synthetic	26s.—31s. per lb., according to quantity. English make.
Mercurials	Market very quiet.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	1s. 9d.—1s. 10d. per lb. Market has weakened.
Methyl Sulphonal	26s. per lb.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 10½d.—3s. per lb. Not very active.
Paraldehyde	1s. 6d. per lb. in free bottles and cases.
Phenacetin	5s. 9d. per lb.
Phenazone	7s. 2d. per lb.
Phenolphthalein	5s. 7d. per lb. in cwt. lots.
Potass. Bitartrate—	
99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Steady market.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included. F.o.r. London.
Potass. Permanganate	7¾d. per lb.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 6d. per lb.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d. per lb.
Silver Proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 6d. per lb. Ample supplies. B.P. quality available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—	
Photographic	£13—£1[illegible] per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Quiet market.
Sod. Salicylate	Market rather easier. Powder 2s. 1d.—2s. 3d. per lb. Crystal at 2s. 3d.—2s. 5d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	15s. per lb. Easier.
Thymol	17s. 6d. per lb. Very scarce indeed.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine	15s. 3d. ,,	
Amyl Acetate	2s. 6d. ,,	
Amyl Butyrate	6s. 9d. ,,	
Amyl Salicylate	3s. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 9d. ,,	
Benzyl Alcohol free from Chlorine	2s. 9d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate	3s. 6d. ,,	
Cinnamic Aldehyde—		
Natural	18s. 9d. ,,	
Coumarin	19s. 6d. ,,	
Citronellol	17s. ,,	
Citral	8s. 6d. ,,	
Ethyl Cinnamate	12s. 6d. ,,	
Ethyl Phthalate	3s. 3d. ,,	
Eugenol	10s. 6d. ,,	
Geraniol (Palmarosa)	35s. ,,	
Geraniol	11s.—18s. 6d. per lb.	
Heliotropine	6s. 9d. ,,	Cheaper.
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose	26s. ,,	
Linalyl Acetate	26s. ,,	
Methyl Anthranilate	9s. 6d. ,,	
Methyl Benzoate	5s. ,,	
Musk Ambrette	45s. ,,	
Musk Xylol	13s. 6d. ,,	Cheaper.
Nerolin	4s. 9d. ,,	
Phenyl Ethyl Acetate	15s. ,,	
Phenyl Ethyl Alcohol	16s. ,,	
Rhodinol	60s. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. 4d. ,,	
Vanillin	26s. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 8d. per lb.
Bergamot Oil	17s. 6d. per lb.
Bourbon Geranium Oil	36s. 0d. per lb.
Camphor Oil	65s. per cwt.
Cananga Oil Java	10s. 6d. per lb.
Cinnamon Oil, Leaf	6½d. per oz.
Cassia Oil, 80/85%	10s. per lb.
Citronella Oil—	
Java 85/90%	5s. 9d. per lb.
Ceylon	3s. 7d. per lb.
Clove Oil	7s. 6d. per lb.
Eucalyptus Oil 70/75%	2s. 3d. per lb. Cheaper.
Lavender Oil—	
French 38/40% Esters	27s. 6d. per lb

Lemon Oil	..	.. 3s. per lb.
Lemongrass Oil	..	.. 4s. 6d. per lb.
Orange Oil, Sweet		... 11s. per lb.
Otto of Rose Oil—		
Bulgarian	..	.. 37s. 6d. per oz. Production below average.
Anatolian	..	.. 18s. per oz.
Palma Rosa Oil	..	.. 16s. 6d. per lb. Cheaper.
Peppermint Oil—		
Wayne County		.. 30s. per lb. Market very active.
Japanese	..	.. 18s. 6d. per lb. Market very active and prices rising.
Petitgrain Oil	..	.. 9s. 3d. per lb.
Sandal Wood Oil—		
Mysore ..	..	.. 26s. 7d. per lb.
Australian	..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Nov. 17th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on October 2nd.

I.—Applications

Barker. Filtering-apparatus. 21,331. Sep. 9.

Blakeley. 21,552. *See* II.

Kiess. Drying kiln. 21,530. Sep. 11.

Marks (Swenson Evaporator Co.). Vacuum evaporating apparatus. 21,674. Sep. 13.

Murphy. Vessels for evaporating liquids etc. 21,274. Sep. 9.

Peddie, and Pirbright Co., Ltd. Filtering apparatus. 21,330. Sep. 9.

Sindl. Centrifuging-apparatus. 21,431, 21,432. Sep. 10. (Czecho-Slovakia, 10 and 11.9.23.)

Smith. Treating liquids. 21,687. Sep. 13.

Walker. 21,641. *See* XI.

I.—Complete Specifications Accepted

17,537 (1923). Huebner and Ardern. *See* V.

29,376 (1923). Lemale. Separating the volatile ingredients of a liquid mixture. (216,834.)

8281 (1924). Burt, Boulton and Haywood, Ltd., and Chinn. Producing disruptive forces in films of liquid or suspensions. (221,442.)

II. Applications

Blakeley. Apparatus for cleaning gas. 21,552. Sep. 12.

Briscoe. Gas-purifying apparatus. 21,661. Sep. 13.

Coley and Vekwick. 21,393. *See* III.

Illingworth Carbonization Co., Ltd., and Illingworth. Apparatus for drying etc. coal etc. 21,324. Sep. 9.

Morowski. Gas-producers. 21,212. Sep. 8. (Austria, 7.9.23.)

Quick. 21,659. *See* XII.

Warmut. Gas-producer. 21,118. Sep. 8.

II.—Complete Specifications Accepted

6434 (1923). Becker. Coking retort ovens. (205,459.)

12,403 (1923). Holmes and Co., Ltd., and Cox. Gas purification. (221,250.)

29,536 (1923). Dicker (S. E. Co.). Processes of carbonising. (221,388.)

6223 (1924). Rice. Solid fuel. (221,432.)

III.—Application

Coley and Vekwick. Production of hydrocarbons. 21,393. Sep. 10.

III.—Complete Specifications Accepted

28,065 (1923). Low. Manufacture of emulsions or solutions of tar or the like. (221,380.)

4433 (1923). Butler and Popham. Preparation of mixtures of tar and bitumen etc. (221,234.)

IV.—Applications

British Celanese, Ltd., Walker, Hall, and Ellis. Manufacture of basic derivatives of the aromatic series. 21,496. Sep. 11.

Morton Sundour Fabrics, Ltd., and Wilson. Dyes and dyeing. 21,198. Sep. 8.

Scottish Dyes, Ltd., and Thomas. Dyestuff intermediates. 21,197. Sep. 8.

IV.—Complete Specification Accepted

2474 (1924). Imray (Soc. of Chemical Industry in Basle). Manufacture of indigoid dyestuffs. (221,418.)

V.—Applications

Comp. Gén. des Industries Textiles, and Duhamel. Washing wool, silk, etc. 21,209. Sep. 8. (Fr., 7.9.23.)

Dreyfus. Manufacture of cellulose derivatives. 21,164. Sep. 8.

Marx. Manufacture of paper, board, etc. 21,497. Sep. 11.

Sindl. Spinning tank for manufacture of artificial silk etc. 21,433. Sep. 10. (Czecho-Slovakia. 11.9.23.)

Trotman (Trotman). Preparation of unshrinkable wool etc. 21,192. Sep. 8.

V.—Complete Specifications Accepted

15,696 (1923). Mackenzie, Robinson, Lumsden, and Fort. Treatment of yarns and fabrics composed of vegetable fibres. (221,296.)

17,537 (1923). Huebner and Ardern. Extraction of liquids from paper pulp, sewage sludges and the like by means of suction. (221,311.)

3572 (1924). Weitzel. Treatment of woollens to prevent shrinkage. (221,422.)

VI.—Applications

Morton Sundour Fabrics, Ltd., and Wilson. 21,198. *See* IV.

Wilkinson. Dyeing textile fabrics. 21,534. Sep. 11.

VI.—Complete Specifications Accepted

15,696 (1923). Mackenzie, Robinson, Lumsden, and Fort. *See* V.

22,018 (1923). Durand et Huguenin Soc. Anon. Dyeing and printing of textile goods etc. (203,681.)

24,121 (1923). Johnson (Badische Anilin & Soda Fabrik). Production of dyeings on fibre. (221,359.)

VII. Applications

Higgins. Treatment of natural base exchange zeolite-like materials. 21,400. Sep. 10.

Kersten. Decomposition of the alkali chlorides. 21,186. Sep. 8.

Naamlooze Vennootschap Philips' Gloeilampenfabrieken. Process for separating mixture of zirconium and hafnium halogenides. 21,219. Sep. 8. (Holland, 15.9.23.)

Nihoul. Manufacture of magnesium salts. 21,182. Sep. 8. (Fr., 19.9.23.)

VII.—Complete Specification Accepted

14,293 (1923). Marks (Grasselli Chemical Co.). Manufacture of concentrated acetic acid. (221,256.)

VIII. Applications

Bayerische Spiegelglasfabriken Bechmann-Kupfer Akt.-Ges. Production of silver coating on glass. 21,188. Sep. 8. (Ger., 19.9.23.)

British Thomson-Houston Co., Ltd. Working quartz. 21,597. Sep. 12. (U.S., 20.9.23.)

IX.—Application

Bayer. Manufacture of porous building-materials. 21,203. Sep. 8. (Denmark, 21.1.24.)

IX.—Complete Specification Accepted

21,830 (1923). Laurie. Preservation of stone. (221,342.)

X.—Applications

Coley. Manufacture of tin. 21,392. Sep. 10.

Croese. Manufacture of high-grade steel etc. 21,476. Sep. 11.

Hargreaves and Hutchins. Electrodeposition of metals. 21,602. Sep. 12.

Potter (Madsenell Corporation). Electro-depositing nickel metals. 21,486, 21,487. Sep. 11.

Potter (Madsenell Corporation). Treating ferrous metal objects. 21,488. Sep. 11.

Rushen (Krupp Grusonwerk Akt.-Ges.). Treatment of ores etc. 21,208. Sep. 8.

XI.—Applications

Hargreaves and Hutchins. 21,602. *See* X.

Metropolitan-Vickers Electrical Co., Ltd. Manufacture of materials for electrical resistors. 21,376. Sep. 10. (U.S., 12.9.23.)

Potter (Madsenell Corporation). 21,486, 21,487. *See* X.

Walker. Electrostatic separators. 21,641. Sep. 13.

XII.—Application

Quick. Process for refining oils etc. 21,659. Sep. 13.

XIII.—Application

Alexander (Stokes). Synthetic resin composition. 21,297. Sep. 9.

XIII.—Complete Specification Accepted

20,865 (1923). British Thomson-Houston Co., Ltd. (General Electric Co.). Coating compositions. (221,334.)

XIV.—Application

British Dyestuffs Corporation, Ltd., Cronshaw, and Naunton. Manufacture of accelerators etc. for vulcanisation of rubber. 21,296. Sep. 9.

XIV.—Complete Specification Accepted

3575 (1924). K. D. P., Ltd. Manufacture of gutta-percha, balata, etc. (214,583.)

XV.—Complete Specifications Accepted

14,998 (1923). Leonhardt. Preparation of sizing-glue or the like. (221,279.)

4183 (1924). Nelson, Dale and Co., Ltd. Manufacturing thin sheets of gelatine. (215,320.)

XVIII.—Application

Langwell. Fermentation processes. 21,414. Sep. 10.

XIX.—Applications

Higgins. 21,400. *See* VII.

Morris and Zeeman. Food preserving. 21,395. Sep. 10.

Schicht Akt.-Ges. Preparation of phosphatides. 21,315. Sep. 9. (Czecho-Slovakia, 27.9.23.)

XIX.—Complete Specification Accepted

17,537 (1923). Huebner and Ardern. *See* V.

XX.—Application

British Celanese, Ltd., Walker, Hall, and Ellis. 21,496. *See* IV.

XX.—Complete Specification Accepted

14,293 (1923). Marks (Grasselli Chemical Co.). *See* VII.

XXI.—Complete Specification Accepted

13,595 (1924). Kodak, Ltd. Photographic reversal processes. (218,632.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number :—*Australia* : Glassware (301) ; Steel (Official Secretary, Commercial Bureau, Australia House, Strand, London, W.C. 2, Ref. 412/7/1/1/287) ; *Brazil* : Paints (B.X./1170) ; *British India* : Steel (Director General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1) ; *Netherlands* : Ironware, iron (314), cutlery (315) ; *New Zealand* : Scientific instruments (B.X. 1236) ; *South Africa* : Agricultural implements, fertilisers (306).

Glue and Gelatin Output in the United States, 1923

The Department of Commerce, Washington, announces that, according to data collected in the biennial census of manufacturers, 1923, the fifty establishments engaged primarily in the manufacture of glue and gelatin reported products valued at $24,366,097, an increase of 14·2 per cent. as compared with 1921, the last preceding census year. In addition glue and gelatin are manufactured to a considerable extent as secondary products by establishments engaged primarily in other industries, principally slaughtering and meat packing and the manufacture of fertiliser. The value of these commodities thus produced outside the industry proper in 1921 was $4,277,256, an amount equal to 20 per cent. of the total value of products reported for the industry as classified. The corresponding value for 1923 has not yet been ascertained, but will be shown in the final reports of the present census. The statistics for 1923 and 1921 are summarised in the following statement, the figures for 1921 being given in brackets : Number of establishments, 50 (47) ; wage earners, average number, 3651 (2915) ; wages, $4,075,904 ($3,573,149) ; cost of materials (including fuel and containers), $14,590,638 ($13,401,858) ; products, total value, $24,366,097 ($21,342,004) ; fish glue, $2,355,041 ($1,693,946) ; animal glue, $13,702,570 and glue (other than fish or animal), $4,633,829 ($13,433,718) ; all other products, $3,674,567 ($6,214,340) ; value added by manufacture, $9,775,459 ($7,940,146).—(*Oil, Paint and Drug Rep., Sept.* 8, 1924.)

PUBLICATIONS RECEIVED

CARBID UND ACETYLEN ALS AUSGANGSMATERIAL FÜR PRODUKTE DER CHEMISCHEN INDUSTRIE. By Prof. J. H. Vogel-Berlin and Dr. A. Schulze-Altenburg. Pp. 130. Leipzig: Otto Spamer, 1924. Price, paper 5 goldmarks, bound 6·50 gm.

REPORT ON THE ECONOMIC AND FINANCIAL SITUATION OF EGYPT, dated April, 1924. By E. Homan Mulock. Department of Overseas Trade. Pp. 55. H.M. Stationery Office, 1924. Price 1s. 6d. net.

THE TRANSPIRATION STREAM. By H. H. Dixon, D.Sc., F.R.S. Pp. 80. London: University of London Press, Ltd., 1924. Price 2s. 6d.

MESSRS. J. & A. CHURCHILL announce that they have in the press, and hope to publish early in 1925, a "Dictionary of Perfumery," by Ernest J. Parry, B.Sc. The work will be in two volumes, and will deal with the raw materials of the perfumery trade and with allied subjects from the points of view of the chemist, the manufacturer and the user. Special articles, which will appear over the writers' signatures, have been contributed by Messrs. A. C. Marrin, C. T. Bennett, B.Sc., T. H. Durrans, M.Sc., M. Dewhirst, B.Sc., A. Garden, B.Sc., M. Salamon, B.Sc., and W. H. Simmons, B.Sc.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

VOL. 43 NEW SERIES | LONDON, AUGUST 1, 1924 | NO. 31

EDITORIAL

WE notice in *Industrial and Engineering Chemistry* for July a letter from Prof. Noyes in which he alludes to his article on a "Political Platform for the International Union of Pure and Applied Chemistry," and to our editorial comments on this topic. He claims to detect a change in our opinions on this matter; we do not attach any importance to our opinions, the chemical world will not be diverted from its ordained path by any utterances on our part, our editorial effusions do not represent the considered judgments of the Society of Chemical Industry nor those of the Federal Council. As our correspondent Mr. Williams points out in this week's issue, chemists are human beings and cannot divest themselves of their humanity or inhumanity however much chemistry is absorbed by them or adheres to them. We do not think our opinions are worthy of the publicity which Prof. Noyes has given to them, but as a matter of fact we are not conscious of any change in them. The question is an important one, however trivial may be our individual views. Our previous editorials have dealt with two aspects of the problem. The first, only briefly and casually referred to, the origin and conduct of the war, we do not consider to be suitable for discussion in these columns. We are all of us entitled to our own opinions on this matter and we shall have them whether we are entitled to them or not. Prof. Noyes as an American will doubtless accept this well-known American dictum. Our opinion on this matter we think remains as strong as it was and is not likely to alter. The other aspect is the policy to be adopted by the Union Internationale; there is no doubt that this is undergoing or has undergone a change. We have on more than one occasion stated that in our opinion this is of more consequence to our French and Belgian allies than to British chemists, and we have mildly hinted that we should neither urge nor advise the French and Belgian chemists to adopt any particular course. We venture to think that neither the British nor the American chemists are likely to influence French and Belgian chemists in this matter. If our allies feel bitter they will not diminish their bitterness because the British and Americans feel less bitter. If our allies on the other hand are disposed to welcome chemists of all nations to the Union Internationale they will do this when they themselves feel disposed and not when we feel disposed. In our consideration of this particular problem we are ignoring entirely the future relations between the various European countries, we put on one side invasions and occupations, defaults, loans and reparations, these are not the concern of the Union Internationale; individual chemists may think what they please and advocate what they please about these; in their corporate capacity as members of the Union they should consider what is the policy which will be of the greatest benefit to the Union. We are not, of course, claiming that the French and Belgians are to be the sole judges of the future of the Union; we are merely claiming that at the present time and in view of what has been discussed and the temper in which the discussion has taken place the most prudent and sensible course is for the British and American chemists to leave the problem alone for a while and that so far as chemical journals are concerned the less we discuss in them the causes of the lack of confidence on both the French and German sides the less likely are we to make statements which will hinder the future prosperity of the Union Internationale.

* * *

It was our intention, until to-day, to deal this week with the chemistry of Yadil, but as we see from the daily press that the proprietors of that antiseptic mixture have issued a writ for libel against the *Daily Mail*, Sir William Pope and Professor Dixon, we are compelled to hold over this

interesting topic. We have no wish to be guilty of contempt of court in discussing proceedings which will be left for the courts to determine, nor do we think that the Society of Chemical Industry would be extremely grateful for the opportunity of indulging in litigation itself while other people are willing to cultivate this exciting and pleasing hobby. It seems to be common ground to both plaintiffs and defendants that formaldehyde and oil of garlic are essential to the manufacture of Yadil Sir William Pope gave an approximate estimate of the percentage of oil of garlic ; the proprietors of Yadil in a communication to the daily press are more precise, they say "roughly one ounce of oil of garlic to every 5481 ounces of Yadil." No doubt when the case comes to trial we shall have this proportion not "roughly" but with a degree of precision represented by three or four more places of decimals. It is well to be precise when dealing with figures : it is not only scientific but is also impressive Many a limited company shows its book debts to the exact penny, say an accuracy of one part in two hundred millions, while it over-estimates its stock or goodwill by fifty or seventy-five per cent. The proprietors of Yadil claim that they make use, not of the injurious formaldehyde, but of the innocuous paraformaldehyde or trioxymethylene, which they call trimethanal. We have but little acquaintance with this latter substance : according to Richter it is distinguished by its insolubility in water, alcohol and ether. We suppose it is more soluble in a dilute solution of glycerine but this also is a matter for the courts. An agreeable vista of examination, cross-examination and re-examination is opened to us whereby chemical knowledge will be increased.

*   *   *

This week has opened with one of those announcements that cause chemists to refer to back numbers of *Chemistry and Industry* and prepare poison gases. Such an announcement could have to do with but a few subjects, and of those, what more prolific of discussion than the utilisation of coal ? An official statement has been issued to the daily press, according to which the Mines Department and the Department of Scientific and Industrial Research have been giving "careful attention to the best means of using the national coal resources," and it seems to have been discovered that "at the back of all is the problem of how best to unlock the heat in the coal" At the instance of the two departments, so the statement runs, the Government has decided to provide at once for the rapid development of the chemical and physical survey of the coal seams with a view to the best use of the national coal resources. In addition, it is intended to encourage all promising new processes for the carbonisation of coal at low temperatures, which have reached the stage of commercial production. Provision will thus be made for the establishment of more of the local committees of coal owners and technical experts which have already done much valuable work in classifying the coal seams by means of physical and chemical tests. Further, "as it is evident that the technical problems of carbonising coal at low temperatures have been solved, but that before we can safely introduce the process with a prospect of financial success, further large-scale work—mainly on engineering problems—remains to be done," the scheme offers, on the engineering side, the assistance, at the cost of public funds, of the Fuel Research Station in the examination of promising processes under conditions which will shortly be made public.

*   *   *

It is, of course, highly desirable that we should possess full information on the extent and characters of our coal resources. More ample knowledge of this kind would prevent much waste and it should in time lead to the purchase of coal on the basis of analysis, as well as to the proper utilisation of the lower grades, too often wasted. Indeed, the object of the offer of assistance to processes for low-temperature carbonisation is largely to facilitate the use of the lower-grade coals for the production of smokeless fuel and of fuel oils. In these columns we have from time to time commented on various aspects of the fuel problem, we have toyed in our sanctum with dreams of cloudless untainted skies, we have waxed enthusiastic over various developments that promise solutions. In a thick and cloudy air, said an old writer, men are sad and peevish ; and if the Western winds blow and that there be a calm or a fair sunshine day, there is a kind of alacrity in men's minds ; it cheers up men and beasts ; but if it be a turbulent, cloudy, stormy weather, men are sad, lumpish, angry, dull, and melancholy. But it was also pleaded that "fire and smoke qualify the air," and it was supposed that "a thick foggy air helps the memory, as in them of Pisa in Italy." Nowadays, we know full well the benefits of pure air, but in respect of the carbonisation of coal we have as many opinions as had the men of old about air. The gas industry has strong ideas on the subject and one may expect some highly interesting encounters. It is not likely that any one solution will appeal to all coal users or proprietors, but we are assured that the attempt is to be made to solve the problem on a scale of national importance, for "only in this way can any ultimate effect on the state of employment and the industrial prosperity of the country be produced" This is no time for destructive criticism. There are ample signs, as our correspondence columns bear witness, that there is a growing uneasiness at the continued waste of coal. We are hopeful that the murmured "something is going to be done" will now be transformed into an actual accomplishment. Many of the data are collected, the scientific knowledge of coal and its problems has grown amazingly, low-temperature carbonisation is being applied in Nottingham, and the Government is now giving a hand. Manchester is no doubt already calculating the saving that will result, and Sheffield may look skywards uneasily, foreboding the disappearance of its familiar pall. And if Sir George Beilby looks out into the future through the mist and wet of what should be a brilliant July morning, he must indeed be a happy man.

THE THEORY OF THE "BENSON" SUPER-PRESSURE STEAM GENERATOR

(From a Correspondent)

It will not be without interest, following upon a previous article in *Chemistry and Industry* (March 7), to consider a little more in detail the scientific principles underlying the design of the remarkable "Benson" super-pressure steam generator, in which water is converted into steam without the absorption of latent heat under the critical conditions of approximately 3200 lb. pressure per sq. inch and a temperature of 706° F. (375° C.).

As will be remembered, the installation consists of a series of coils of $\frac{3}{4}$ in. steel tubing arranged vertically, through which distilled water is being passed continuously at 3200 lb. pressure by means of a gear-driven force pump. The coils are heated by an oil or pulverised-fuel flame blast, using hot air for combustion, and towards the end of the travel the water attains a temperature of 706° F. (375° C.), and is bodily converted into steam without ebullition or boiling, and therefore without the absorption of latent heat. The steam is then discharged at a slight superheat 720° F. (385° C.) through a reducing valve, being thereby reduced in temperature to about 620° F. (330° C.), and into a second series of coils forming a superheater, in which it is heated to an average of 850° F. (455° C.), and finally discharged at this temperature and 1500 lb. pressure to the turbine or other source of use.

The essential reason underlying the design of the "Benson" generator and the employment of 3200 lb. pressure is to obtain on a practical scale very high pressure steam with the aid of the coil generator or "boiler." The elimination of latent heat in itself does not result in any higher efficiency in the condensing turbine, the heat being of course lost in the condenser just the same. That is to say, the increase in theoretical efficiency to be obtained by using steam at 3200 lb. pressure, as compared with say 2750 lb., is very small. The practical difference, however, is enormous, because in the first case no latent heat of steam is required and a coil generator can be used, whereas in the second case the latent heat of steam is about 290 B.Th.U. (from 1 lb. of water at 32° F.), so that ebullition or boiling accompanies the generation of the steam, and a coil generator consequently is not practicable.

The main difficulty with the use of high-pressure steam has always been to construct a boiler to stand the conditions, and 127 years of evolution—since 1797 when Richard Trevithick invented the "Cornish" boiler, worked at 25 lb. pressure—has only resulted in the average industrial steam pressure being to-day, say, 100—160 lb., ordinary power station pressures 160—220 lb., and the modern super-power station 350 lb. Whilst a few water-tube boilers are now constructed to work up to about 600 lb. and even 800—1200 lb. as an experiment, for several thousand pounds pressure it is necessary to use narrow bore coils to reduce the area that has to stand the strain, and incidentally also to eliminate the element of danger by having an extremely small water content. A steel tube can be constructed to stand thousands of lbs. per square inch pressure, and the present "Benson" generator was put on hydraulic test by the insurance company to 6400 lb. per square inch for twenty minutes without a trace of leakage.

But the absorption of latent heat has hitherto proved an insurmountable obstacle to the use of the coil generator, because particles of liquid (water) are converted into comparatively large bubbles of gas (steam) of much greater volume, so that in a narrow bore coil the whole water contents are blown out. Mr. Benson has solved this problem by a thorough consideration of the properties of steam. As the pressure rises, the latent heat, which is 966·6 units under atmospheric conditions, diminishes, since the change in volume between water and steam becomes less and less. The ordinary steam tables do not show this as they seldom go above 250 lb. pressure, and it is necessary to study some publication such as Goodenough's "Properties of Steam and Ammonia" (John Wiley or Chapman and Hall). The following typical figures illustrate the reduction in the latent heat as the pressure rises :—

(1 lb. Water at 32° F.)

Absolute pressure, lb. per sq. in.	Saturated Steam Temperature, ° F.	Sensible heat from 32° F.	Latent heat B.Th.U.
114·9	338	308·5	882·2
361·6	435	411·4	791·2
538·7	475	455	745·8
1093·0	550	544	644·8
1785	620	633	518
2369	660	700	412
2880	690	770	280
3075	700	820	198
3206	706·3	924	Nil

Mr. Benson has therefore completely solved the problem by going right up to the critical conditions when no latent heat at all is required, since the steam is at the same volume as the water (three times that of 60° F.), and therefore no ebullition takes place. Once steam is formed, and what is the essential difference between a liquid and a gas is outside the scope of this article, then we can do what we like in the way of superheating or reducing the pressure.

To calculate the amount of the increase in thermal efficiency by raising the steam pressure to 1500 lb. or over is a complicated question, and it is best obtained from a series of Rankine cycles plotted for different pressures at constant total heat of steam on temperature entropy diagrams, both of course under adibatic (or theoretically perfect) expansions. Thus taking a total heat of steam at 1350 B.Th.U. calculated from 32° F., and superheating as required to attain the given total heat, at 100 lb. pressure only 400 B.ThU. (29·6 per cent.) is theoretically available for actual work in expanding down to a vacuum (29 in.), whereas at 350 lb. the figure is 468 B.Th.U. (34·7 per cent.), and at 3200 lb. 595 B.Th.U. (44·0 per cent.).

Practically, of course, there is a considerable loss for various reasons, but the matter can be concisely expressed by saying that the ordinary high-class industrial steam engine or turbine is running at 10—11 per cent. thermal efficiency from the coal, the most modern super-power station 17—19 per cent. (an exceptional figure), whereas a large

"Benson" generator plant would give 28—30 per cent., an amazing advance. In other words, we can now generate power from raw coal, using a condensing unit and pulverised fuel for heating, at an efficiency equal to the Diesel engine with oil, and the principle is equally revolutionary applied to land, marine, locomotive and motor-car work. In addition, the use of the exhaust steam from the turbine in boiling and process work, as in the chemical industries, would apparently give an over-all thermal efficiency of something like 80—85 per cent. since no heat is lost in the condenser.

THE FATTY ACID MOLECULE

By T. W. JONES, B.Sc.

Examination of the fatty acids, their salts and esters by the method of X-ray analysis has but confirmed the correctness of the structures already ascribed to them on purely chemical reasoning. The long rectilinear CH_2-chain formation of these compounds has long been accepted on theoretical grounds. Direct experimental proof, we know, has a satisfaction not possessed by any theory, however plausibly it may fit the facts. Langmuir and Adams gave us a clear picture of the results of spreading oil on water, and that the fatty acid molecule then stood on its head so to speak, the COOH group in the water and the rest of the chain erected vertically. The clue to another line of experiment was given by Friedel's hypothesis of a meso-morphic state of matter; a sort of half-way house between the crystalline and amorphous conditions. In this state, matter may be in two phases, the nematic and the smectic. Among the bodies said to assume the smectic phase on solidification are the soaps; these are optically positive, possess a high viscosity and are quite rigid except in the direction of their optical axis. They should, therefore, consist of a regular formation of equi-distant molecular layers and be capable of diffracting X-rays in a manner similar to that of the reticular parallel planes of a crystal system.

The correctness of this hypothesis was proved by M. Friedel and le duc de Broglie (*Comptes Rendus*, 1923), and they found, in the X-ray spectrum from the cleavage plane of a lamina of sodium oleate, a predominant line corresponding to a spacing of 40 A.U. between two homologous points of two successive layers of the lamina. They formed the opinion that the long CH_2-chains of the sodium oleate molecules were arranged parallel to the optical axis and that the spacing was at least equal to the length of these chains and large compared to the atomic distances.

Messrs. Piper and Grindley in their X-ray examination of the fibres so often observed in soap curds, obtained (*Proc. Phys. Soc. Lond.*, 1923 **35**, 269) lines corresponding to spacings of 33·5 A.U., 38·5 A.U., and 43·5 A.U. for the sodium salts of lauric, myristic and palmitic acids respectively. These spacings are of the same order as that obtained by the two previous workers for sodium-oleate curd. In addition they show a regular increase in length with the increase of the CH_2-chain of the acid. Muller and Shearer (*J.C.S.*, 1923, **123**, 2043 and 3156) obtained spacings of the same order, and showing a uniform increase with increase in the CH_2-chain, from their examination of the pure saturated fatty acids. Shearer, in his work on the esters of the fatty acids (*J.C.S.*, 1923, **123**, 3152), observed spacings concordant with each other, but considerably smaller than those found for the acids themselves, or for their sodium salts. For example his figures for the esters of palmitic and stearic acids were:—

Methyl palmitate 22 A.U. Methyl stearate 24·0 A.U.
Ethyl ,, 23·2 A.U. Ethyl ,, 25·2 A.U.

whilst Muller's figures for free palmitic and stearic acids were 34·7 A.U. and 38·7 A.U. respectively. Shearer's figures also bring out the regular increase of the spacing with increase of the ester CH_2 chain both on the acid side and the ester side of the COO-group.

In addition to these lines corresponding to the wide spacing all the investigators have found in each spectrum observed two other lines corresponding to spacings in the laminae of the order 4 A.U. Thus Piper and Grindley observed spacings of 4·9 A.U. and 4·2 A.U. for the sodium salts examined. These were constant, *i.e.*, they did not vary for the different salts. Shearer and Muller found similar spacings of 3·7 A.U. and 4·1 A.U. respectively, which were constant for all the acids and esters examined. These shorter spacings, it would appear, correspond to the cross-section of the unit cell of these smectic bodies, as the longer spacing corresponds to their length. The unit cell would appear, therefore, to be a long prism of the same effective cross-section for all the acids, esters and sodium salts examined, and containing one or more molecules, as we shall presently see. According to Piper and Grindley the rectangular shape of the cross-section can be accounted for on the accepted distribution of the COOH-group as being

$$\begin{array}{c}C\text{-}O\text{-}H\\ \|\\ O\end{array}$$

and it is quite conceivable that a group so distributed would have an effective width in its plane greater than in a direction at right angles to it.

The constancy of these narrow spacings as compared with the variability of the larger spacing with changes in the number of carbon atoms in the chain agrees with the chemical view that additional CH_2-groups increase the fatty acid molecule in one direction only. As the X-ray spectrometer only measures the perpendicular distance between two *identical* planes of the crystal, it is probable that the spacing of any plane will have in general only an approximate connexion with the actual molecular dimensions. That this is so is obvious from a comparison of these observed spacings and the dimensions for the molecule given by Langmuir (*J. Amer. C. S.*, 1917, 39, 1865). His value for the length of the palmitic acid molecule is 24 A.U., whilst Muller's observed spacing is 34·7 A.U. The latter figure is too great to allow of the unit cell containing one such molecule and too small for two. Again, taking

the accepted diameter of the carbon atom (1·5 A.U.) and calculating the length of a palmitic-acid molecule in which the carbon atoms are piled upon top of one another, we obtain a figure widely different from Muller's value. It is, however, possible to imagine the unit cell as containing two molecules if these are shortened in length by the adoption of a zig-zag configuration of the CH_2-chain. Such an arrangement of two molecules to a cell is a very common one in crystal structure. On the assumption that the carbon atoms are arranged in a zig-zag pattern, it is possible to calculate the angle θ between successive pairs

sin $\theta/_2$=1·5/4·22 or θ 109°30′, which is almost exactly the angle 109°28′ which the normals from the centre to the faces of a tetrahedron make with one another. The configuration adopted must, therefore, permit this angle between successive carbon atoms and must, moreover, give the observed increase with each additional carbon atom.

Shearer (*ibid*) finds an increase of 1·22 A.U. for each extra CH_2-group in the ester chains, whilst Muller finds with the acids an increase of 2·0 A.U. for each increase of two carbon atoms. Of this 2·0 A.U. one carbon contributes, he thinks, 1·5 A.U. and the other 0·5 A.U. Evidence, therefore, points to the existence of two types of chains. The first, which would apply to the esters, would be an ordinary zig-zag in which the angle between successive carbon atoms would be 109°30′. This gives an increase of 1·22 A.U. for each extra CH_2-group. In the other the carbon atoms are arranged in a spiral formation in sets of four, the fifth being directly over the first: each set of four need not, however, be in the same plane as the preceding four. In such a configuration each additional two CH_2-groups contribute 2·0 A.U. to the length of the chain, one of them adding 1·5 A.U. and the other 0·5 A.U. This would agree with the results found for the acids and sodium salts.

Both these types of increase are found in the diamond structure, which, in addition to the closed rings, comprises chains showing increases of 1·22 A.U. for each carbon atom increase and 2·0 for each increase of two carbon atoms.

If the configuration of the acids is as suggested, there should be a difference in the experimental results from odd and even acids of the same series. The difference, however, is as yet unascertainable, as it lies within the range of present experimental error. But it is a significant fact that if the spacings of the odd acids are plotted on a diagram, similar to that used to represent the increase in the spacing of the even acids against the increase in the CH_2-chain, the points representing them lie just above the line of the even acids. This is in accord with the theory put forward by Garner and Randall (*J.C.S.*, 1924, **124**, 881) to explain the existence of the two enantiotropic forms of the odd acids. They find that the sum of the heat of transition of the α-form of the odd acids of a series into the β-form and the heat of crystallisation of the α-form correspond approximately with the heat of crystallisation of the β-form. Also the heats of crystallisation of the α-form of the even acids and the β-form of the odd acids lie very nearly on a smooth curve, and it is therefore suggested that the two forms have a similar constitution in the solid state and give the acids the following configurations:—

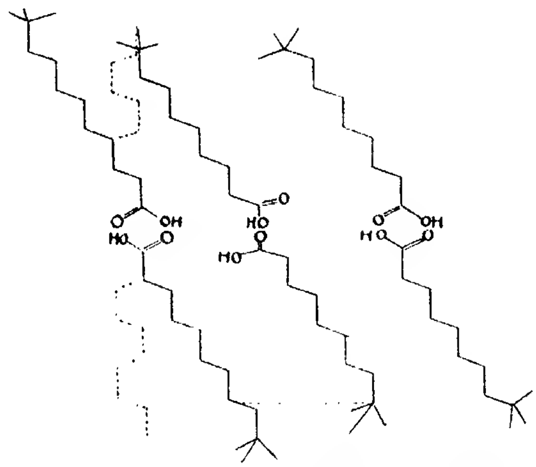


FIG. I α-Even FIG. II α-Odd FIG. III β-Odd

It is obvious that the carboxyl groups play an important part in this alternation, and it is possible that this group is orientated in two different ways, in the odd and even acids. The symmetrical forms of Figs. 1 and 2 would be formed with a larger amount of heat as required by experiment.

In the acids and sodium salts the molecules would, by reason of the affinity of the CH_3 groups for each other, orientate themselves with these groups in contact inwards. The planes containing the sodium atoms would, therefore, be the planes of slip required by Friedel's theory. The exact conformation of the diagrams given by Randall and Garner are slightly different from those shown by Muller and Shearer (dotted lines), but they agree equally well with the dimensions experimentally found. Furthermore, they bring out more clearly than the latter the fact that the general direction of the length of the molecule need not necessarily be perpendicular to the cleavage plane, although to account for the uniform increase in spacing of this plane for each additional CH_2-group, it must be supposed that the molecules of any one series are all inclined at the same angle to this plane.

From considerations of the shortness of the long spacings and the fact that an additional CH_2-group gives an increase of half that found for the same increase in the acids, it appears that the esters contain but one molecule per unit cell. That the molecule does not bend at the COO-group but continues in the same direction is borne out by the fact that increases in either acid or ester chain result equally in a lengthening of the spacing. So that the X-rays measure the distance between the COO-

groups and the molecules are arranged as :—

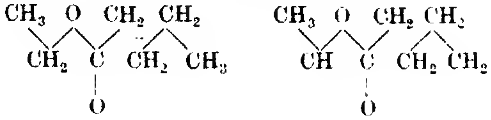


Fig. IV

Measurements of the spacings of ring-chain compounds such as *p*-hexadecyl-phenol and *p*-octadecyl-phenol indicate a similar uniform increase for additional CH_2-groups, but the experimental accuracy is not sufficient to permit a definite statement as to the type of chain present.

From evidence gained from the unsaturated acids elaidic and brassidic it seems probable that a fuller examination will but confirm chemical theories of the nature of the unsaturated linkages. For example, the wide spacing of elaidic acid, stereo-isomeric with oleic acid, is about 9 A U longer than that of stearic acid, which contains the same number (18) of carbon atoms. The smaller spacings corresponding to the cross-section of the cell are, however, the same as those already found for the saturated acids.

BRITISH CAST-IRON RESEARCH ASSOCIATION LABORATORIES

A further stage in the development of the Cast Iron Research Association was reached a few days ago when the Association formally took possession of its own Laboratories, situated in Guidford Street, Birmingham, and equipped for the conduct of chemical analyses and general metallurgical and heat-treatment work. The capacity of the Association to deal with its work will be greatly increased, but it is not intended to abandon the policy of having investigations conducted in prominent University laboratories and in the works of members.

It is anticipated that the Association, which commenced a new financial year on July 1, will incur an expenditure during the year of between £6000 and £7000. The research programme includes important investigations on erosion- and corrosion-resisting cast irons; moulding sands; graphitisation heat-resisting cast iron; the production of malleable cast iron; cupola practice; cast irons for electrical and magnetic purposes: measurement of melting and pouring temperatures; the fundamental properties of cast iron; standardisation of test bars, materials and methods; facing sands and backings, and cast iron to resist abrasive wear, and jointly with the British Motor and Allied Manufacturers Research Association, automobile cylinders and pistons.

Recent new members include the Brightside Foundry and Engineering Co., Ltd., Sheffield; Powell Duffryn Steam Coal Co., Ltd., Glamorgan; Boving Engineering Works, Ltd., Stoke-on-Trent; J. Blakeborough and Sons, Ltd., Brighouse, Yorks; J. W. Jackman and Co., Ltd., Manchester, and Younger and Gallon, Dunston-on-Tyne.

FORTHCOMING EVENTS

Sept. 4 and 5. Iron and Steel Institute, Autumn Meeting at British Empire Exhibition, at 10.30 a.m. each day. (1) "Changes of Volume of Steels During Heat Treatment," by L. Aitchison and G. R. Woodvine. (2) "Investigations on the Herbert Pendulum Hardness Tester," by C. Benedicks and V. Christiansen. (3) "Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on some Magnetic Properties of Steel," by E. D. Campbell and G. W. Whitney. (4) "Pickling: The Action of Acid on Iron and Steel, and the Diffusion of Hydrogen Through the Metal," by C. A. Edwards. (5) "Examination of Iron from Konarak," by J. N. Friend and W. E. Thorneycroft. (6) "On the Nature of High-Speed Steel," by M. A. Grossman and E. C. Bain. (7) "Improvements in the Brinell Test on Hardened Steel, including a New Method for Producing Hard Steel Balls," by A. Hultgren. (8) "Present Position of the Theories of the Hardening of Steel," by W. Rosenhain. (9) "Effect of Free Surfaces on the Plastic Deformation of Certain Metals," by F. C. Thompson and W. E. W. Millington.

Sept. 8 to 11. Institute of Metals, Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at the British Empire Exhibition. On September 10 further papers will be presented for discussion, the afternoon being devoted to visits to works. A reception will be held in the evening at the National Physical Laboratory, Teddington.

The following papers will be read.—"A Method for Measuring Internal Stress in Brass Tubes," by R. J. Anderson and E. G. Fahlman. "The Application of the Ideal Solubility Curve to the Interpretation of Equilibrium Diagrams in Metal Systems," by D. H. Andrews and Prof. J. Johnston; "Seventh Report of the Corrosion Research Committee of the Institute of Metals," by G. D. Bengough and R. May; "Comparative Results on Copper-Silicon-Aluminium and Other Aluminium Alloys as Obtained on Separately Cast Specimens and Specimens cut from a Crankcase Casting," by E. H. Dix and A. J. Lyon; "The Determination of Sodium in Aluminium," by D. M. Fairlie and G. B. Brook; "The Extrusion of Brass Rod by the Inverted Process," by R. Genders; "Investigation of the Effects of Impurities on Copper. Part II—The Effect of Iron on Copper," by D. Hanson and Grace W. Ford; "The Relationship Between Tensile Strength, Temperature and Cold-Work in Some Pure Metals and Single Solid Solutions," by D. H. Ingall; "On the Effect of Progressive Cold-Rolling on the Brinell Hardness of Copper," by H. Moore; "Experiments on the Working of Nickel for Coinage," by Sir T. K. Rose and J. H. Watson, "Some Experiments on the Effect of Casting Temperature and Heat-Treatment on the Physical Properties of a High-Tin Bronze," by F. W. Rowe, "Some Experiments on the Influence of Casting Temperature and Mass on the Physical Properties of Admiralty Gun-Metal," by F. W. Rowe; "Studies in the Aluminium-Zinc System," by T. Tanabe; "Metal Spraying and Sprayed Metal," by T. H. Turner and W. E. Ballard.

SOCIÉTÉ DE CHIMIE INDUSTRIELLE

On June 27, the Fuel Group listened to a paper by Prof. M. P. LeBeau on the "Thermal Fractionation of Gases Resulting from the Carbonisation of Solid Fuels."

The method which is utilised by the author consists in heating 1 g. of fuel in a vacuum at temperatures increasing by 100° C. every hour, up to 1000°, and extracting the gases given off at each interval of temperature, liquid and less volatile products being retained in a condenser cooled to 80° by a mixture of acetone and carbon-dioxide snow. The measure of the volumes of gas and the analysis of the various fractions give data from which a curve representing the thermal fraction for each fuel can be established. The method has been applied to the study of anthracite, coal, lignite, peat, pine and oak wood, and the curves obtained were found to be characteristic of the products examined, each fuel and group of fuels having a special type of curve which was always the same for any single fuel. Further developments show that the method can also be applied to the characterisation of groups of carbohydrates such as glucose, galactose and starch. On carbonising nitrogenous compounds such as casein and egg albumin very different curves were obtained. The interest of the method lies in the fact that it furnishes valuable indications for the utilisation of fuels, that it makes a new classification possible, and may even provide useful help in the elucidation of their chemical constitution.

FARADAY SOCIETY

At the Annual General Meeting held on July 7, Professor F. G. Donnan, C.B.E., F.R.S., was elected to succeed Sir Robert Robertson as President. The Annual Report records considerable activity during the past year, the result of which is reflected in the accounts, which show a deficit of £109 11s. 5d. on the year.

Eleven meetings in all were held during the year and of these four were General Discussions, which have become so striking a feature of the work of the Society. The subjects of these were as follows: I. Alloys Resistant to Corrosion. II. The Physical Chemistry of the Photographic Process. III. The Electronic Theory of Valency. IV. Electrode Reactions and Equilibria. The widespread appreciation in which the publications of the Society are held is indicated in the fact that the sales of Transactions and reprints amounted to nearly £900, a figure in excess of the amount received for subscriptions.

It is very surprising to note that the membership of this very active Society is only 432 and that consequently an appeal for a larger membership is made in the Annual Report. Particulars relating to the Society may be obtained from the Secretary and Editor, Mr. F. S. Spiers, 90 Great Russell Street, London, W.C. 1.

ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS

ANNUAL GENERAL MEETING

The Eighth Annual General Meeting of the Association was held at the Chemical Society's Rooms, Burlington House, Piccadilly, W. 1, on Thursday, July 17, 1924. Sir Max Muspratt, Bart., occupied the Chair. The Chairman, in moving the adoption of the Annual Report, said: The Association has again gone through a most successful and important year. We have no changes in the personnel of the Council to record, but there are members of Council who have taken up work in other spheres where their co-operation is very valuable. Our General Manager, not being satisfied with the small scope which the Association affords him, has become the President of the Society of Chemical Industry. Much as the members of the Council felt that it was asking them a great deal to allow their General Manager to devote much of his time to the other important body, we felt that in the interests of co-operation between everyone concerned with chemical industry and chemical science, we ought to grant the permission, and I feel confident that all the members agree with that wise course. (Applause.) Undoubtedly in the past the Society of Chemical Industry and the Association of British Chemical Manufacturers, although their membership in many ways overlapped, were not working in the close co-operation that was best for the members of the two bodies, and I am extremely pleased to think that under the late President of the Society of Chemical Industry, Dr. Armstrong, and under the presidency of our General Manager, Mr. Woolcock, that co-operation and close working together is going to be enormously improved. I have just come from Liverpool, where the Annual Meeting of the Society of Chemical Industry was held last week, and I believe it was a most successful gathering. The thing that I gathered from it was that the close co-operation between manufacturers and others associated with the chemical industry has made great strides in the recent past, and, I venture to think, with satisfaction and advantage to both bodies it will continue to make even greater strides in the future.

Another method of co-operation between those interested in chemistry has been afforded by the very prominent part that this Association has taken in the British Empire Exhibition. When other industries were standing back and could not make up their minds, the Chemical Industry did decide that they were going cordially to support the Exhibition and the result, I venture to think, is an exhibit second to none of any given in the world, showing the complete range from the simplest domestic chemical products, through the more refined products, right away up to the pure Scientific section. It is a chemical education for all who go to the Exhibition. Nothing of the kind has been tried before, and no great exhibition in the future, I venture to say, will be complete which does not carry on that idea. The Exhibition not only brings

chemical manufacturers and consulting and scientific chemists and others interested together, but it is giving a great message to the whole world. It is showing the position this country occupies in science and chemical industry and a vast number of students from all parts of the country are flocking to that Exhibition and spending much of their time in the chemical section Those students will help to form an enlightened public opinion of the next generation. and it is most valuable that chemical industry should thus take its right position. But the response of the general public also has been enormous. Even on a day like Bank Holiday when one would think that the "Fun Fair" would attract all those who were in the Exhibition grounds, the numbers who visited the chemical portion were very large, and very many bought those sixpenny text books which were sold in the scientific section, showing how seriously and earnestly the general public are now taking the chemical industry. Then again the influence upon the world at large, the distinguished men and women who are coming from all parts of the world, the visits of scientists, industrialists, politicians, statesmen and others, means that a large proportion of these are being influenced by what they are seeing at that Exhibition in which our Section, we venture to say, is one of the most excellent. It has been mooted in high quarters that it may be possible that the Exhibition will be opened again next year and succeeding years. I for one cordially welcome the suggestion and I hope that the chemical industry will again, as it has done this year, support it. I am certain that direct and indirect advantages to the whole industry and the individuals composing it will accrue.

There is a reference in the Report to the films for chemical industry. These films are being shown in quite a number of cinematograph halls throughout the country and they help to concentrate interest in the chemical industry. Any firm who wishes to give a private exhibition for their working people or people who might be interested in their particular line of business can always obtain the free use of these films just for the cost of the carriage.

On the subject of dyestuffs so much has been said and thought that I do not propose to make any long statement. All I wish to point out is this, that the subject is extremely difficult, and within the Association the interests are very conflicting. The Council of the Association has tried to keep the balance between these various interests and to make representations in the right quarter, not with a view to what is good for this firm or that firm, or for any group of firms, but to what is best for the whole industry. If at times we have trodden upon the corns of specific interests, that has got to be done if we are to do our duty by the whole of the members of the Association.

There is just a reference in the Report to the Safeguarding of Industries Act. Unfortunately that has come into a sphere where political ideas play a larger part than industry; but Part I is still to continue in operation for some little time to come, and I hope that as far as possible the subject will be kept away from political principle or prejudice —words, I am afraid, at times synonymous.

A question that is coming forward in the near future is the Consolidated Factories Bill. This deserves serious consideration. The Association has not taken a narrow-minded view with regard to such legislation; it has always tried to see the principles which the Board of Trade or the Home Office wished to have enforced in industry. At the same time it has taken the necessary steps to watch the matter, not with a view to blocking the progress of the principle but to see that something workable comes out as a result of the discussions which have taken place. We are taking the same course of action in this field as we have taken in others—that is to say, we are approaching the matter with a sympathetic mind, with a desire to live in the present day, not looking upon the practice of the past as anything sacred which must not be touched; we do want to have good conditions for our work-people. We want them to live their happiest lives through their time in the factory, but at the same time we venture to think that we know the psychology of our workers a good deal better than any Government officials can do, and we think that some kind of latitude and elasticity should be given in these regulations. There is no object in putting in wash-bowls, for example, when we know perfectly well that they are put in in places where they will never be used. We want to make employment easier and pleasanter in our works, but we do not want to be run into a great deal of unnecessary expenditure which is not going to have any result in the way of happiness for our workpeople.

In the question of Patent Law, Chemical Industry is largely interested, and seeing that a Trade Marks, Patents and Designs Federation has been formed, the Council has appointed a very excellent representative in the person of Dr. Ree. Next comes the question of assessment for rating.

The rating laws of this country are an absolute quagmire. The thing has grown up with no definite principle as to how rates should be levied, and in this attempt under the Rating of Machinery Bill to deal with one section of the problem almost every other section has been involved, and every kind of principle (or want of principle) in connection with rating has had to be considered and if possible consulted. Personally I am not very hopeful that very much is coming out of this Rating of Machinery Bill, and we can only hope that the enquiries that are going forward with regard to the whole principle of rating will, in the course of two or three years, cause something to emerge that will put upon Chemical Industry- the members of which, let it be remembered, are citizens—a fair incidence and not an unfair incidence. We do not want to push our burdens upon other people, but, on the other hand, we do not want to carry unfair burdens, and I hope that every member who can suggest how such consolidation can be obtained will give us the benefit of his experience.

The Census of Production is shortly to be renewed. I welcome that decision very much indeed. The difficulties in quite a number of chemical industrial

problems are due to the fact that nobody knows the condition in which industry stands in this country, and one has to accept any statements that suit the particular point of view that a speaker is elaborating. A Census of Production, properly carried out, in the course of a decade at the outside, will give a mass of definite information which will enormously aid us in all these problems, of unemployment, of health, of taxation and of rating, and I am delighted to think that upon the Committee which is to decide the form that this Census is to take Mr. Perry has been nominated. It is a great responsibility, but we could not have it in more efficient hands.

Referring to the fact that he was addressing them for the last time as Chairman of Council, Sir Max Muspratt thanked the members of the Council and the staff for the loyalty, the hard work, the initiative and the common sense which they had shown, and which had made it a very easy and delightful duty to be Chairman of the Council.

The Treasurer (Mr. C. A. Hill), in seconding the Report, dealt more particularly with the balance-sheet of the Association.

In the course of the general discussion Dr. E. F. Armstrong referred to the question of transport. There were, he said, a very large number of bodies interested in the question of transport charges. All present, both in their capacities as industrialists and as private individuals, knew that the amalgamation of the railways had so far been of doubtful benefit to the public, and he felt that it was most important that an Association like their own should be very watchful of their interests on this point. If the railways took them in detail they were lost, but they might achieve something by standing together. He thought they could not congratulate themselves too much on their success at Wembley. The idea of having an exhibit at Wembley was undoubtedly their own, and although perhaps the idea of the Scientific Section did not originate in their Council, he asserted that nobody else would have carried it out in the way it has been carried out except the Association.

Dr. Levinstein said he would like to emphasize the great value of the co-operation with the scientific societies which had been made. The success of the scientific exhibit was very largely due to the assistance given by the Royal Society. They had found a most willing and friendly spirit, and were able to mark out a sphere of influence for the Association. As one who knew a great deal about the subject of dyestuffs he was naturally precluded from making any useful remarks! (Laughter.) He contented himself with endorsing the very diplomatic language of the Report. He thought the Association was going on from strength to strength, and that the Report spoke very favourably for the position of the Chemical Industry in this country.

Sir John Brunner, Bart., referred to the Chemical Engineering Department of University College, London. The Association knew that an experiment was being tried in education—namely, to form what was very sorely needed in chemical work, a means of study for the chemical engineer. It had been a great point of controversy among those who manage chemical works whether it was possible, in the time which is allotted to a student, to make a chemical engineer. Many people thought that if you were to try to perform any such task you would turn out a half-baked engineer and a half-baked chemist, and that it would be very much better to divide your own staff into two, to have a thoroughly well-trained chemist and a thoroughly well-trained engineer. But there were very many places in our far-flung Empire where one could not afford to have a large staff, and it seemed to him that there would be great openings for the men trained in this Chemical Engineering Department. Every man so trained would be able to go abroad and take jobs single-handed as managers of, not exactly chemical works, but works where chemistry is a very essential part in the running of the works—such as a sugar factory.

The Rt. Hon. J. W. Wilson referred to the questions in the Council which require very delicate handling. He believed that the Council in the past year had always endeavoured to work for the general welfare of the Chemical Industry, and he thought that on the whole the results had been satisfactory, and the Association had amply justified itself, even apart from Wembley.

Mr. Sadler suggested that the Association should pay its way, and that they should call up the full 100 per cent. for this next year.

Dr. Ree (Chairman of the Manchester Chamber of Commerce) said that the Association had fulfilled to a great extent the ideals with which it started. In the old days there was a good deal more friendliness between the British and German manufacturers than between the British manufacturers themselves. That condition of things was now completely altered, and very much to the advantage of the industry.

The motion to adopt the Report was then carried unanimously. The auditors, Messrs. Feasey and Company, were re-elected. Mr. Perry seconded, and this was agreed to.

Mr. Parnaby (Chairman of the Committee of Scrutineers) read the results of their scrutiny, and the Chairman declared the elections duly carried out.

Dr. E. F. Armstrong proposed a very hearty vote of thanks to the Chairman, Sir Max Muspratt, which was seconded by Sir John Brunner, and carried with acclamation.

Annual Dinner

In the evening the Annual Dinner of the Association was held at Lucullus Restaurant, British Empire Exhibition, Wembley, and was presided over by Mr. D. Milne Watson, D.L., M.A., LL.B., the newly-elected Chairman of the Association. The guests, among whom were a number of representatives of the most important chemical organisations abroad, included the following: Percy Ashley, Assistant Secretary of the Board of Trade, Prof. H. E. Armstrong, Prof. Wilder Bancroft, of America, Vice-President of International Union of Pure and Applied Chemistry, Percy Cazalet, of the Chemical, Metallurgical and Mining Society of South Africa, Prince

Ginori Conti, of Italy, President of the Federazione della Associazione Industriali Chimiche, L. J. Hunt, Prime Warden of the Dyers' Company, Prof. Jedlicka, Chemical Society of Czechoslovakia, Prof. Naoto Kameyama, Society of Chemical Industry of Japan, Prof. Riko Majima, Chemical Society of Japan, S. J. Pentecost, President of the Society of Dyers and Colourists, Dr. Sieger, of the Dutch Chemical Society, Dr. Werner Stauffacher, of the Swiss Dyestuff Industry, N. Garrod Thomas, Prof. J. F. Thorpe, of the Imperial College of Science, Dr. Valeur, of the Societe Chimique, and Prof. A. von Weinberg, Vice-President of the German Chemical Society.

After the company had drunk the toasts of His Majesty the King, and of the Rulers of the Countries represented by the guests, the Chairman proposed the toast of the evening, "Our Guests," coupled with the names of Prof. Wilder Bancroft, of America, Prince, Conti, of Italy, Dr. Valeur, of France, and Prof. von Weinberg, of Germany; to which the four gentlemen suitably responded

The evening concluded by a visit of the members and their guests to the Chemical Section of the Palace of Industry.

CORRESPONDENCE

INTERNATIONAL AMITY

Sir,—Your issue of May 2 has just come to hand, and I note that you are again referring to the question of international amity which has been raised by yourself first in the issue of February 29 and the discussion of which has been joined by Dr. Fritzsche and Prof. Noyes. Perhaps by the time this letter reaches you the whole subject will be dropped, still in spite of this I cannot resist the impulse to write down what I think about it.

All through this discussion you have referred to scientific men in general, and to chemists in particular, as if they were apart from the general community in their feelings and emotions with regard to such complicated and difficult matters as are involved in the making of peace and war. Now I venture to suggest that this view is unsound: in our consideration of matters like this we should *first* regard ourselves as ordinary men and women, full of human strength and weakness, loves and hates, joys and sorrows, and all those unmeasurable qualities which make men and women what we know them to be, and afterwards if it so happen that our scientific training should enable us to see through these complicated problems a little more clearly than our fellows, then and then only should we use our knowledge, not indeed as scientific men, attempting the solution of a definite scientific problem, but just as ordinary human individuals, seeing things a little more clearly, if you will, but from the same standpoint as that of ordinary people.

I cannot help feeling that Professor Noyes has completely overlooked this aspect of the matter when he wrote his notes of to-day's issue (May 2). The last paragraph of his letter suggests the following:—Let all this struggling, starving, passionate, disappointed mass of people which fills Europe to-day be changed—so that all their evil passions and ambitions shall pass away and they shall become as angels, singing glory to the League of Nations and the World Court for evermore.

If Prof. Noyes will attain his ambition to lead rather than follow the financiers and politicians, he will first have to produce a policy which will be able to resist the subtle attack of these, the most cunning and most learned of all men in human iniquity; and not one which carelessly disregards all those simple emotions which may be connoted by the words "human nature"! I think it was you, Mr Editor, who a short time ago was urging chemists occasionally to forget their theories and be plain men, and I for one feel sure that the theories would not suffer much thereby.

As for Dr. Fritzsche's attitude as expressed in his two letters, there is little difficulty in understanding what he means, taken all round he persists that Germany did what she held to be right and proper, and he as a German is not going to say, or—let any one else say—anything else. His one weakness appears to be that he is not prepared to concede this position to any other person in respect to their own views and conduct. The former aspect of the matter is logical and comprehensible, the latter is equally incomprehensible.

As far as making friends with the Germans goes it seems to me a matter of the greatest difficulty, I have tried it personally with one or two individuals but they all seem to follow the method of Dr. Fritzsche, and that appears to lead nowhere; while taken as a whole it would appear that the Germans made peace at a moment which, from a military point of view, was most fortunate for them, and, having stopped the war, they made a treaty which they have quite frankly done all in their power to avoid keeping. This appears to be the general situation viewed from a distance. No doubt much argument might be made on both sides, but I submit that the ordinary commonsense person in whom taken in the aggregate the general power of the nation at present lies, sees the matter in this light, and that being so Prof. Noyes' proposition seems more hopeless than ever.—I am, Sir, etc.,

Botany, N.S.W. HARRY WILLIAMS

P.S.—I have not read Prof. Noyes' pamphlet, but I feel sure that the general tenor of his theme may be comprehended for its colour in the issue of May 2.

INDUCED ALTERNATE POLARITIES

Sir,—In your issue of July 25, Prof. Ingold records his opinion against the theory of induced alternate polarities as being a false combination of correct ideas. Whether or not the theory offers a true explanation of facts, it is evident that the *polar* and *alternate* influences in a carbon chain are very intimately connected with one another.

In a recent paper (*J.C.S.*, 1924, **125**, 1121) attention has been drawn to the influence of substituents on optical activity, particularly of the *d*-amyl complex $C_5H_{11}X$ and the menthyl esters of *o*-substituted benzoic acids. In these and other cases groups

produce characteristic changes in the molecular rotation of a parent compound, and positive and negative groups influence the rotation in opposite directions. There is here, so far as present evidence shows, no trace of an alternate nature, and the influence of the group may be described as polar. Nevertheless, the relative effect of different groups goes hand in hand with the alternate influence of these same groups upon benzene substitution and other properties, and the two sets of phenomena would appear to have a common origin.

With respect to the question raised by Prof. Lapworth in your same issue of a tervalent nitrogen "key atom" acting in opposition to one of biovalent oxygen, it is interesting to note that in the amyl series referred to above the hydroxyl group produces practically the same change in rotation as the amino group, amyl alcohol being quoted as $[M]_D = -5{\cdot}19°$ and the amine as $[M]_D = -5{\cdot}10°$. Possibly, however, the latter figure may yet be revised in an upward direction.—I am, Sir, etc., H. G. RULE

Edinburgh University

REPORTS ON WATER ANALYSES

Sir,—Reports on water analyses are rarely satisfactory in England. Reform is needed principally in three directions.

1. The experimental figures should be given: no attempt should be made to combine basic and acidic radicals.

2. Results should be expressed in parts per hundred thousand only.

3. The phraseology should be that adopted in other branches of chemical work.

Practically all water reports fail to conform to these requirements. The first is the most important. At present, reports issued by water analysts give tables purporting to show in terms of *salts* the probable constituents of the water. That such tables are widely divergent from the facts must be admitted by all chemists who accept the dissociation theory and as all but a few chemists do accept this theory, the sooner these tables are suppressed the better.

Nowadays the analytical data are usually given but unfortunately particulars of salts which have no objective existence are also furnished. The number of chemists who believe that the basic and acidic ions present in a water are totally or even principally in the combined state must be negligibly small and yet reports showing them to be totally in the combined state are still issued.

2. Most reports give the results in parts per 100,000, but they are also unnecessarily given in grains per gallon.

3. Expressions such as "fixed carbonic acid," "combined and semi-combined CO_2" and "hardness" should be eliminated. Some slight advantage might be obtained by retaining the word "hardness," but if retained it should have only one meaning. To some chemists it means "$CaO+MgO$ expressed as $CaCO_3$," but others include sodium chloride. For the use of the remaining terms, however, there is no excuse as ordinary chemical nomenclature is quite as convenient.

There is an urgent need for a modern book on water analysis. Possibly when such a book is available chemists will be persuaded to discard the present unscientific method of reporting on waters.—I am, Sir, etc., G. THOMPSON

5, International Mansions,
High Street, Rugby

PERSONAL AND OTHER ITEMS

Prof. F. G. Donnan, C.B.E., F.R.S., has been elected to succeed Sir Robert Robertson as president of the Faraday Society.

Prof. V. C. Myers, Director of the biochemical department of the New York post-graduate medical school, has accepted the chair of biochemistry in the Iowa State University.

The American Portland Cement Association proposes to erect a bronze tablet in Leeds to the memory of Joseph Aspdin, a bricklayer of Leeds, who in 1824 patented a formula for a material which, when hardened, resembled Portland stone and which ultimately became known as Portland cement. If accepted by Leeds, the tablet will be unveiled on the occasion of the united celebrations with the British Cement Makers' Federation of the centennial of the invention, October, 1924.

Early this year the Imperial College of Science and Technology was enabled, by generous donations from Sir Arthur Acland, Bt., and Sir Otto Beit, Bt., to establish a scheme of 10 Dominion Scholarships for research work in science, tenable at the college during the academic year 1924–25, open to university graduates in the several Dominions and in India. With the co-operation of the India Office and the Colonial Office, appointments to these scholarships have now been made by the respective Governments as follows:—

India.—Mr. Sarbbanisahay Guha Sircar (Calcutta University); Mr. A. S. Ganecan (Madras University). *Australia.*—Miss M. I. Collins, M.Sc. (University of Sydney) (for work in economic botany, including forestry); and Mr. A. S. Fitzpatrick, M.Sc. (University of Melbourne) (for work in applied chemistry, specially in relation to fuels). *Canada.*—Mr. Armand Circe, C.E. (Ecole Polytechnique, Montreal); and Mr. R. J. Henry, B.A., B.Sc. (University of Toronto). *New Zealand.*—Mr. H. L. Richardson, M.Sc. (Victoria University College, University of New Zealand); and Mr. H. O. Askew, M.A. (Canterbury College, University of New Zealand). *South Africa.*—Mr. Hans Pirow (for mining engineering) and Mr. Lawrence P. McGuire (for plant physiology).

The Ramsay Memorial Fellowship Trustees have made the following awards of new Fellowships for the session 1924–25:—

A British Fellowship of £300 to Mr. S. W. Saunders, B.Sc., for work at University College, London. A Glasgow Fellowship of £300 to Mr. Alex. Robertson, M.A., B.Sc., for work in the University of Manchester. A Danish Fellowship of the value of £229 to Mr. Kai Julius Pedersen, for work in the University of Bristol.

The Trustees have renewed the following Ramsay Fellowships for the same session: Dr. Samuel Coffey (British Fellowship), for work at University College, London; Dr. Alan Titley (British Fellowship), for work in the University of Oxford; Mr. Thomas S. Stevens (Glasgow Fellowship), for work in the University of Oxford; Dr. Miguel Crespi (Spanish Fellowship), for work at University College, London; Dr. J. Kalff (Netherlands Fellowship), for work in the University of Manchester. Dr. H. Weiss (French Fellowship), for work in the Davy Faraday Laboratory, Royal Institution; Dr. Edward Boomer (Canadian Fellowship), for work in the University of Cambridge.

Sir Robert Robertson, F.R.S., has been appointed a member of the Ramsay Memorial Advisory Council, in place of the late Sir James Dobbie.

The death has occurred of Miss K. A. Burke, who, after being private assistant to Sir William Ramsay, became the first woman member of the teaching staff of University College, London. Miss Burke was a most capable teacher, and had a great share in the development of the social and athletic life of the college.

New Technical Journal

A new scientific publication to be known as the *Journal of Oil and Fat Industries* will shortly be published by the American Oil Chemists' Society. This periodical will be devoted to the chemistry and chemical engineering of all phases of the manufacture and uses of animal and vegetable fats and oils. The first issue will appear early in July from the Eschenbach Printing Company's press at Easton, Pa., Subscriptions for the Journal may be addressed to H. S. Bailey, Editor, Box 756, Savannah, Ga., or T. B. Caldwell, Secretary of the Society, Law and Co., Wilmington, N.C.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Government Wool-Disinfecting Station

Mr. Davies, replying to Mr. Hannon, said that there was a profit on current expenditure since the beginning of the present financial year in regard to the Government Wool-Disinfecting Station. The total accrued loss on March 31, 1924 (including interest on capital expenditure and an allowance for depreciation) was approximately £54,000.

The New Geological Museum

Replying to Major Church, Mr. Jowett said it had been decided to erect a new building in South Kensington to house the Geological Survey and the Museum of Practical Geology, and a supplementary estimate to provide the necessary funds would be presented at an early date. The future of the present site of the Museum was not yet decided, but the administrative work was being carried on there, and the public would have access to the library and map room.—(July 28.)

REVIEWS

Text-Book of Cellulose Chemistry. By Emile Heuser. Translated from the Second German Edition by Clarence J. West and Gustavus J. Esselen, Jr. Pp. xi+212. London. McGraw-Hill Publishing Co., Ltd., 1924. Price 12s. 6d.

The task of compiling on systematic scientific lines a record of the chemistry of cellulose is beset with many difficulties. The unwieldy literature of the subject is scattered and its study is complicated by the fact that, in many cases, the investigations described have a technical objective or are conducted in a spirit of light-hearted speculation which is repellant to the scientific thinker. A text-book of cellulose chemistry has further to satisfy many different types of readers and, if the subject is dealt with on the basis of molecular structure, the arguments have, in the end, to meet the criticism of the specialist in the complicated subject of sugar chemistry.

It is therefore with a feeling of sympathy for Professor Heuser and with a full appreciation of the difficulties which have been faced, and for the most part overcome, that the reviewer has studied the present English translation. The aims of the book and the spirit in which it should be read are clearly defined in the Introduction. Adopting throughout the method of illustrating each type of reaction by reference to the behaviour of simple aliphatic hydroxy-compounds, the author deals in succession with cellulose acetates, esters and ethers, proceeding thereafter to the oxidation and degradation of the polysaccharide. This leads naturally to a closing chapter dealing with the molecular structure of the cellulose unit.

Generally speaking, the book is likely to fulfil the aim of the author, and readers, whether their interests lie in the laboratory or the factory, will profit by having their attention focused on the reactions of cellulose which can be interpreted in terms of constitution. The book suffers, however, from the defect (one to which we have been long accustomed) that it creates the impression that cellulose chemistry rests essentially on the work of Continental, and more particularly, German investigators. There is also a tendency to make sweeping generalisations with a confidence which is not justified. For example, the statement that there is only one type of cellulose, which is the same chemical individual in all plants, may well be challenged and the assurance that starch, inulin, glycogen, cellulose and the pentosans all "consist of a polymeric form of a hiose anhydride of similar chemical composition" is entirely misleading. Sins of omission, partial and complete, are also common. Barnet's method of acetylation is not mentioned and the acetylation of cellulose is in consequence discussed at considerable length as an example of acetolysis. Another case calls for stronger criticism. Description of the methylation of cellulose is confined to an extract from the introductory paper by Denham and Woodhouse published many years ago. Although

later references are quoted in a foot-note, the author's account of the application of methylated celluloses to constitutional questions is based merely on preliminary experiments and reveals incidentally an imperfect acquaintance with the properties of methylated sugars. The tendency of the author to limit his readers to the work of German investigators reaches a climax in the constitutional discussion in Chapter VI where he is courteously corrected by his translators who have inserted a synopsis of British and American researches which cancels out practically the whole of the chapter in question

Professor Heuser's book has deservedly reached a second edition, and further issues will doubtless be forthcoming. An excellent start has been made in rendering the literature of cellulose accessible in a form in which it can be studied intelligently, but the author will probably be the first to admit that it is no more than a start and that there is room for many improvements. The translators have carried out their task accurately and, although adhering closely to the original, have not hesitated to insert notes where corrections were necessary.

J. C. IRVINE

WOODFIBRES OF SOME AUSTRALIAN TIMBERS. By R. T. BAKER and H. G. SMITH. Pp. 159, 64 plates. Sydney: Government Printer, 1924. Published by the Authority of the Commonwealth Government.

During the war a shortage of paper was experienced in Australia, and in 1916 a committee was appointed by the Government of New South Wales to enquire into the prospects of making paper locally from indigenous timbers. In the publication under notice Messrs. Baker and Smith record the results of investigations begun during their membership of this committee and continued for some time subsequently. The fibres of about sixty " forest " and " brush " timbers of Eastern Australia have been characterised and illustrated, and the yield of cellulose determined for each wood. Eucalyptus timbers naturally figure largely in the work, and the results obtained for the " Ash " group of this genus, taken in conjunction with a survey of other manufacturing requisites, lead to the conclusion that a paper mill producing 13,500 tons of pulp per annum, equivalent to one-fifth of the annual Australian pre-war consumption of newspaper, might well be erected and maintained in full employment in the Buddong Falls district of New South Wales. In an assessment of 28,000 acres of Crown lands available in this district it is estimated that out of 32 trees per acre useless for lumbering purposes the greater portion (including 16 of *E. Dalrympleana* and 12 of *E. Delegatensis*) could be used for pulp production. An ample supply of water of the requisite purity is available in the area concerned.

The pulp from *E. Dalrympleana* is stated to resemble chestnut wood pulp; and the eucalyptus wood when cooked for four hours by the sulphate process gave a 47·8 per cent yield of a very satisfactory grade of pulp, which could be easily bleached. "The accumulated evidence shows that certain eucalyptus species having light coloured timber, and growing in considerable quantity on the eastern portion of Australia, in close proximity to abundant water supplies, are well suited for the production of chemical pulp for the manufacture of paper " Furthermore, the ascertained rate of reproduction of these species upon reafforestation is one of the most rapid known.

Eucalyptus wood fibres do not usually much exceed one millimetre in length, but long-fibred pulp has been produced commercially from the Queensland Pine (*Araucaria Cunninghamii*), the tracheids of which reach as much as 9 millimetres in length, although they mostly range between 3 and 4 millimetres. In addition, the authors indicate that several of the ' scrub ' timbers growing at the head of the Clarence River show considerable promise as sources of long-fibred pulp Among a group of 13 of the best species are *Grevillea robusta* (silky oak), *Doryphora sassafras* (sassafras), *Ceratopetalum apetalum* (coachwood), and *Eugenia* sp. (water gum).

In spite of the valuable work here recorded, and the patiently compiled reports of more than one committee, little or no effort has yet been made to develop on a commercial scale the latent natural resources of Australia which are dealt with in this investigation. By this publication, however, Messrs. Baker and Smith have added a further noteworthy contribution to their lengthy series of botanical and chemical investigations on the unique and wonderful flora of Australia, and have indicated once again an important line of prospective economic development.

JOHN READ

PRINCIPLES OF ELECTROPLATING AND ELECTROFORMING (ELECTROTYPING). By W. BLUM and G. B. HOGABOOM. Pp. xii+356. London McGraw-Hill Publishing Co , Ltd , 1924. Price 20s.

This volume appears to have been directly inspired by the activities of the American Electro-Platers Society, a society which has shown great activity and undoubtedly accomplished valuable work in the United States of America in raising, not only the status of the electro-plater himself, but the standard of his work. The book is, therefore, of considerable interest, since for this reason it may be taken as embodying the best of American practice in the art of the present day.

A very wide field is covered in the twenty-one chapters of which the book consists. The principles of chemistry, electro-chemistry and chemical analysis are dealt with, not anything like adequately, but sufficiently so perhaps to meet the needs of the great majority of interested readers.

Some of the definitions given are not sufficiently clear for modern standards of accuracy, and indeed are not always correct as, for example, the definition of an electrolyte as " the solution through which the current passes " (see page 53) The book suffers to some extent, also, from the attempt to crowd too much matter in comparatively limited space, and there is a want of balance, some matters of minor

importance being stressed in undue proportion. On the whole, however, the book will be a most useful handbook for English workers in the art, and especially for those workers who are interested in improving methods of practice.

It has been hitherto somewhat difficult to obtain in convenient form details of American practice, and much of the information conveyed in this book, though not known to students of American technical literature, has not been available to the average electro-plater in this country. The authors are to be congratulated on a publication which can be recommended to practical workers as a thoroughly useful and, on the whole, reliable handbook.

W. R. Barclay

Physikalische Chemie. By Alfred Benrath. Pp. viii+107. Dresden and Leipzig: Theodor Steinkopf. Price, paper, 2s.

This little volume constitutes the eighth part of a work on physical chemistry, which is being prepared under the general editorship of Prof. R. E. Liesegang, with the object of giving a summarised account of the work on physical chemistry published during the years 1914–1922. The editor hopes in this way to supply a book which will enable those who lost touch with the literature of these years, to obtain an acquaintance with it without the expenditure of a large amount of time and energy.

In the present volume the author deals with the physico-chemical properties of pure substances and solutions. The treatment of pure substances occupies only 22 pages and deals mainly with the relationships between the physical properties of elements and compounds, and the theory of allotropy. Smits' theory of allotropy and Cohen's work on the same subject are reviewed. The passivity of iron is considered in connexion with Smit's theory of allotropy.

The remainder of the book is devoted to the work on solutions. These are considered under the headings (*i*) Solutions of indifferent substances and (*ii*) solutions of electrolytes. Under the last-named heading the author considers the newer developments of the theory of electrolytic dissociation, the theory of complete dissociation, the theory of indicators and the dissociation of molten and crystallised salts. The newer theories of solvate formation are also considered.

The author has done his work faithfully and in many cases he has considered the various subjects from a date much earlier than 1914, but he has not treated the material in the strictly critical manner which might well have been expected in a work of this nature. The book will, without doubt, be extremely useful to those wishing to become acquainted with the recent developments in the subjects treated, and to such it may be recommended. But for those engaged in work on these subjects the book offers little or nothing with which they are unacquainted, and it is to these that the absence of a strictly critical treatment robs the work of the real value and usefulness which it might so easily have possessed.

J. F. Spencer

Elements of Water Bacteriology, with Special Reference to Sanitary Water Analysis. By Prof. S. C. Prescott and Prof. C. E. A. Winslow. Fourth Edition, Rewritten. Pp. viii+211. New York: John Wiley and Sons, Inc.; London: Chapman and Hall, 1924. Price 11s. 6d.

The fourth edition of this useful handbook has been brought up-to-date and partly rewritten. The printed page has been enlarged and the size of type changed. It gives a concise review of the present methods adopted in the bacteriological examination of water and water supplies from the sanitary point of view. The aim of the book is to give an adequate idea of current American practice, and the authors have accepted the proceedings outlined in the last report of the Committee on Standard Methods of the American Public Health Association They have succeeded in presenting a critical discussion of the wider principles involved, which are essential to the water bacteriologist, and to the student who desires to acquire a fundamental comprehension of the problems with which he will have to deal in actual practice.

British methods of investigation and interpretation are closely in accord with those used in America, and the general trend of work in both countries is to focus attention on procedures which are rapid and which have proved themselves of definite value.

As *B. Coli* has been accepted as the best index of pollution and of especial value in the control of filtration plants, the authors have deleted much of the less important details in historical development given in the last edition.

The report of the English Committee appointed to consider the standardisation of methods for the Bacteriological Examination of Water of 1904, is referred to, but British readers should be reminded that a second Committee reported in 1914 (*Journal of State Medicine*, Vol. 22, p. 558).

The number of water laboratories in the United States has increased largely since 1910, and the authors have thought it wise to reduce the amount of space devoted to the isolation of the typhoid bacillus, since this step is so rarely undertaken by water bacteriologists.

One short chapter is devoted to the bacteriology of sewage and sewage effluents, and another to the bacteriological examination of shell-fish.

The valuable bibliographical list of 365 references to books and papers of the third edition has been retained, and in the present edition a further 141 have been added.

The authors have a world-wide reputation and this book should prove of great value and will doubtless be cordially welcomed by students and all those engaged in the control of water supplies, whether they be laboratory investigators, engineers or medical officers of health.

John I. Goodlet

Prof. J. B. Baillie, professor of moral philosophy in the University of Aberdeen, has been appointed Vice-Chancellor of the University of Leeds.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.
Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. .. £23 10s. per ton.
Acid, Boric, Commercial—
  Cryst. .. .. .. £45 per ton.
  Powder .. .. £47 per ton.
Acid Hydrochloric .. 3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. .. £21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric .. .. Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali.. .. £6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder .. Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime .. £7 per ton, packages extra.
Borax, Commercial—
  Crystal .. .. .. £25 per ton.
  Powder .. .. £26 per ton.
  (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride .. £5 17s. 6d. per ton d/d.
Mothylated Spirit 64 o.p.—
  Industrial .. .. 3s. 1d.—3s. 5d. per gallon, according to quantity.
  Mineralised .. .. 4s. 2d.—4s. 6d.
Potash Caustic .. .. £30—£33 per ton.
Potass. Bichromate .. 5¾d. per lb.
Potass. Chlorate.. .. 3d.—4d. per lb.
Salammoniac .. .. £32 per ton d/d.
Salt Cake.. .. .. £3 10s. per ton d/d.
Soda Caustic, solid .. Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals .. .. £5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% .. £24 per ton.
Sod. Bicarbonate .. £10 10s. per ton, carr. paid.
Sod. Bichromate.. .. 4½d. per lb.
Sod. Bisulphite Powder 60/62%.. .. .. £18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate .. .. 3d. per lb.
Sod. Nitrate refd. 96% .. £13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65 About £14 10s. per ton d/d.
Sod. Sulphide cryst. .. £9 per ton d/d.
Sod. Sulphite, Pea Cryst. £15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—
  Golden .. .. .. 5¾d.—1s. 4d. per lb., according to quality.
  Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow 1s. 1d. per lb.
Barytes .. .. .. £3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide .. 3s. 9d. per lb.
Carbon Bisulphide .. £24—£26 per ton according to quantity.
Carbon Black .. .. 7d. per lb. ex wharf. Dearer.
Carbon Tetrachloride .. £56 per ton, drums free.
Chromium Oxide, green.. 1s. 3d. per lb.
Indiarubber Substitutes, White and Dark — 4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black .. .. 45s per cwt., barrels free.
Lead Hyposulphite .. 7½d. per lb.
Lithopone, 30% .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. .. £15 10s. per ton f.o.r. London.
Sulphur .. .. .. £10—£12 per ton, according to quality.
Sulphur Chloride .. 3d. per lb., carboys extra.
Thiocarbanilide .. .. 2s. 6d. per lb.
Vermilion, pale or deep .. 4s. 10d. per lb
Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—
  Brown .. .. .. £14 10s. per ton d/d. Demand active.
  Grey .. .. .. £19—£20 per ton. Fair demand.
  Liquor .. .. .. 9d. per gall. 32° Tw.
Charcoal .. .. .. £7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
  1s. 2d. ,, ,, 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 7d. per gall. Unrefined.
Wood Naphtha—
  Miscible .. .. 5s. per gall. 60% O.P. Market dull.
  Solvent .. .. 5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar .. .. £5 per ton.
Brown Sugar of Lead .. £46 per ton.

TAR PRODUCTS

Acid Carbolic—
  Crystals .. .. 6½d. 6¾d. per lb Quiet.
  Crude 60's .. .. 1s. 9d.—1s. 11d. per gall., according to district. Still quiet.
Acid Cresylic, 97/99 .. 2s 1d.—2s. 2d per gall. Demand still good. Market firm.
  Pale 95% .. .. 1s. 10d.—1s. 11d. per gall. Steady demand.
  Dark .. .. .. 1s. 10d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—
  Strained .. .. 8½d.—9½d. per gall. Quiet.
  Unstrained .. .. 7½d.—8½d. per gall.
Benzole—
  Crude 65's .. .. 10½d.—1s. per gall. ex works in tank wagons.
  Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
  Pure .. .. .. 1s 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% .. .. 1s. 5½d. per gall.
  Pure .. .. 1s. 8d.—2s. per gall.
Xylol coml. .. .. 2s. 3d. per gall.
  Pure .. .. 3s. 3d. per gall.

Creosote—
Cresylic 20/24% .. 9d.—9½d. per gall. Few inquiries.
Middle Oil .. } 5½d.—6d. per gall in Lancashire
Heavy Oil .. } 6d.—7d. per gall. in Yorkshire.
Standard Specification }

Naphtha—
Solvent 90/160 .. 1s. 1d.—1s. 4d. per gall. according to district. Quiet.
Solvent 90/190 .. 1s. 1d.—1s. 4d. Quiet.

Naphthalene Crude—
Drained Creosote Salts £4—£6 10s. Quiet.
Whizzed or hot pressed £9 per ton. Little business.

Naphthalene—
Crystals and Flaked .. £13—£16 per ton in Yorkshire and London respectively. More inquiries.

Pitch, medium soft .. 55s.—60s. per ton f.a.s. for next season. Frequent inquiries.

Pyridine 90/160 .. 19s. per gall. Market less firm.
Heavy .. 12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

There has been a fair demand for dyestuffs during the past week. Prices remain constant. A number of intermediate products have been reduced in price.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 7d. per lb.
Acid H .. .. .. 4s. per lb 100% basis d/d.
Acid Naphthionic .. 2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 8d per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic .. 9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 7¾d.—8½d. per lb. naked at works.
Aniline Salts .. .. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 1d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 19/31° C. .. 4½d. per lb. Demand steady.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline .. .. 2s. 3d.—2s. 11d. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £85 per ton.
Diethylaniline .. .. 4s 7d. per lb. d/d., packages extra, returnable.
Dimethylaniline .. .. 2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 3s. per lb. d/d
Monochlorbenzol .. £63 per ton.
β Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. 1s. 4½d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 5s. 3d. per lb. d/d.
p-Nitraniline .. .. 2s. 3½d. per lb. d/d.
Nitrobenzene .. .. 5¼d.—5½d. per lb. naked at works
o-Nitrochlorbenzol .. 2s. per lb. 100% basis d/d.
Nitronaphthalene .. 11d. per lb. d/d.
p-Nitrophenol .. .. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol 4s. 6d. per lb. 100% basis
m-Phenylene Diamine .. 4s. per lb. d/d.
p-Phenylene Diamine .. 10s. 3d. per lb. 100% basis d/d.
R. Salt .. .. .. 2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate .. 2s. 3d. per lb. 100% basis d/d.
o-Toluidine .. .. 8½d. per lb.
p-Toluidine .. .. 3s. 6d. per lb. naked at works.
m-Toluylene Diamine .. 4s. 3d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P .. £45 per ton.
Acid, Acetyl Salicylic .. 3s. 2d.—3s. 5d. per lb., according to quantity. Good demand. Price firm.
Acid, Benzoic B.P. .. 3s. 6d. per lb. Larger supplies available.
Acid, Boric B.P. .. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric .. .. 19s.—21s. per lb.
Acid, Citric .. .. 1s. 6d.—1s. 6½d. per lb., less 5% for ton lots. Business subnormal.
Acid, Gallic .. .. 3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst. .. 7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic .. .. 1s. 6d.—2s. per lb. Weak market.
Acid, Tannic B.P. .. 3s. per lb. Market quiet.
Acid, Tartaric .. .. 1s. 1¼d. per lb. less 5%.
Amidol .. .. .. 9s. per lb. d/d.
Acetanilide .. .. 2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
Amidopyrin .. .. 13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate .. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P. £37 per ton.
Atropine Sulphate .. 12s. 6d. per oz. for English make.
Barbitone .. .. 15s. per lb. Quiet market.
Benzonaphthol .. .. 5s. 3d. per lb. Small inquiry.
Bismuth Salts .. .. A steady market. Prices according to quantity:
Bismuth Carbonate .. 12s. 9d.—14s. 9d. per lb.
" Citrate .. .. 11s. 4d.—13s. 4d. "
" Salicylate .. 10s. 2d.—12s. 2d. "
" Subnitrate .. 10s. 9d.—12s. 9d. "
Borax B.P. .. .. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides .. .. .. Unsettled. Spot supplies short. Raw materials dearer. Market advancing.
Average spot values:—
Ammonium .. 1s. per lb.
Potassium .. 10d. per lb.
Sodium .. 11d. per lb.
Calcium Lactate .. .. Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate .. .. 3s. 10d.—4s. per lb. Very firm and scarce.
Chloroform .. .. 2s. per lb. for cwt. lots. Very steady
Creosote Carbonate .. 6s. 6d. per lb. Little demand.
Formaldehyde .. .. £54 per ton, *ex* works. English make in casks. About 8s. per cwt. extra for carboys.
Glycerophosphates— Fair business passing.
Calcium, soluble and citrate free .. .. 7s. per lb.
Iron .. .. .. 8s. 9d. per lb.
Magnesium .. .. 9s. per lb.
Potassium, 50% .. 3s. 6d. per lb.
Sodium, 50% .. .. 2s. 6d. "
Guaiacol Carbonate .. 10s. 6d.—11s. 3d. per lb.
Hexamine .. .. 3s. 6d. per lb. for English make. Market steady.

Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor ..	English make offered at 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial ..	£30 per ton net.
Magnesium Oxide—	
Light Commercial ..	£75 per ton, less 2½%.
Heavy Commercial ..	£20 per ton, less 2½%.
Heavy Pure	1s. 6d.—2s. per lb., according to quantity. **Steady market.**
lenthol—	
.B.R. recryst. B.P. ..	50s. per lb. Weaker.
Synthetic	26s.—35s. per lb., according to quantity. English make. Strong demand.
lercurials	Market flat.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate ..	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
lethyl Salicylate .	1s. 10d.—2s. per lb. Weak tendency.
lethyl Sulphonal ..	26s. per lb.
Ietol	11s. per lb. British make.
'araformaldehyde ..	2s. 10½d.—3s. per lb. Not very active.
'araldehyde	1s. 5d.—1s. 6d. per lb. in free bottles and cases.
'henacetin	6s.—6s. 3d. per lb. Price and demand steady.
'henazone	7s. 3d.—7s. 6d. per lb. A shade firmer. Forward prices higher.
'henolphthalein	6s. 6d. per lb. Ample supplies.
'otass. Bitartrate—	
99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
'otass. Citrate	1s. 10d.—2s. 2d. per lb.
'otass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues heavy.
'otass. Metabisulphite ..	7½d. per lb., 1-cwt. kegs included.
'otass. Permanganate .	7d. per lb. Keen competition keeps price low.
)uinine Sulphate ..	2s. 3d. per oz., in 100 oz. tins. Very heavy demand.
tesorcin	5s. 6d.—5s. 9d. per lb. Firmer. Scarce.
accharin	63s. per lb., in 50-lb. lots.
alol	3s. 6d.—3s. 11d. per lb.
ilver proteinate	9s. 6d. per lb.
'od. Benzoate, B.P. ..	2s. 6d. per lb. Ample supplies. B.P. quality available.
od. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
od. Hyposulphite—	
Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
od. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
od. Nitroprusside ..	16s. per lb. Less for quantity.
od. Potass. Tartrate (Rochelle Salt) ..	75s.—82s. 6d. per cwt., according to quantity. Steady market, good demand.
Sod. Salicylate	Market more active. Powder 2s. 2d.—2s. 4d. per lb. Crystal at 2s. 1d.—2s. 6d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol	18s. per lb. Very scarce indeed. Still rising. Forward quotations 22s. per lb.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine	15s. 3d. ,,	
Amyl Acetate	2s. 9d. ,,	
Amyl Butyrate	6s. 9d. ,,	
Amyl Salicylate	3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 10½d. ,,	
Benzyl Alcohol free from Chlorine	2s. 10½d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate ..	3s. 6d. ,,	
Cinnamic Aldehyde ..		
Natural	16s. ..	Advanced.
Coumarin	20s. ,,	
Citronellol . ..	17s. ..	Again advanced.
Citral	10s. ,,	
Ethyl Cinnamate ..	13s. 6d. ,,	
Ethyl Phthalate	3s. 3d. ,,	
Eugenol	11s. ,,	
Geraniol (Palmarosa) ..	35s. ,,	
Geraniol	11s.—18s. 6d. per lb.	
Heliotropine	7s. 9d. ..	Advanced.
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose ..	26s. ,,	
Linalyl Acetate	26s. ,,	
Methyl Anthranilate ..	9s. 6d. ,,	
Methyl Benzoate ..	6s. ,,	
Musk Ambrette	45s. ,,	
Musk Xylol	14s. 6d. ..	Again cheaper.
Nerolin	4s. 9d. ,,	
Phenyl Ethyl Acetate ..	15s. ,,	
Phenyl Ethyl Alcohol ..	16s. ,,	
Rhodinol	57s. 6d. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. 4d. ,,	
Vanillin	25s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 8d. per lb.
Bergamot Oil	19s. 6d. per lb.
Bourbon Geranium Oil ..	36s. 6d. ,,
Camphor Oil	75s. per cwt.
Cananga Oil Java ..	10s. 6d. per lb.
Cinnamon Oil, Leaf ..	6½d. per oz.
Cassia Oil, 80/85% ..	8s. 9d. per lb.
Citronella Oil—	
Java 85/90%	5s. 8d. per lb. Again cheaper.
Ceylon	3s. 7d. per lb. Again cheaper.
Clove Oil	7s. 6d. per lb. Dearer.
Eucalyptus Oil 70/75% ..	2s. per lb.
Lavender Oil—	
French 38/40% Esters	29s. per lb.
Lemon Oil	3s. per lb.
Lemongrass Oil ..	3d. per oz.

Orange Oil, Sweet ..	.. 13s. per lb.	Cheaper.
Otto of Rose Oil—		
Bulgarian ..	.. 35s. per oz.	
Anatolian ..	.. 26s. per oz.	
Palma Rosa Oil ..	.. 19s. per lb.	
Peppermint Oil—		
Wayne County	.. 21s. per lb.	
Japanese ..	.. 14s. 3d. per lb.	
Petitgrain Oil ..	.. 9s. 3d. per lb.	Cheaper.
Sandal Wood Oil—		
Mysore	.. 26s. 6d. per lb.	
Australian ..	.. 21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Sept. 23rd, they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on August 7th.

I.—Applications

Davies. Rotary ovens. 17,117. July 17.

Davies. 17,351. *See* VIII.

Day. 17,221. *See* XIX.

Duncan. Furnaces. 16,811. July 11.

Hardinge. Dry-grinding apparatus 16,942. July 15.

Hulsmeyer. Production of non-oxidising steam. 16,888. July 14.

Hurrell. Production of colloidal suspensions. 17,211. July 17.

Lush, and Technical Research Works. Production of metallic catalysts. 17,061. July 16.

Magnet-Werk Ges. Eisenach Spezialfabr. fur Elektromagnet Apparate. Utilisation and treatment of waste material. 17,178. July 17. (Ger., 12.2.24.)

I.—Complete Specifications Accepted

8497 (1923). Peachey Process Co., Ltd., Shaw, and Parsons. Treatment of articles or material with gases. (218,715.)

9526 (1923). Hodson. *See* VIII.

9599 (1923). Thermal Industrial and Chemical (T.I.C.) Research Co., Ltd., Rider, and Watts Heating liquids by introduction into molten metal. (218,723.)

9875 (1923). Bateman. Separators employed for separating liquids of different density. (218,742.)

14,670 (1923). Thermal Industrial and Chemical (T.I.C.) Research Co., Ltd., and Rider. Apparatus for the heat treatment of materials. (218,807.)

II.—Applications

Both. Production of gas and/or vapour from hydrocarbons. 16,968. July 15.

Donald. Drying peats etc. 16,938. July 15.

Jansen. Distillation and/or cracking of hydrocarbon oils. 17,253. July 18.

Konig. 16,853. *See* XXIII.

Tausz. 17,072. *See* XII.

II.—Complete Specifications Accepted

760 (1923). Jackson (Koppers Co.). Coke-ovens. (218,690.)

9526 (1923). Hodson. *See* VIII.

13,569 (1923). McIntire. Retort furnace. (218,802.)

26,567 (1923). Wilputte. Coke ovens. (218,898.)

31,764 (1923). Rude. Carbonisation of coal and production of high-grade gas. (218,925.)

IV.—Applications

Bloxam (Akt.-Ges. fur Anilin-Fabrikation). Manufacture of dyestuffs. 16,954. July 15.

Ransford (Farbenfabriken vorm. F. Bayer und Co.). Manufacture of dyestuffs. 17,300. July 18.

V.—Applications

Bourcot and Regnault. Removing ink from printed paper. 16,943. July 15. (Fr., 19.7.23.)

Farbenfabriken vorm. F. Bayer und Co. Manufacture of artificial silk. 18,301. July 18. (Ger., 20.7.23.)

Haefely et Cie. Akt.-Ges. Manufacture of mica-coated fibrous material. 16,952. July 15. (Switz., 28.7.23.)

Naamlooze Vennootschap Nederlandsche Kunstzijdefabriek. Manufacture of artificial threads from viscose. 17,073. July 16. (Ger., 8.8.23.)

V.—Complete Specifications Accepted

25,273 (1923). Christoph und Unmack Akt.-Ges. Hardening the surfaces of fibrous materials. (205,494.)

29,586 (1923). Soc. pour la Fabr. de la Soie "Rhodiaseta. Manufacture of artificial threads. (218,913.)

VI.—Applications

Bedford. Dyeing wool. 17,331. July 19.

Dawson, Farrell, Roberts, and Smith. Scouring and bleaching textile fibres etc. 16,972. July 15.

VII.—Application

Miller and Williams. Preparation of water-soluble phosphate salts. 17,025. July 16.

VII.—Complete Specification Accepted

836 (1923). Cowburn. Production of concentrated sulphuric acid. (218,694.)

VIII.—Application

Davies. Fire-resisting materials for rotary ovens etc. 17,351. July 19.

VIII.—Complete Specifications Accepted

9359 (1923). Marks (Libbey Glass Co.). Melting glass. (218,718.)

9526 (1923). Hodson. Manufacture of basic bricks, furnace linings, retorts and the like. (218,720.)

9964 (1923). Gandin, and Dartmoor China Clay Co., Ltd. Bleaching kaolin etc. (218,747.)

IX.—Applications

Colley, and Hickman, Ltd. Production of road material from furnace slag. 16,817. July 14.

Fiorenza. Building materials etc. 17,177. July 17.

IX.—Complete Specification Accepted

10,064 (1923). Saunders. Synthetic mineral asphalt. (218,750.)

X.—Applications

British Aluminium Co., Ltd., Gwyer, and Phillips. Alloys. 17,359. July 19

Burgers. Treatment of pig iron. 17,277. July 18.

Lush, and Technical Research Works. 17,061. *See* I.

Naamlooze Vennootschap Philips' Gloeilampenfabrieken. Separating hafnium and zirconium. 17,203, 17,309. July 17, 18. (Denmark, 18.7.23 and 25.8.23.)

Western Electric Co., Ltd. (Western Electric Co., Inc..) Metallic compositions. 17,043. July 16.

X.—Complete Specifications Accepted

7258 (1923). Finspongs Metallverks Aktiebolag. Heating elements for electric rotating resistance furnaces for treating zinc powder. (195,610.)

19,485 (1923). General Electric Co., Ltd. Manufacture of alloys containing tungsten carbide. (213,524.)

657 (1924). Aktiebolaget Ferrolegeringar. Production of alloys poor in carbon and silicon. (209,742.)

XI—Application

Pehrson and Rowlands. Electric furnaces, kilns, etc 17,162. July 17.

XI.—Complete Specification Accepted

7258 (1923). Finspongs Metallverks Aktiebolag. *See* X.

XII.—Applications

Chemical Engineering Co. (Manchester), Ltd., Battersby and Spensley. Separation of oils or fats. 17,053. July 16.

Lush, and Technical Research Works. 17,061. *See* I.

Tausz. Purification of oils. 17,072. July 16. (Ger., 16.7.23.)

XII.—Complete Specification Accepted

29,210 (1923). Bollmann. Removing odoriferous substances from oils and fats. (218,910.)

XIII.—Complete Specification Accepted

12,969 (1923). Indurit Products Co., Ltd., and Fairgrieve. Production of articles of the phenol-formaldehyde condensation product type. (218,793.)

XIV.—Complete Specification Accepted

19,197 (1923). British Dyestuffs Corporation, Ltd., Lefebure and Hailwood. Accelerating the vulcanisation of caoutchouc. (218,854.)

XVI.—Complete Specification Accepted

25,538 (1922). Igawa, and Asahi Garasu Kabushiki Kaisha. Manures. (218,401.)

XVIII.—Application

Steffens. 17,261. *See* XX.

XIX.—Applications

Chitty, Jones, and Woodlands, Ltd. Heat treatment of flour. 16,837. July 14.

Day. Water-distilling apparatus. 17,221. July 18.

Howles and McDougall. Manufacture of insecticides, sheep dips, etc. 17,361. July 19.

Sim and Weir. Deaerating water. 17,032. July 16.

XX.—Applications

Clark (Knoll and Co. Chemische Fabrik). Manufacture of double compounds of dimethylxanthines, earth alkali, and salicylic acid. 16,886. July 14.

Fairweather (National Aniline and Chemical Co., Inc.). Production of -nitranisole. 16,920. July 15.

Steffens. Dehydration of alcohol. 17,261. July 18. (U.S., 16.8.23.)

XXIII.—Application

Konig. Process for continuously recording heat value of gas mixtures. 16,853. July 14. (Ger., 14.7.23.)

GENERAL NOTES

Official Trade Intelligence

The Department of the Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W.1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number: *Argentina:* Textiles (135); *British India:* Steel bars, wrought iron cotters, and gibs (Madras and Southern Mahratta Railway Co., Ltd., 25, Buckingham Palace Road, London, S.W. 1); *Canada:* Leather goods (B.X./1102); *Denmark:* Metals and Technical products (119); *France:* Oils, Fats and greases (121); Groundnuts (122); *Melilla:* Soaps (132); *New Zealand:* General machinery (111); *Rumania:* Tin, terneplates and chemicals (128); Electrical plant (129); *South Africa:* Textiles, cutlery and electro-plate (114); Chemists' and druggists' sundries (115); Steel tubes (A.X 1166); *Spain:* Oil seed, chemical manures and colours (130).

Trade Information.

The Ruths Steam Accumulator Co., Ltd, of Central House, 45, Kingsway, London, W.C. 2, announce that their steam accumulator, of which, owing to its interest for the chemical industry, a description was given in the July 25 issue of *Chemistry and Industry*, is now being made in this country. Those interested are invited to visit the company's stand (Nos. 291-292, Bay 24) in the Palace of Engineering in the British Empire Exhibition. The Ruths Steam Accumulator Company are the sole licensees for the British Empire for the manufacture and distribution of the Ruths Steam Accumulator.

The Half year's Trade of Great Britain

Imports at £88,501,452 show a reduction of £33,585,147 on the May figures and a decrease of £858,072 on June 1923. Exports are down on the previous month by £8,236,644 at a total of £62,024,238, which is a decrease of £859,321 on June a year ago. Imports for the six months of this year were valued at £598,423,937, an increase of £59,548,409 over the corresponding period of last year, which British exports totalled £388,464,802, a rise of £5,785,775. Figures of some of the items of interest to our readers are appended.

	Import (value c.i.f.) June, 1924 £	Inc. or dec. as compared with June, 1923 £	Export (value f.o.b.) June, 1924 £	Inc. or dec. as compared with June, 1923 £
Coal	463	− 563	5,728,045	−3,222,734
Other non-metallic mining and quarry products, etc.	426,496	− 94,796	168,761	12,968
Iron ore, etc.	757,015	− 52,317	47,690	+ 10,572
Non-ferrous metalliferous ores, etc.	1,085,013	− 263,789	90,257	− 41,115
Wood and timber	4,011,422	− 448,353	45,486	+ 3,483
Cotton	6,116,510	+3,667,715	156,264	+ 46,987
Wool	4,871,525	− 425,540	618,548	− 242,904
Silk	153,809	+ 46,072	2,303	− 1,005
Other textile materials	520,347	− 160,967	31,017	− 20,518
Oil seeds, etc.	3,822,480	− 254,435	446,298	− 136,533
Hides and skins	1,628,762	+ 488,861	159,285	− 21,320
Materials for paper making	1,248,507	− 170,137	135,702	+ 1,417
Rubber	523,598	− 155,196	9,421	+ 3,684
Miscellaneous	643,638	− 23,399	160,979	− 107,783
Earthenware, etc.	682,196	+ 5,914	1,034,448	− 21,754
Iron and steel manufactures	1,692,851	− 534,954	6,300,115	− 525,251
Other metals	2,384,538	+ 456,316	1,203,349	+ 30,131
Cutlery, etc.	395,793	− 218,472	717,950	+ 102,061
Chemicals, etc.	1,018,816	+ 89,984	1,902,644	− 481,216
Oils, fats, etc.	3,359,853	+ 123,060	858,746	+ 210,250
Leather and manufactures thereof	1,044,255	+ 48,017	542,715	+ 65,559
Paper and cardboard	955,632	− 306,284	702,459	− 15,332
Rubber manufactures	328,158	− 35,178	446,741	− 6,293

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JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufactnrers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

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EDITORIAL

It is no easy task to trace the history of holidays; it may be conjectured that in old days when nearly everyone lived in the country it was desirable to collect at harvest-time all those whose energies could be usefully directed towards the hayfield or the cornfield. We imagine that our vacations are now regulated by schoolmasters and other educators of youth; they fix for us the times when we can leave the chargeable noise of this great town. Fortunately for us the time which suits the schoolmaster for a trip to Brittany or Scotland equally suits the average chemist, and it is the time of year when the great towns are most unendurable and the country most delightful. Mothers, nurses and young children hasten to modern seaside resorts where outrageous prices are paid for uncomfortable and inartistic rooms facing a dreary patch of shingle, wet sand, or muddy sea. Every time we are persuaded that it is good for our body or soul to visit the coast of Norfolk, Suffolk or Essex we exclaim, either inwardly or aloud, in the words of Charoba:

"Is this the mighty ocean? is this *all*?"

The man, of any age from sixteen to sixty, who works in a town, if he possess a soul or an approximation to one, yearns for the country. Those who from early childhood have frequented mountains, hills and dales can never, even in London, quite forget them. They see, a mountain ascending, a vision of trees; bright volumes of vapour through Lothbury glide, and a river flows on through the vale of Cheapside!

* * *

How full are the old authors of references to the glades, springs and rivers, the wooded hills and tufted mounds which delighted the toil-worn Roman. It seems to us that every chemist who loves his science must long in August and September to go to a district where chemistry, as most of us imagine it, has no part. Of course, we all know the chemistry of agriculture is most fascinating and difficult, but it is not the study of this which drags us away from our chains and fetters, our retorts and our flasks. Give us an old country town or village whose houses were chiefly built in the seventeenth or early part of the eighteenth century; it is better they should be of stone with stone roofs; let us have a village green or a spacious square with a crazy old church clock and the bewildered chimes, as some poet calls them; a pastoral country is best where men talk of the breed of bullocks; it is an additional advantage if it is a cheese-making district. There let us ruminate, let us climb some local eminence and look round on a dozen counties spread out for our delectation; let us hear the lark, the peewit and, best of all, the curlew or the golden plover, and we can endure for a further spell our town existence. Call it not life. Some little care must be exercised in the choice of an inn or a hotel; it must not be too luxurious, too like the Carlton or the St. Pancras; we wish to have the country, not to move our town home to a distant spot. We like a hearth, for even in August and September we have been grateful for a fire; running water hard by is pleasant, but are not all these adjuncts described by many a philosopher?

Sit non doctissima conjux:
Sit nox cum somno; sit sine lite dies.

Let us have a daily newspaper, a local one is the best, and let our only scientific pursuit be the collection of reports of presidential addresses to the British Association to be read when we return to town.

We desire no alternate polarities or steam superheaters with us; time was when we could judge a field of oats before it was cut, or after it was threshed; we aspire to this again, but any other perfectly useless piece of knowledge is equally suited to a vacation. It is good to take a Virgil or a Martial with you to the country, or a volume of Anatole France or Coppée; it is also good to bring them back unopened. It is a sign your holiday has done you some service. If you return with a few pieces of rock or mineral wrapped up in fragments of the *Craven Herald* or the *North Oxfordshire Gazette*, let that also be to your credit. *O rus, quando ego te aspiciam?*

* * *

We have made a sort of exception in favour of the meetings of the British Association. It is nearly a hundred years since Sir Humphry Davy, Charles Babbage, Playfair, and most of all, Sir David Brewster, began an agitation for the co-ordination of British Science. In conjunction with the Yorkshire Philosophical Society and its secretary, John Phillips, a meeting was held in York in the year 1831, when the British Association was brought into existence. Mr. O. J. R. Howarth, in his pleasant retrospect published a couple of years ago, quotes from Brewster passages which bear some resemblance to others of more recent date: speaking of England Brewster said: "Bribed by foreign gold, or flattered by foreign courtesy, her artisans have quitted her service—her machinery has been exported to distant markets—the inventions of her philosophers, slighted at home, have been eagerly introduced abroad—her scientific institutions have been discouraged and even abolished." Brewster blamed everybody, our learned societies, especially the Royal Society, the ignorance and supineness of the Government, and the injudicious organisation of our scientific boards and institutions, and so on. We can almost imagine—but the British Association was founded and flourishes yet. The address of Sir Robert Robertson shows us that the Government's neglect of science is not so scandalous as it was a century ago. If anyone in holiday mood is inclined to be pessimistic, let him read the words of Brewster; he will wonder whether there was some inherited taste for criticism, some inherent desire to point out to all and sundry what stupid people they were; did not some such spirit dominate Ruskin and Carlyle? "Ye would be fools and victims and ye are." Sir Robert Robertson shows us how first one Government department, and then another, found out the need for chemical assistance in the interest of revenue, or health, or efficiency in offence or defence. A reference to his chart, which will be published in next week's issue, brings this home to us very forcibly, and we suppose that during the next fifty years the growth of Government science will be at least as great as during the previous hundred and fifty. The lack of organisation of our scientific institutions is not so striking as it was, and many of our present chemists are determined to improve the organisation of their science at an early date. It is a task which awaits those now on a holiday. But in the meantime let them enjoy their sunny shores, their flowery meads, with no thought of the morrow.

CHEMISTRY AND THE STATE *

Address by

SIR ROBERT ROBERTSON, K.B.E., F.R.S.

Introduction

It should be premised that in this account of the relationship of the State to chemistry in Great Britain, an attempt has been made to limit it to a description of the more or less direct assistance given by that science to various departments as they came into being or took form. Only in recent years, and as a result of the war, has there been a direct recognition of a corresponding obligation on the other side.

It is obvious that it is to the universities, and, as was the case to a greater extent in the past, to private workers, that the great advances made by British chemists are due. Departmental requirements have, of course, reaped the advantage of these advances, but examples of important contributions to chemical knowledge emanating from the departments themselves are not lacking. The collected story of their connexion with the activities of the State may be worth reciting, if it should show the development of its appeal to chemistry, and illustrate the gradual breakdown of the view held by the chief of the tribunal before which Lavoisier came, that "the State has no need for chemists."

We will find that their employment in an official capacity was in the first instance in connexion with the State's pressing necessities, such as its defence, the regulation of its currency, and the collection of its revenue, all of them subjects warranting the maintenance of equipment and staff.

As the need for safeguarding the nation's health, well-being, and the quality of its food-supply became recognised, legislation followed, frequently based on the work of Commissions on which sat distinguished chemists of the day, and it became necessary to set up a State chemical department to assist in carrying this into effect.

For some time the science of chemistry had received a limited and vicarious assistance from State grants to the late Science and Art Department and to the universities, but it was reserved for the war to establish definitely and finally the position that the whole future existence of a State might and probably would depend on the existence of a flourishing and efficient chemical industry. This resulted in the definite steps of assisting the application of science to industry, and providing direct encouragement for workers in the purely academic field.

It is proposed, therefore, to sketch the development of the main chemical activities of the State, and to review the conditions in Great Britain in the hope that it may be of use generally to define the present position, and perhaps of interest to this Dominion in the present stage of its chemical development.

* Presidential Address before Section B of the British Association Meeting at Toronto

Defence—Explosives

It would appear that the importation of the technical process from abroad is no new thing, for it is stated that in 1314 gunpowder and guns were being imported into England from Ghent. Not only the material but the executant also appears to have been imported in the person of a John Crab, a Fleming, who took service with the English and supervised the guns and munitions used at Crécy. By 1338, cannon were mounted on board English ships of war, and in 1346 gunpowder was being supplied to the King. Although the manufacture of gunpowder is mainly a mechanical operation, variations in the composition which must have involved chemical experiment are recorded in such works as the "Fire Work Books" of that interesting class, the Master Gunners. In England, a Master of the Ordnance in 1447 is stated to have made 20 tons of gunpowder. This manufacture, however, early became stabilised, and the proportions of the composition underwent little change until the middle of the nineteenth century, when it was modified, but as freedom from smoke began to be demanded a new propellant of a type that could be produced only by chemists was evolved.

It is of interest that Faraday was employed by the War Office as Lecturer at the Royal Military Academy from 1829 to 1853, and on appointment took as his assistant James Marsh, whose name, associated with the process for determining arsenic, is so well known to chemists. Marsh received the gold medal of the Society of Arts for this work, and a silver medal from the Board of Ordnance for his discovery of the quill percussion tube for cannon, and further he devised some of the earlier types of time-fuse. Abel succeeded Faraday at the Academy and began his long career of activity as scientific adviser to the War Office, becoming War Department Chemist in 1854.

It is necessary to mention some of the important advances made by Abel and his staff, including Kellner and Deering. By pulping guncotton, he rendered it safe to handle and store; his researches on the properties of guncotton laid the foundation of later work on its stability and explosive properties; and his research (with Noble) on the behaviour of gunpowder when fired is an example of a thorough investigation. Abel was consulted also on subjects other than explosives, and in his laboratory were conducted experiments which led to the adoption in 1879 of the present close-test apparatus for testing the inflammability of oils, experiments on steels and the effect of foreign materials in them, experiments on dangerous dusts and on the cause of accidents in coal mines.

The work of Abel in rescuing nitrocellulose from the position of an erratic substance, liable to decompose and explode on storage, led to its use as a reliable explosive, not only for military purposes, but also in commercial compositions, such as sporting powders and blasting explosives.

When it became necessary to devise a smokeless propellant for the British Service, the chemical work was in the hands of Abel with his assistant Kellner, Dewar, and Dupré, and in 1890 this resulted in the recommendation for the adoption of cordite.

It now became necessary to extend the only chemical manufacture carried on at the Royal Gunpowder Factory, that of guncotton, by adding the manufacture of nitroglycerine, the technical handling of cordite, and plant for treating acids, and accordingly in 1891 a chemical manager of this section with a staff of chemists was appointed.

The chemical work carried out by the British Government for defence, both as to its immediate object and as to its reaction on the explosives industry of the country, is worth review. In such a review the position before the war may first be described. Propellant manufacture was seriously undertaken, the small quantity of high explosive used at this time being mostly obtained from private manufacturers. Guncotton, as has been stated, had been manufactured by Abel in a fairly stable form, and this explosive was chosen for the Service propellant cordite, together with nitroglycerine and mineral jelly, the mixture being gelatinised by acetone, so that in a plastic condition it might be squirted into the cords which give it its name. A close study was devoted to this manufacture in all its aspects; the processes of manufacture were greatly improved, and the dangers reduced.

The Royal Gunpowder Factory took its place as a model of an explosives factory, and afforded an example of what could be done by a State department in conducting a scientific manufacture with regard to improved technique, economy, and efficiency. Thus the method of nitration to produce guncotton was greatly improved in safety, freedom from fumes, and ultimate stability of the product, by the adoption of the process of downward displacement of the waste acids from the nitrated product by a layer of water; for nitroglycerine a displacement process by which the layer of that liquid, separating on the surface of the waste acids, was caused to overflow from the top of the vessel by introducing waste acid from a previous charge at the bottom, led to an increased safety and yield, and saved height in the erection of a factory; the chemistry of the process of guncotton boiling was worked out and placed on a scientific foundation; and acetone, which in the process of drying the cordite had been allowed to escape into the air, was recovered from the drying stoves and saved for further use. These advances in manufacturing method were taken up by other manufacturers, both in the United Kingdom and abroad.

In the technique of the manufacture of propellant explosives before the war this country then had advanced to a high pitch of efficiency, so that when the demand came for enormously increased quantities of propellants, new factories, such as that of Gretna, took up the manufacture on lines already well established.

Safety in manufacture had also been closely studied, and precautions introduced that commended themselves to private firms. It may be said in this connexion that the application of the Explosives Act of 1875 by the Home Office Inspectors of Explosives has been of much benefit to the explosives trade in reducing casualties. Perhaps in no other

country are precautions taken to such an extent as in Great Britain, so that to visitors from abroad they sometimes appear unnecessary and vexatious, but experience has shown that the policy is sound, especially as it brings into all sections of the work an atmosphere of carefulness and responsibility, with an eventual gain in health of the workmen and freedom from accidents.

Research on explosives before the war was carried out at the Royal Gunpowder Factory and at the Research Department, Woolwich. At the former establishment, the chemistry of the products manufactured was investigated, especially with regard to the mode of decomposition of guncotton, of nitroglycerine, and of cordite: their respective rates of decomposition at different temperatures were determined, a subject bearing on their behaviour on storage. Knowledge of this kind, is essential in a Service such as ours, on account of the extremes of temperature from tropical to frigid to which explosives may be subjected in stations throughout the Empire.

At Woolwich an experimental establishment had been set up on the instigation of Lord Haldane to deal with explosives and metals used in gunnery. Here the study of the chemical and explosive properties of all types of explosives was undertaken and methods were developed for determining their stability and sensitiveness. This knowledge found application in laying down criteria for the choice of explosives for use in a Service whose demands are exigent on account of the drastic conditions above mentioned, affecting both storage and the design of mechanism containing explosives. So far as the subject-matter is not considered to be confidential, this work has been published in scientific journals, so that it is available in connexion with the study of the theory of explosive substances.

A new phase was entered with the declaration of war, and ultimately all chemical help was mobilised for the defence of the realm. A nucleus existed at Woolwich, where the small staff of eleven chemists had been occupied in the study of explosives and their application. In two directions this experience proved of importance, for it enabled immediate answers to be given to questions which would otherwise have necessitated protracted storage trials, and it afforded the staff the training necessary to qualify them to meet the fresh demands that became urgent on the outbreak of hostilities.

After the beginning of the war the increase of work imperatively called for a larger staff, and more chemists were appointed, until at the beginning of 1917, the home supply being exhausted, permission was obtained to withdraw from France members of the Special Brigade, R.E., of whom more than thirty were transferred to the Department. Finally, the chemical staff numbered 107 chemists and physicists distributed in an organisation which had been gradually evolved, comprising sections for dealing with different classes of work, such as organic chemistry, physical chemistry, analytical and general chemistry, physical investigation, calorimetry, stability, pyrotechny, applications of high explosives, fuze design, and records.

The manufacture of high explosives had not previously been undertaken by Government, and the known processes for making trinitrotoluene, which was early chosen as a Service high explosive, were unsatisfactory. One of the first subjects, therefore, taken up after the outbreak of war was the provision of an efficient and rapid process for the manufacture of trinitrotoluene, especially without the use of fuming sulphuric acid (oleum). From the results of a large series of nitrations in the laboratory, a process was evolved characterised by several novel features, and this was put to the proof on the semi-industrial scale of a quarter ton, a plant being designed and erected in the Research Department, Woolwich, for nitration, including appropriate arrangements for the mixing and concentration of acids. This small plant substantiated in a remarkable way the process evolved from the laboratory work, and from the start turned out trinitrotoluene of good quality and yield. The process found immediate application in the large Government factories that were designed and erected by Mr. Quinan and also in numerous private works built at this time. The small-scale plant mentioned was used also for the purpose of training chemists, who proceeded to operate chemical plant in Government and private factories.

A study of trinitrotoluene in all its aspects was undertaken, and much attention devoted to its chemistry, the proportions in which the isomers occur in the crude product being determined by thermal analysis, and investigations were made on their interactions, stability, sensitiveness, heat values and explosive properties. Most of the scientific results of this work have since been published.

When it became evident, as it soon did to Lord Moulton, that the supply of high explosives in use, lyddite and trinitrotoluene, would not suffice, the Research Department put forward mixtures of ammonium nitrate and trinitrotoluene, the amatols, as a result of a study of their properties and of their effects in shell-bursting trials. Gun trials confirmed these trials at rest, and the adoption of amatol as a high explosive quickly followed. Various methods of filling these mixtures into shell were at this time worked out, and many of them were applied on the very largest scale.

It was found that 80/20 amatol (80 parts of ammonium nitrate to 20 of trinitrotoluene) was less easy to bring to detonation than lyddite or trinitrotoluene itself, and it required special arrangements in the train of initiation of detonation. These were successfully devised, and good and trustworthy detonation of our shell was secured. Ultimately, amatol became practically the only explosive for land and aerial warfare, and justified the early estimate of its properties and capabilities. It is economical in that it makes use of a cheap ingredient, and has explosive properties that render it very suitable for the purposes for which it is used. In 1917 the production was at the rate of about 4000 t. a week.

The Department continued the study of amatol, especially with regard to its chemical stability and

compatibility with the various materials with which it came into contact. Certain impurities in ammonium nitrate were discovered to be objectionable, and investigation of these led to an improvement in the purity of the ammonium nitrate supplied. The manufacture of amatol and the modes of filling it into shell occupied the attention of a large staff of chemists attached to the factories, and an increase in knowledge of its chemical and physical properties led to improved methods of handling it.

The Service propellant cordite required for gelatinisation in the course of its manufacture the solvent acetone, of which the supply ran short when the programme for propellants began to exceed all previous calculations. To meet this situation, cordite of the existing type was retained for Naval Service, but for Land Service a modification was introduced under the name of cordite R.D.B. (Research Department powder 'B'). This propellant could be made without any alteration in the plant required for the manufacture of cordite. Instead of acetone the solvent employed was ether-alcohol, and instead of guncotton a lower nitrate of cellulose was used. The great factory at Gretna, also built by Mr. Quinan, manufactured cordite R.D.B. exclusively, and this soon became the only propellant made in this country for the Land Service. It was produced both by Government and by private firms in enormous quantities. The alcohol was made in the country from grain, and other was produced from it, so that dependence on sea-borne solvent was reduced. It was this need for alcohol that led to the restrictions imposed on that liquid when used as a beverage.

Numerous problems arose in connexion with these manufactures as they developed and in the application of the explosives in the various types of ammunition, and these necessitated the study of the explosives in all their aspects. A large addition to the knowledge already existing was thus acquired on the more theoretical side of the study of explosives, and much of this has been made available by publication.

As the demand on our resources increased, and the necessity grew for investigating every source of supply and possible alternative, it came to pass that nearly every professor of chemistry in the country was mobilised for investigation in this field and in that of chemical warfare, and much valuable work was done by them, both of a research and inspectional nature.

For the manufacture of explosives and the operation of filling them into munitions of various kinds in the existing factories and the new ones which sprang up, a large staff of chemists, amounting to about 1000, was required, and in this way many chemists whose earlier work lay in quite other directions, such as at the universities or in teaching posts, received an insight into technology and took control of workmen.

During the war itself, instructional work in this subject was not wanting, for current progress in the factories under his control was discussed in a systematic manner by Mr. Quinan with representatives of his staff, a course which led to important improvements. Although most of these war-time plants for the manufacture of explosives have been dismantled, much of the technical experience gained has been saved, and will be found incorporated in a series of memoirs (Technical Records of Explosives Supply) published by H.M. Stationery Office. The information set forth in these volumes is in a form which has a much wider appeal than to the explosives technologist only, and their study is commended to those who take up the subject of chemical technology in any of its aspects.

In addition, factories for the production of substances not in themselves explosive equally required the services of chemists, and many were employed in the production of such substances as methyl alcohol, acetone, and acetic acid.

Instruction in chemistry is provided by the Fighting Services for Naval and Marine cadets at Dartmouth, and for Army cadets at the Royal Military Academy and the Royal Military College, Camberley. For selected officers, both of these Services have a professorial staff for providing systematic courses in theoretical and practical chemistry, with special reference to Service applications, at the Royal Naval College, Greenwich, and at the Artillery (formerly the Ordnance) College, Woolwich.

Defence—Chemical Warfare

While our well-developed position of the great inorganic chemical manufactures was a source of strength when the demand came during the war for an enormous production of ammonium nitrate, for example, our neglect to foster a great organic chemical industry led to dangerous delays and improvisations. This was apparent from the beginning when several universities had to co-operate to produce a sufficient supply of local anæsthetics, and when presently our lack of dyes, photographic developers and sensitisers revealed our former dependence on foreign supplies. In November, 1914, the Royal Society had set up a Committee to assist the Government, and this became an Advisory Committee when, after May of the following year, the gas attack caused the British Government, which up till then had scrupulously refrained from its use, to retaliate with that weapon. Special companies were created of chemists whose work often had little of a chemical aspect, but many of these men, in twelve to eighteen months, had to be withdrawn for research and control of plant. Chemical advisers were appointed to the armies and for liaison purposes, a central laboratory for rapid identification was established in France, and co-operation was effected with the physiologists. At home assistance was afforded to chemical contractors, and the manufacture of respirators to meet needs rapidly becoming more complex was carried out with great vigour and efficiency. The increasing importance of gas warfare led to a proving ground at Porton being acquired, when the research which had been carried out at the Imperial College at South Kensington became centralised there. As the final proof of explosive projectiles is carried out at Shoeburyness, it was now possible on this new proving ground to settle questions relating to the filling and correct performance of chemical shell, thus enabling the Chemical Warfare Designs Committee to recommend ammunition to meet the

needs of a situation which was continually developing, until the proportion of chemical shell compared with high explosive shell was finally a large one.

In the ramifications of this work all the chemical skill in the universities not already applied to explosives was mobilised, since the demand for new designs involved the manufacture of new substances for shell, bombs, and grenades, new smoke and incendiary compositions, and continuous research and experimental work both on the offensive and defensive sides.

In a few cases only was the country capable of expanding its existing manufactures, as in the case of phosphorus and chlorine; it was not equipped for the home production of phosgene, arsenical compounds, or mustard gas. New factories had, therefore, to be erected and staffs specially trained, in striking contrast to the existence in Germany of standardised plant capable of rapid transference from one purpose to another with little alteration; an example of this was their manufacture of arsenical preparations in the azo-dye sheds.

As a result of an intensive study of absorbent substances, our respirator was never beaten, and it is claimed that, although our output was smaller, the better employment of gas, tactically for surprise, lay with us. Starting late and entering a field entirely new, we were able while there was yet time to protect the soldier, and to make a reply on the offensive side that was rapidly becoming more and more effective.

Not all of the work specially devoted to chemical warfare has been without its effect on peace-time requirements. Thus liquid chlorine, of which very little was made in this country before the war, is now being prepared electrolytically and transported by rail in tank waggons for use in various industries. For the preparation of phosgene, which had been used in Germany in the manufacture of dyes of the triphenylmethane series, better methods were discovered in this country, so that cheaper and purer phosgene is being used here for the first time to prepare the important group of colours known as the Victoria blues. Improved methods are now available for the manufacture of arsenical compounds, such as arsenic trichloride, a substance used for combating the growth of prickly pear in Australia; and mention may be made of the work of Prof. Moureu in France, on the stabilisation and concentration of acrolein, as it has led to the production of a substitute for celluloid from that body. In addition, the study of many of the bodies used for chemical warfare has been of value from the aspect of the elucidation of their chemical constitution.

Metallurgy

When the part played by metals in the history of civilisation is considered, the development of some more durable alloy or some stronger metal appears intimately linked with a distinct advance, constituting a new age, often characterised by eponymous association with the metal. As the possession of some superior metal may give ascendency to a people, it is natural that States should show interest in metallurgy, both militarily and to maintain the standard of the medium of exchange. It is thus seen that iron and the precious metals, gold and silver, have for the most part interested the modern State, the metallurgy of the other metals only more recently coming in for attention on military grounds. Accordingly, we find the armourer and the minter holding important positions in early times.

It must be stated at the outset that the relations in Great Britain between the State and metallurgical science before the war of 1914 to 1918 were for the most part sporadic, the great developments in that science being to a large extent independent of the State. It undoubtedly exerted, however, an influence on the nature and quality of metallurgical products, of which it was a large user for warlike, structural, and shipbuilding purposes, by specifying the conditions of their acceptance: standards established by the Government, often based on enquiry and experiment, gave confidence to other users and resulted in the improvement of industrial materials.

Although iron-making had flourished intermittently since the Roman occupation, and had reached considerable proportions under Elizabeth, no great contribution to knowledge can be attributed to Great Britain in the progress of metallurgy until the restriction of the cutting down of timber for charcoal towards the end of the sixteenth century forced into consideration the use of coal for smelting, the pioneer work being that of Dud Dudley, who in 1642 cast iron cannon at his foundries for the Royalist troops. It was his experience as an Admiralty official that brought Cort, more than 100 years later, to recognise the inferiority of English wrought iron, and to leave the Service for the purpose of improving existing processes so that his successful wrought iron was accepted towards the end of eighteenth century for anchors and iron wor the Royal Navy. His invention of the pu process led to great prosperity in the iron trade.

The need to meet Government requirements became similarly urgent in the case of steel, which in its earlier production as puddled steel so failed in uniformity of composition that as a materi of construction it could not be used by the Admiralt nor permitted by the Board of Trade. Bessemer's great advance of converting molten iron cast into steel by blowing air through it, described in 1856 to this Association, enabled him to propose a material more suitable for guns and projectiles than the cast iron then employed. Bessemer steel came into use for many purposes, and its production increased rapidly, but boiler plates submitted to the Admiralty still showed great variations in carbon content. Meanwhile the rival open-hearth process was steadily developed and established by Siemens. In 1875 the Director of Naval Construction had pointed to the danger due to lack of uniformity of steel made by the converter process, but in 1879 he was able to report the success of the new open-hearth steel. The Government challenge had been taken up by Siemens, who produced a steel to meet all its specifications, so causing its acceptance for Admiralty work, and its admission by the Board of Trade for structural use.

After Thomas and Gilchrist had in 1877 solved the problem of dephosphorising iron by the basic

process, the Admiralty instituted an enquiry as to its properties, which led to an official recognition of basic steel, thus greatly enlarging the source of supply through the use of native ores.

Among the men who assisted the Government in these enquiries was Dr. Percy, who placed metallurgy in this country on a scientific basis, while lecturing on that subject at the Royal School of Mines and at the Ordnance College. Abel, appointed War Department Chemist in 1854, gave much attention to the use of iron and steel for military purposes, investigating the question of erosion of guns and throwing new light on the constitution of steel by his isolation of Fe_3C. He did good service in convincing the great ironmasters of the importance of chemistry in their industry. To Roberts-Austen also, Chemist and Assayer to the Mint, many Government inquiries and commissions were indebted for advice on the subjects he had enriched by his researches, such as the physical constants and mechanical properties of metals, the effect of impurities, the cementation of iron, heat treatment, and many others, including the first "freezing-point" curve of a series of binary alloys in 1875. It was in consequence of these that his co-operation was invited by the Alloys Research Committee, whose first six reports contained a great deal of his work, covered a wide field, and did much towards the realisation by engineers of the value of microscopical and thermal methods in the study of metals. Later reports to this committee, whose work in 1902 was transferred to the National Physical Laboratory, have maintained their high standard, and have been contributed to by such workers as Carpenter, Hadfield, and Rosenhain.

The last of these reports, the eleventh, embodies work at the National Physical Laboratory from 1914 to 1918, the year when that Institution became a part of the Department of Scientific and Industrial Research. It deals with light alloys, the need for which the war has emphasised, especially in connexion with aircraft. For this purpose the Laboratory's work has resulted in furnishing alloys of aluminium with zinc and copper, with copper and manganese, and with copper, nickel and magnesium, possessing remarkable and useful properties, such as high tensile strength at ordinary and also at raised temperatures.

Since the war light aluminium alloys continue to be studied at the National Physical Laboratory, which is the Government establishment where metallurgical research is carried out mainly for the advancement of knowledge. Here has been worked out the constitution of many important systems, binary, ternary, and quarternary, in which aluminium is the largest constituent, and the wire models constructed for the ternary alloys have proved of great value in the study of their constitution. Such questions as age-hardening have been investigated and the cause ascertained.

Systems with copper as the dominant metal have been investigated as regards their constitution, as well as the effect on their mechanical and electrical properties of known additions of other substances that may be present as impurities.

But attention is also being given to ferrous alloys for whose investigation specially pure components have to be prepared, in order to eliminate the effect of impurities of which a very small proportion may often have a marked influence on the product, and several equilibrium diagrams with iron as the main component have been worked out. Research on the more physical side includes investigation on the heat evolved during the plastic deformation of a metal, on the effect of heat treatment and composition on the magnetic properties of tungsten steels, on fatigue, and on the physical constants of metals. By the application of X-ray analysis to the crystal structure of metallic systems, Rosenhain has obtained confirmation of his conception of the nature of solid solutions.

The chemical section of the National Physical Laboratory carries out a large amount of work in connexion with these researches, the investigation of methods of analysis, and the preparation of standards for the analysis of steel, as well as chemical work of a non-metallurgical nature.

Maintained by the Fighting Services since 1904 to increase the efficiency of the metals used in the manufacture of ordnance and armament, the Metallurgical Branch of the Research Department, Woolwich, increased in numbers, building and equipment during the war, and at present employs about 25 metallurgists. It has been occupied for the most part with steel, the heat treatment of which in relation to its mechanical properties has been the subject of close study, resulting in improved gun forgings being delivered by the makers. Two main types of steel have been under consideration, those which would give a minimum yield point of about 35 tons per square inch when treated in large masses, and those at about 25 tons. As a result much information has been acquired on the properties and heat treatment of steel containing various proportions of nickel, chromium, molybdenum and vanadium. The study of the elastic properties and of the erosion of gun steel has been of importance to gunnery. The Moore adaptation of the Brinell hardness test, in which a small ball and load are used in a specially designed machine, was originally developed in the Department for testing small arm cartridge cases, and has since found many other important applications here and elsewhere.

Among other investigations on non-ferrous metals, those on "season-cracking" of brass and its prevention, and on methods of extrusion, have been productive of useful results, and in connexion with the Non-Ferrous Metals Research Association, work is in progress on the casting of brass to produce sounder ingots, on the die-casting of brass and bronze, and on the failure of lead cable sheathing by cracking.

During the war, the use of substitutes, the easing of specifications to increase output with safety, the examination of enemy ammunition, and the tracing of causes of failure and discovery of remedies provided a large field for investigation.

The other aspect of metallurgy of special interest to the State, that of minting, has a long history:

from early times the need for a high and uniform standard of coinage, and the crime of debasing it, have been recognised. The difficulties that confronted the early assayers, without methods of quantitative analysis and with no fine balances, are apparent from the description of their methods, but it may perhaps be held that these needs as they became borne in on the early assayers and their frequent collaborators the alchemists, led the way to the appeal to weighing in chemical work.

As early as 928 A.D. laws were proclaimed by King Athelstan appointing 'mynteres' whose products were scrutinised at the trial of the pyx; later, in 1180, supervisors of the coin manufactured by 'moneyers' were appointed.

An official mention occurs in the reign of Edward I of a Guild of Goldsmiths in London, which had, however, existed since 1180, in an Act providing for the assay of silver vessels by the Wardens of that craft. The earlier writings on the subject of assaying are those of Germans, of whom Queen Elizabeth brought over a number to introduce their methods and assist in the development of the resources of the country.

The course of testing seems to have been originally by means of the touchstone, supplemented much later by observing the effects of acid on the trace left by drawing the metal over the stone, the method of determination of density, the cupellation method, officially recognised by Henry II, and finally the wet method of analysis.

To safeguard the fineness of the coinage a King's Assayer was appointed in 1222, a Master of the Mint manufacturing the coin under contract, and a Warden acting on behalf of the King. A Commission, having toured the Continental mints, reported in 1870 in favour of the present organisation of the Chancellor of the Exchequer being Master of the Mint in virtue of his office, a Deputy-Master being responsible for the administration, while the valuation of bullion and questions of assay are the duties of the Chemist and Assayer.

Many of the Mint officials have contributed largely to metallurgical knowledge. One of them, William Humphrey, in 1565 received the first patent for making brass, and a later one, Sir John Brattle, communicated work to the Royal Society shortly after its foundation on the oxidation of lead. Sir Isaac Newton when Warden is said to have himself conducted experiments on the composition of foreign coins. The melting-points of metals were studied in conjunction with Wedgwood by Alchorne, who was appointed Assay Master in 1789. From 1851 to 1870 several distinguished men of science, such as Hofmann, Graham (who in 1866 published a work on the effect of the occlusion of gases in metals), Miller, and Stenhouse, were officials of the Mint; but in 1870 it was considered preferable to conduct the chemical operations of assaying within the Mint itself, and Roberts-Austen, to whose pioneering work in metallurgy allusion has been made, was appointed. To his successor, Kirke Rose, are due many advances in knowledge of the precious metals. Thus, researches at the Mint have been directed to the investigations of metallic systems of gold with silver and other metals, the means of avoiding brittleness in gold coins, the electrolytic refining of gold, the mechanism of annealing of metals, the surface tension of solid and molten metals, as well as to improvements in the technique of the methods of assay.

Revenue

In reviewing the influence of our science in its application to Revenue questions, it is convenient to consider historically the substances on which the State has levied duties.

In the older tariffs, fixed charges were levied on goods considered as a whole, but a time arrived when the chemist was called in; it then became possible to make an assessment on the ground of a percentage. Uncertainty prevailed, therefore, as to the basis of taxation and gross adulteration flourished until scientific safeguards were introduced.

The chief substances with which the chemist is at present concerned from the Revenue point of view are the following:—(1) liquids containing alcohol; (2) tobacco; (3) sugar; (4) tea and cocoa; (5) dyestuffs, under the Dyestuffs (Import Regulation) Act, 1920; (6) substances under the Safeguarding of Industries Act, 1921.

(1) *Liquids containing alcohol.*—On imported wine Richard I imposed a duty, and as time went on complications were caused by the introduction of imposts for various purposes, including reprisals.

Acts were passed, as in the time of Charles II, for preventing the reprehensible practices of mixing wine and vitiating it with other substances such as cider, sugar, herbs and vitriol; it is still forbidden to mix wines of different sorts.

The difficulty of distinguishing the strength of alcoholic liquids is apparent in the older enactments, when, for example, the Legislature describes brandy as a "strong water perfectly made imported from beyond the sea," and it was not until the reign of William III that they were assessed, if not in proportion to their strength, at least in some relation thereto. The first step was their separation into 'single' and 'double' proof, a rough and inconclusive one, but accounting for the use of a term still recognised as that on which the full statutory rate of duty is leviable.

For charging Revenue the gallon was first taken as a measure in 1825, but definite alcoholic strength was not introduced as a basis until 1860, under a treaty with France, while a little later, in 1862, Parliament distinguished between wines above and below 26 degrees of proof spirit, this figure being raised in 1886 to 30 degrees.

The want of some accurate method of test had been felt, and it is interesting to follow the gropings after a method for recognising a standard strength of alcohol. Thus observations on the surface tension of spirits were employed, for Postlethwaite in 1751 described as a mark of their being up to proof the length of time elapsing before bubbles disappear from the surface of the liquid contained in a glass tube which had been shaken, but as he believed this method may be falsified, he recommended for more accurate work "the essay instrument, or hydrostatical balance," although for

business men it would be sufficient to burn a measured quantity of the spirit in a metal cylindrical vessel immersed in cold water, and measure the remainder, which should be equal to half the original volume, if the spirits were proof. Although "Boyle's bubble" had been described in 1675, and Monconý's areometer in 1679, the first instrument generally adopted by the Revenue in 1730 was the hydrometer of Clarke, legalised in 1787. It is complicated, however, and its temperature correction by "weather weights" was unsatisfactory, so that Parliament gave instructions for "proper experiments to be made."

At the request of the Government to the President of the Royal Society, Sir Charles Blagden (secretary) and one of the clerks, Mr. George Gilpin, undertook to make experiments on the specific gravity of alcohol and water in varying proportion. These experiments, conducted with exemplary care and ability, were reported to the Royal Society in 1790, 1792 and 1794, and formed the basis for the tables of Sikes, whose hydrometer became the sole legal instrument in 1818, and is still in use. These tables remained legal for nearly a hundred years, but in 1916 were replaced by a new and extended set, prepared under the supervision of Sir Edward Thorpe at the Government Laboratory, whence also in the same year were issued comprehensive tables of spirit strengths for use with pyknometers, as these had shortly before been legalised for alternative use in the determination of alcohol. Both of these sets of tables were founded on the definition of proof spirit contained in the Act of George III, which is, that spirit which at the temperature of 51° F. weighs exactly 12-13 parts of an equal measure of distilled water. In other words, it contains 49·28 parts by weight of pure alcohol and 50·72 parts by weight of distilled water.

As these tables refer only to alcohol-water mixtures, all disturbing substances must be removed before the strength of liquids is determined by hydrometer or pyknometer. The methods of freeing spirit in commercial articles from everything but water were investigated and laid down by the Government Laboratory in 1903 by Thorpe and Holmes.

From the point of view of trade it is highly important to have free use of ethyl alcohol, while from that of the Revenue it is essential to prevent the use of such duty-free spirit as a beverage. The most effective means to meet both requirements is to denature spirit which is to be delivered duty-free for trade purposes, and the question of the choice of a suitable denaturant is by no means easy. So long ago as 1856, the Government Chemist of the day, Mr. Phillips, proposed the addition of 10 per cent. of crude wood naphtha, and this has been found satisfactory for most purposes. The proposal was submitted to and approved by three well-known chemists of that day, Graham, Hofman and Redwood, and this present year circumstances have necessitated the addition of a further nauseating ingredient, pyridine, in addition to mineral naphtha which was added in 1891. Mineralised methylated spirit which is sold without Revenue control, excepting that a licence is needed, contains this proportion, industrial methylated spirit 5 per cent., and power alcohol $2\frac{1}{2}$ per cent. on the alcohol.

That some misunderstanding exists as to the facilities available for the use of alcohol in commerce in the United Kingdom appears from an article recently communicated to the Ottawa Section of the Society of Chemical Industry, in which are contrasted a considerable number of compositions approved in Canada with the apparently small number legalised in Great Britain. It might be well, therefore, briefly to indicate the position, in order to make clear the facilities that are available.

Mineralised methylated spirit consists of a mixture of 90 parts of alcohol, $9\frac{1}{2}$ parts of wood naphtha, and half part of crude pyridine, together with $\frac{3}{8}$th of 1 per cent. of mineral naphtha and 0·025 of an ounce of methyl violet dye in each 100 gallons of the mixture. It is sold under licence, but is otherwise unrestricted and duty-free.

Power methylated spirit, prepared in accordance with the following formula: 92 parts of alcohol, 5 parts of benzol, 0·5 part of crude pyridine, and 2·5 parts of wood naphtha, together with 0·025 of an ounce of Spirit Red III dye in each 100 gallons of the mixture, is also sold without restriction and freedom from duty when mixed with 25 per cent. of hydrocarbons or denatured ether or some other substance approved by the Commissioners of Customs and Excise.

Industrial methylated spirit, consisting of 95 per cent. of ethyl alcohol and 5 per cent. of wood naphtha, can be obtained for the arts and manufactures under the authority of the Board of Customs and Excise, under bond and certain not very onerous restrictions. Between three and four million bulk gallons are annually used for the making of such products as varnishes, linoleum, soap, solid medicinal extracts, ether, toilet preparations for external use, fine chemicals, photographic plates, dyes, surgical dressings, fireworks, and for many other purposes, including its use in the chemical laboratories of colleges, schools and works, and for preserving museum specimens. It is free from duty, but must not be present in an article capable of internal use, either as a beverage or a medicine.

Duty-free pure alcohol is allowed by the Board of Customs and Excise for scientific purposes to universities and public institutions for teaching and research, and specially denatured alcohol in arts and manufactures in which the use of the industrial methylated spirit is unsuitable.

The pure alcohol is allowed to colleges and public institutions for teaching and research purposes without any onerous conditions beyond the keeping of a stock account. Pure methyl alcohol is permitted by the Board of Customs and Excise to be used duty-free in arts and manufactures under regulations similar to those for industrial methylated spirit, and is largely used in the manufacture of formaldehyde, of methyl derivatives among dyestuffs and fine chemicals, and for the purpose of crystallisation.

The specially denatured alcohol, also free from duty, is allowed to manufacturers under restrictions

compatible with the safety of the Revenue, a very wide choice of denaturants being permitted. When, as frequently happens, a suitable denaturant is found in some intermediate product, or acid used, or produced during the manufacturing operations, or when the alcohol is a constituent of some mixed solvent, permission is the more readily granted for its use. An example of progressive policy in the use of pure spirit is the recent decision of the Board of Customs and Excise to allow the use of pure ethyl alcohol denatured with 2 per cent. of pure methyl alcohol in the production of insulin, without onerous Excise restrictions. It is understood that the recent action of the Board of Customs and Excise has been received with satisfaction by the Association of British Chemical Manufacturers. The quantity of pure and specially denatured alcohol used during last year was about half-a-million gallons.

In the case of duty-paid spirits used for medical purposes such as the preparation of tinctures, and for scientific purposes in chemical laboratories, a rebate is allowed under the Finance Act of 1920, amounting to about 80 per cent. of the duty.

While the responsibility rests on the Board of Customs and Excise of safeguarding the illicit use of alcohol, chemists have been represented on such commissions as that of the Industrial Alcohol Committee of 1905, whose recommendations led to the Revenue Act of 1906, in which the proportion of wood naphtha was reduced to 5 per cent., permission being also given for the payment of an allowance of 5d. per proof gallon or about 8d. per bulk gallon on British spirits used for industrial purposes, in consideration of the increased cost of the spirits owing to Excise restrictions.

An important alcoholic liquid that has been liable to imposts from the time of Charles II is beer, and it was charged according to its strength or weakness as judged by the palate. After the application of science to brewing about the middle of the eighteenth century, the saccharometer was introduced, the pattern due to Bate being still in use for Revenue purposes. In 1850 an investigation made by the then Government Chemist, Mr. Phillips, and his assistant, Mr. Dobson, established a quantitative relationship between the proportion of alcohol produced in the process of fermentation and the solid matter previously in solution in the worts that had been fermented, and tables were prepared for use in determining the original gravity of the beer, *i.e.*, the specific gravity of the worts before fermentation had begun. These tables, after verification by Profs. Graham, Hofmann and Redwood, were employed in the Revenue service until 1914, when they were superseded by revised ones prepared by Sir Edward Thorpe and Dr. Horace T. Brown, these being rendered necessary mainly owing to the employment in brewing of many substitutes for malt unknown in the earlier days. As a rapid means for determining the original gravity the immersion refractometer is constantly in use in the Government Laboratory. This laboratory also furnished the scientific evidence for the Inland Revenue Act of 1880, which enabled brewers to use a great variety of substances for brewing.

(2) *Tobacco.*—Not long after its introduction Elizabeth imposed a small duty on tobacco, which under James I met with not only his famous Counterblast, but an increased duty of 6s. 10d. a pound. Although Charles I continued its repression, and the Puritans regarded its use as "profanity," the snuff-box became in the time of Queen Anne a necessity of the fashionable world. A regular trade sprang up in preparing substitutes from various leaves, and numerous enactments proved incapable of preventing smuggling and adulteration. It was recognised that systematic chemical and microscopic examination had to be applied to the problems arising from this adulteration, and in 1843 a laboratory, which ultimately grew into the Government Laboratory, was erected to check it, with the result that this form of fraud was almost entirely stamped out. A strict watch is still maintained on all tobacco for home use or for export, both from the point of view of absence of foreign materials and of its hygroscopic condition, as the Revenue charge is based on the latter. Chemical control is exercised over the use of preservatives and the denaturing of tobacco before it can safely be allowed out of Revenue control.

(3) *Sugar.*—In the reign of James I the importation of sugar was already sufficiently large to make it worth while to impose a duty on it, until at the beginning of the nineteenth century this amounted to 30s. a hundredweight. Before 1875, when the duty was abolished, disputes had arisen as to its proper assessment on the basis of description and character. When it again became dutiable in 1901 an extended classification was based on the polariscope scale, and sugars in numerous preparations had to be determined chemically. This has raised several difficult questions of chemical procedure, especially when natural as well as added sugars are present.

(4) *Tea and cocoa.*—Attempts were made in 1777 to stop the adulteration of tea with foreign and exhausted leaves and other matter, but it was not until 1875 that the Sale of Food and Drugs Act placed on the Revenue authorities the responsibility for examining tea on importation. This is done on an extended scale by the application of chemical, microscopic and practical tests. There has been, however, no imposition of standards in the United Kingdom, as is the case in Canada and the United States.

The duty, and the drawback on the duty, on cocoa preparations has introduced chemical problems into the system of Revenue control, some of them of considerable difficulty, as, for example, those connected with the use of substitutes for the natural cocoa fat.

(5) *Dyestuffs, under the Dyestuffs Import Regulation Act,* 1920.—The importation of dyestuffs under this Act is controlled by a Dyestuffs Advisory Licensing Committee, on which distinguished chemists represent the science.

Importation of synthetic dyestuffs and intermediates is prohibited except under licence, and although the individual substances leave little

room for doubt, more difficult questions come before the Government Laboratory in the case of substances containing a coloured ingredient.

(6) *Substances taken under Safeguarding of Industries Act*, 1921.—Part I of this Act imposes an *ad valorem* duty on the products of certain "Key" industries, of which the fine-chemical manufacturing trade is one. After the Act had passed into law, the Government Laboratory became concerned with the chemical aspect of that section which has gained notoriety through legal inquiries involving the precise significance of chemical and technical terms. But apart from such matters, many difficult chemical problems have arisen in determining the composition of the great variety of chemical substances imported. Thus it has proved a task of some magnitude to deal with about 8000 subjects per annum, when their examination may include the quantitative determination of the ingredients of materials such as synthetic perfumes, photographic developers, medicines, colloidal preparations, alkaloids, etc. The grade of a specified material has also frequently to be assessed, and this involves a special knowledge of its manufacture and use.

The effect of the war was generally to increase the amount of existing duties and to impose fresh ones. The former condition led to increased vigilance in the chemical control on account of the introduction of substitutes to replace the dutiable substances; the latter were imposed as a post-war condition and are described above. In connexion with the war-time prohibition of exports, not only of munitions but practically of all useful commodities, the services of the Government Laboratory were required to decide as to the nature of about 20,000 substances, including cases in which the prohibited goods were skilfully disguised.

For all matters involving chemical advice the Board of Customs and Excise applies to the Department of the Government Chemist, who maintains on his staff for this section of the work a sufficient number of chemists and assistants to make the necessary investigations and deal with the chemical points at issue, as well as to carry out the necessary practical work, both in London and at several of the ports. This aspect of the work of the Government Laboratory involves a knowledge of Revenue law and precedent as well as an intimate acquaintance with a large range of chemical manufacture.

The importance of chemical control in safeguarding the Revenue is obvious. With increase in the number of subjects brought under supervision, the greater refinements and accuracy demanded, the investigation of new processes, and the amount of chemical work, the number of chemists is rapidly increasing.

(*To be continued*)

As Prof. H. Kamerlingh-Onnes, of Leiden, has requested to be relieved of his professional duties, his place will be taken by Prof. W. J. de Maas.

FORTHCOMING EVENTS

Aug. 9. NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS. Annual General Meeting, to be held in the Lecture Theatre of the Institute, Newcastle-on-Tyne, at 2 p.m.

Sept. 4 and 5. IRON AND STEEL INSTITUTE, Autumn Meeting at British Empire Exhibition, at 10.30 a.m. each day. (1) "Changes of Volume of Steels During Heat Treatment," by L. Aitchison and G. R. Woodvine. (2) "Investigations on the Herbert Pendulum Hardness Tester," by C. Benedicks and V. Christiansen. (3) "Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on some Magnetic Properties of Steel," by E. D. Campbell and G. W. Whitney. (4) "Pickling: The Action of Acid on Iron and Steel, and the Diffusion of Hydrogen Through the Metal," by C. A. Edwards. (5) "Examination of Iron from Konarak," by J. N. Friend and W. E. Thorneycroft. (6) "On the Nature of High-Speed Steel," by M. A. Grossman and E. C. Bain. (7) "Improvements in the Brinell Test on Hardened Steel, including a New Method for Producing Hard Steel Balls," by A. Hultgren. (8) "Present Position of the Theories of the Hardening of Steel," by W. Rosenhain. (9) "Effect of Free Surfaces on the Plastic Deformation of Certain Metals," by F. C. Thompson and W. E. W. Millington.

Sept. 8 to 11. INSTITUTE OF METALS. Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at Wembley.

The following papers will be read:—"A Method for Measuring Internal Stress in Brass Tubes," by R. J. Anderson and E. G. Fahlman; "The Application of the Ideal Solubility Curve to the Interpretation of Equilibrium Diagrams in Metal Systems," by D. H. Andrews and Prof. J. Johnston; "Seventh Report of the Corrosion Research Committee of the Institute of Metals," by G. D. Bengough and R. May; "Comparative Results on Copper-Silicon-Aluminium and Other Aluminium Alloys as Obtained on Separately Cast Specimens and Specimens cut from a Crankcase Casting," by E. H. Dix and A. J. Lyon; "The Determination of Sodium in Aluminium," by D. M. Fairlie and G. B. Brook; "The Extrusion of Brass Rod by the Inverted Process," by R. Genders; "Investigation of the Effects of Impurities on Copper. Part II—The Effect of Iron on Copper," by D. Hanson and Grace W. Ford; "The Relationship Between Tensile Strength, Temperature and Cold-Work in Some Pure Metals and Single Solid Solutions," by D. H. Ingall; "On the Effect of Progressive Cold-Rolling on the Brinell Hardness of Copper," by H. Moore; "Experiments on the Working of Nickel for Coinage," by Sir T. K. Rose and J. H. Watson; "Some Experiments on the Effect of Casting Temperature and Heat-Treatment on the Physical Properties of a High-Tin Bronze," by F. W. Rowe; "Some Experiments on the Influence of Casting Temperature and Mass on the Physical Properties of Admiralty Gun-Metal," by F. W. Rowe; "Studies in the Aluminium-Zinc System," by T. Tanabe; "Metal Spraying and Sprayed Metal," by T. H. Turner and W. E. Ballard.

BRITISH ASSOCIATION OF CHEMISTS

The annual meeting of the Manchester Section was held at the Albion Hotel, Dr. J. L. Hankey presiding. In his Annual Address the chairman said that whilst many societies had lost members, the Manchester Section, like the Association in general, could record an increase. The steady influx of new members, especially under the " A " qualification, was most satisfactory, and indicated that the Association filled a purpose which was not served by other existing chemical organisations. The Unemployment Benefit Fund, which was a determining factor in this satisfactory position, appeared to be on sound lines. Benefits had been paid to 26 members, 7 of whom were at present in receipt of benefit. The scheme was founded on an obligatory basis, and it would not be possible to change this to a voluntary basis without involving a large increase in the limit rate of contribution. Dr. Hankey appealed for full support for the Fund from those already in assured positions, and expressed his belief that the Fund was the outward expression of a sentiment of solidarity among chemists which alone could raise the status of the profession. The desirability was emphasised of establishing some working arrangement with the Institute of Chemistry. The Conference held by the Institute at Liverpool last October had evidenced the progress of the view that both organisations were necessary and that they mutually supplemented one another. Negotiations with the National Union of Scientific Workers had led to the agreement to issue a joint Journal which would shortly appear. In conclusion Dr. Hankey appealed for support for the Journal.

Dr. H. Levinstein expressed his agreement with the views expressed by the Chairman, particularly with regard to the Unemployment Benefit Fund, and their relationship with the Institute of Chemistry. There was no doubt that the B.A.C., had made real progress in the last six months, and quite a remarkable change had been brought about in the opinion of the profession in general. Before the Labour Government came into power no deputation from the B.A.C. would have been received by the President of the Board of Trade as the Deputation regarding the Dyestuffs Agreement was received by Mr. Webb. The B.A.C. in this and in other ways was receiving at last its due recognition. Nevertheless rapprochement with the Institute should be one of the main objects, and the B.A.C. should explore all possible avenues of co-operation. Co-operation was one of the great needs of the chemical profession, and its pertinence was enforced by the financial stringency in which the Chemical Society and the Society of Chemical Industry found themselves. As far as possible, all overlapping or duplicating of work, whether in publication or meetings, should be avoided. He thought it not impossible that in the future through central organisation some arrangement for the compounding of subscriptions should be put into operation.

Mr. E. F. Morris, and subsequently Mr. W. E. Kay, explained the motives which had led the Council to receive a deputation from the Society of Technical Engineers and other Engineers' Associations (which were related to the Institutes of Civil and Mechanical Engineering in much the same way as the B.A.C. is related to the Institute of Chemistry) on the subject of the proposed National Council of Staff Technicians. The Council, however, felt that the interests of the Association at present would be best served by concentrating on organisation among chemists themselves, a view endorsed by several other speakers.

Mr. R. Brightman suggested that co-operation with the Institute of Chemistry and with the Society of Chemical Industry might well begin along informal lines. Something might be done if the various committees got into touch at informal meetings, and it should be possible to organise at least one joint meeting during the winter session of the Institute of Chemistry, the Society of Chemical Industry and the B.A.C., in districts where local associations had been formed. Ultimately a joint programme might be arranged for the session open to all members irrespective of what organisations they might be members. In regard to publications, a lead was already being given by the Chemical Society and the Society of Chemical Industry in regard to abstracts of chemical papers. He hoped that this lead would be followed. It should prove possible at any rate to issue in one journal the proceedings of the Chemical Society, the Society of Chemical Industry, the Institute of Chemistry and the B.A.C., instead of scattering them in four volumes as at present. Perhaps the Federal Council would ultimately explore such possibilities of co-operation and economy.

At the election of officers and Committee Mr. C. W. Carpenter was elected chairman, Mr. E. A. Marchment, Hon. Treasurer, and Mr. G. E. Yarrow was re-elected Hon. Secretary. The meeting concluded with votes of thanks to the retiring officers.

SACCHARINE INDUSTRY IN GERMANY

Saccharine was introduced into Germany about forty years ago, when a number of German chemical concerns took up its manufacture and the product became an important article in commerce. The competition thus introduced so threatened the sugar and sugar-beet industry of the country, however, that the Government passed the Saccharine Law. This limited the sale of saccharine to the sick, under certain exceptional circumstances, and confined its manufacture to one company, and the five other German chemical concerns then manufacturing it were forced to cease production. This legislation resulted in considerable stocks being smuggled into Germany from Holland and Switzerland. During the acute sugar shortage experienced through the war the law was repealed in 1916, when the Government allocated its further production to another firm. The demand increasing, the saccharine was rationed until 1920, and since then the trade in this commodity has been free, and it is now widely used both by households and industries. This action of the Government arose from the necessity of exporting considerable sugar in exchange for grain. It is calculated that for one pound of sugar Germany receives five pounds of grain.—(*U.S. Comm. Rep.*, *May* 26, 1924.)

CORRESPONDENCE

A POINT OF ORDER

Sir,—There is no difficulty in representing by means of conventional symbols the fact that one atom has transferred an electron to each of two other atoms. This can be shown by comparing the polar formula of the nitro-group I with that of the carboxyl-group II.

Each formula shows two negatively-charged oxygens; but these have taken their extra electrons in one case from an atom of carbon and an atom of hydrogen, whilst in the other case both electrons have been taken from the same atom of nitrogen. The positive and negative charges are, however, completely balanced, so that each group is a neutral radical (although strongly polarised) and not an ion.

These conventional formulæ will be found to be in harmony with the complete electronic formulæ, since the atoms of nitrogen and of carbon are each credited with a *sextet* of L-electrons, precisely as in the nitrate and carbonate ions, the three-fold symmetry of which is reproduced in the crystals of sodium nitrate and of calcite. It is, however, much more risky to assign a double positive charge to carbon than to nitrogen, since this would usually imply (*e.g.*, in acetylene, if formulated as $\mathrm{H}\overset{++}{\mathrm{C}}\!-\!\overset{--}{\mathrm{C}}\mathrm{H}$) a reduction in the number of L-electrons to four.

The application of these electronic formulæ to compounds of the type of vinyl ethyl ether introduces an additional problem. I presume that this compound acts primarily as an olefine, and that the main (but not necessarily the only) product of activation would be represented by the polar formula $\overset{-}{\mathrm{C}}\mathrm{H}\cdot\overset{+}{\mathrm{C}}\mathrm{H}\cdot\mathrm{O}\cdot\mathrm{C_2H_5}$. In such a case the oxygen appears to determine the direction in which the ionisation of the vinyl-group will preferentially occur; but it is difficult to picture the oxygen in an ether as itself becoming ionised, unless perhaps in an oxonium salt, *e.g.*, in a hydriodide formed as an intermediate product prior to splitting off ethyl iodide. Some separate symbol is therefore evidently needed to express the influence of groups which do not themselves react, but are none the less able to influence the way in which the more reactive groups in the molecule will react.

I am glad to be able to confirm by optical evidence the view that "the benzene ring may functionate as a resonator rather than as a true key polarising group," since this phrase expresses exactly the influence of the aromatic ring in benzylidene-camphor on the absorption spectrum of the parent ketone. In this case Miss H. S. French has shown that the "resonance" of the conjugated system increases the intensity of the selective absorption of the carbonyl group 560 times, but without producing the slightest alteration in the characteristic frequency of the band. The second carbonyl-group in camphorquinone, on the other hand, refuses to accept this passive role, and shifts the selective absorption from the ultra-violet into the visible region, although the intensity of the absorption is not changed. The relevant curves and data are contained in a paper of which an abstract has already appeared in this *Journal* (this vol., p. 641).—I am, Sir, etc.,

T. M. Lowry

THE USE OF ALUMINIUM UTENSILS

Sir,—Allow me through the medium of your columns to thank Mr. Jeromo Alexander for his suggestion of a possible danger in the use of "aluminium" for pots and pans in which food has to be cooked. If aluminium is alloyed with zinc or copper, is it at all likely that these latter metals would dissolve in the presence of metallic aluminium? I should scarcely think so. If anything was dissolved it would be aluminium. Although this is more than mere surmise, the confinement to my chair prevents me from making experiments to prove it. Although aluminium is not classed with the poisonous metals, yet one does not know what its effects may be when taken day after day in some condition of solution or colloid. The detection of small quantities of aluminium, when mixed with soup, jam, or other foods, might be no easy matter—not like the detection of lead or copper. In the old days of adulteration of bread with alum, the colour test with logwood was generally used. Alizarine was subsequently used by me as a distinctive test for alumina (*J.S.C.I.*, 1885, 310), and possibly a method somewhat as follows might serve the purpose:—Decolorise with chlorine—destroy excess—exactly neutralise, or leave very faintly acid—add a little sodium acetate and a drop of acetic acid—boil with a very little alizarine, say one drop of a 1 per cent. mixture with water. The presence of aluminium would probably be indicated by a pink or red coloration. Not being able to make experiments myself I thought that these suggestions might be of some use to those who are interested in the matter.—I am, Sir, etc.,

Joseph Barnes

PERSONAL AND OTHER ITEMS

Dr. J. T. Conroy and Mr. F. W. Bain have been appointed as additional directors to the board of the United Alkali Co., Ltd.

Lord Bearsted has given £10,000 to the University of Sheffield for the encouragement of study and research in the department of metallurgy. As Lord Mayor of London Lord Bearsted laid the foundation-stone of the university buildings 21 years ago.

The title of Reader in Physical Chemistry in the University of London has been conferred on Mr. W. E. Garner, M.Sc., in respect of his post at University College.

Dr. Shiro Tashiro, associate professor of biochemistry in the University of Cincinnati, has been awarded the Gakushûn prize by the Imperial Academy of

Arts and Science of Japan for his work "in proving that the nervous impulse is a chemical reaction and not primarily a physical reaction."

Prof. Julius Wagner, who died recently at the age of sixty-seven, had held a professorship in the University of Leipzig since 1901. His work lay mostly in the domain of analytical chemistry, and he had published books on mass analysis, tables of chemical constants and related subjects.

We greatly regret to announce the death of Sir George Beilby, F.R.S., who was president, during the year 1898-99, of the Society of Chemical Industry. An obituary will appear in a later issue.

Information Bureaux and Special Libraries

A Conference will be held at High Leigh, Hoddesdon, Herts, during the week-end September 5-8, to which are invited all those who need to utilise information systematically, or who are interested in the conduct or operation of information bureaux, intelligence services and special libraries. The programme will include papers and discussions on the functions, future developments, and the methods and equipment of intelligence bureaux, and on their relations with other institutions, including national and public libraries. It is hoped to obtain representatives of such varied fields of activity as Government and municipal departments, technical and research institutions, industrial concerns, financial houses, insurance offices, newspapers and civic and social organisations, all of which have a common interest in the collection, treatment and dissemination of facts and information relevant to their particular activities. Further information may be obtained from Mr. A. F. Ridley, Athenæum Chambers, 71, Temple Row, Birmingham.

Gift to Leeds University

The Council of the University of Leeds, at its meeting on July 16, received with much pleasure an announcement of the gift by Mr. Alfred Lund, J.P., of Pudsey, of a sum of £5000 for the foundation of scholarships for students of the Clothworkers' Departments, and the following resolution was passed:—

> That the Council records its deep sense of gratitude to Mr. Alfred Lund, J.P., for his liberal gift of £5000 for the foundation of scholarships for students of the Clothworkers' Departments. This practical evidence of interest and confidence in the work of the University is a source of great encouragement to all its members, and the Council is gratified to think that Mr. Lund's generosity will be the means of enabling promising students of the Clothworkers' Departments to undertake study and research which will lead to the further advancement of so important an industry.

Iron Ore in Tasmania

A conservative estimate of the iron ore deposits in Tasmania by Messrs. W. H. Twelvetrees and A. M. Reid, government geologists, gives the amount of 42,710,000 tons. The following are the localities in which the ore deposits occur:—Blyth river, 17,000,000 t.; Dial Range and Penguin, 700,000; Long Plains (Rio Tinto), 20,000,000; Zeehan district, 3,700,000; and Beaconsfield and Anderson's Creek, 1,300,000 t. The Rio Tinto deposits are estimated to have an average grade of 65 per cent. iron. The Zeehan district deposits show an analysis of over 70 per cent. iron. The Blyth river deposits run from 44 per cent. up to 69 per cent. iron. Iron-ore deposits occur in several other districts, but they are insufficiently developed and investigated to enable an ore reserve to be expressed in figures.

Metallurgy in Luxemburg in April

The metallurgical output in Luxemburg in April 1924 was 185,625 tons of cast iron, and 156,868 t. of steel, compared with 165,312 t. and 150,952 t. respectively, in the preceding months. By far the bigger proportion was produced by the Thomas process.

The Italian Glycerin Trade

Since the war the Italian foreign trade in glycerin has not been important. Domestic production suffices for local needs, and a small quantity of the crude is exported to London, Hamburg and Antwerp. Some purchases through London are for shipment to New York, and occasionally direct sales to importers in the United States are effected. In 1922, the production of crude glycerin amounted to 13,800 quintals (1 quintal=220·46 lb.), compared with 9100 q. in 1921, 8400 q. in 1920, 7220 q. in 1919, and 20,450 q. in 1918. The output of refined glycerin totalled 6070 quintals in 1922, against 5400 in 1921, 10,400 in 1920, 12,700 in 1919 and 22,750 in 1918. Shipments of crude glycerin are usually made in iron cylinders holding about 400 litres, weighing approximately 1100 lb. The buyer frequently furnishes the containers. For domestic trade, refined glycerin is sold in glass containers holding approximately 100 lb. The following table shows the Italian foreign trade in glycerin during 1923, and also for 1913, and the years 1919 to 1922 inclusive:—

	Imported Quintals	Exported Quintals
1913	7009	12,588
1919	22,908	17,448
1920	76	29,715
1921	3572	5594
1922	4178	2802
1923	760	2676

Of the amount exported in 1923, 97 per cent. was crude, and of the imports 60 per cent. was refined.—(*U.S. Com. Rept.*, *June* 9, 1924.)

Rapid Drying of Gelatin

One of the difficulties in the manufacture of glue and gelatin is the lengthy and costly process of drying. According to Dr. H. Stadlinger (*Chem. Z.*, July 1), this difficulty is obviated by forcing the liquid extract through fine nozzles into a liquid or gaseous medium, when the rotatory motion imparted causes the formation of small drops which at a suitable temperature can be dried within one minute, without any injury to the gelatin. It is claimed that, with equal weights, the drops will adsorb 110 times their weight of water in 30 minutes, whereas the sheet product requires 24 hours. Work is proceeding in the Scheidemandel laboratory on the production of various grades of glue and gelatin.

Asbestos in Canada

Sales of asbestos by the mines in Canada for 1923, in quantity exceeded that of the previous year, being 231,482 tons valued at $7,522,506 compared with 163,706 t. valued at $5,552,723 in 1922. Total asbestos rock mined was 3,768,542 t., and the mill recovery of marketable asbestos 237,000 t., or approximately 7·3 per cent.

OBITUARY

W. R. EARP

The death of William Richard Earp marks the end of a career remarkable for persistence of effort under difficulties. Born in 1847, at Hope, Dovedale, Earp first gained opportunity for self-instruction as assistant librarian to the Mechanics' Institute, Hanley. Whilst still young, he became an assistant surveyor in the Talk o' the Hill Colliery, and in 1868 he entered the chemical trade in London. In 1872 he set up a small firm to manufacture fertilisers in Staffordshire, and four years later he left to establish the Ellesmere Chemical Works in Runcorn, where he made pure chemicals for laboratory use, and also distilled naphtha and refined lead and other metallic residues. Coming into contact with the tanning industry, the success of a patent depilator and a patent antiseptic induced him to take over a tannery at Preston Brook, and to manufacture tanners' chemicals at Ellesmere. A venture into the borax industry in 1895 proved disastrous, as he refused a fair offer to join Borax Consolidated (formed owing to competition in the trade), and he was cut off from raw materials, whilst an investment in a bogus borate mine in Argentina entailed heavy losses. Ill-health and the collapse of the main building at his works made financial disaster inevitable. Mr. Earp was not daunted, but started again, with continuous success, as a manufacturer of tanners' chemicals, specialising in sulphonated oils. He died suddenly on July 25, in his chair during sleep, an active worker to the last. He was an original member of the Society of Chemical Industry.

PARLIAMENTARY NEWS

Subsidy to Beet-Sugar Production

Speaking in the Committee of Supply on the estimates for the Ministry of Labour, Mr. Snowden said that the Government had accepted the principle of Exchequer assistance for the sugar beet industry. Excise duty of 9s. 9d. would be put upon beet sugar manufactured in this country, but they would have a subsidy of 19s. 6d. per cwt. State assistance for ten years was needed to enable the industry to find its feet. The subsidy might be reduced to 13s. in four years, but legislation would be necessary. The subsidy would enable six new factories to be started almost at once, employing more labour. [The Government proposal will give the home beet-sugar industry the advantage of 21s. 5d. over foreign imported sugar, instead of 11s. 8d. as at present.]

REVIEW

THE SPECIFIC HEATS OF GASES. By J. R. PARTINGTON and W. G. SHILLING. Pp. 252. London: Ernest Benn, Ltd., 1924. Price 30s.

In consideration of the importance of the question of the specific heats of gases, it is rather singular that a coherent account of the subject should not hitherto have been presented in book form. On the one hand, problems involving heat capacities are amongst those with which the technologist in a great variety of industrial processes is continually concerned, whilst on the other it is apparent that exact measurements of the specific tests of gases over wide ranges of temperature and pressure afford material of fundamental importance for the investigation of many theoretical problems. In the circumstances, it may be taken for granted that the present work will appeal to a wide circle.

The subject matter is divided into six chapters. In the first are discussed the more important equations of state, of which some fifty-six are reproduced. The second is concerned with the methods of determining specific heats, and the third with the influence of temperature. Chapter IV deals with the influence of pressure and with a number of important general relations such as Kirchhoff's equation, Nernst's theory and the so-called reaction isochore. In tables which form a supplement to these four chapters, the authors have collected all the available specific heat data for normal temperatures and pressures. From these, a critical selection has been made, and further tables give the true and mean heat capacities of the industrially important gases over the range of 0°–2000° C. In Chapter V the application of specific data to problems connected with internal combustion engines, furnaces, gas producers and refrigerators is considered, whilst the final chapter is devoted to a brief consideration of the theoretical aspect of the subject.

The authors state explicitly that the book is not intended for the elementary student, but is addressed to the expert. It should not be inferred from this that the work is merely theoretical, or that any advanced knowledge of mathematics or mathematical physics is required before the reader may hope to appreciate its merits. On the contrary, it is essentially concerned with the experimental aspect of the subject.

It represents a valuable critical survey of the entire field, affords a clear picture of what has been accomplished in this province of research, and indicates to what extent available data require to be supplemented in the interests both of theory and practice.

As a book of reference it will be found most useful, and the authors have undoubtedly succeeded in their endeavour to present the basic facts without attempting to provide for all the possibilities of their application.

The bibliography which the authors have compiled should also be of great value, not only to the works chemist, but to those who contemplate research work involving the measurement of heat capacities.

H. M. DAWSON

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 0d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 1d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	7d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	45s per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	4s. 10d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton. Fair demand.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall. 60% O.P. Market dull.
Solvent	5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£46 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d.—6¾d. per lb. Quiet.
Crude 60's	1s. 9d.—1s. 11d. per gall., according to district. Still quiet.
Acid Cresylic, 97/99	2s 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—1s. 11d. per gall. Steady demand.
Dark	1s. 10d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	8½d.—9½d. per gall. Quiet.
Unstrained	7½d.—8½d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d. per gall.
Pure	1s. 8d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.

Creosote—

Cresylic 20/24%	.. 9d.—9½d. per gall. Few inquiries.
Middle Oil .. / Heavy Oil .. / Standard Specification	5½d.—6d. per gall in Lancashire; 6d.—7d. per gall. in Yorkshire.

Naphtha—

Solvent 90/160	.. 1s. 1d.—1s. 4d. per gall. according to district. Quiet.
Solvent 90/100	.. 1s. 1d.—1s. 4d. Quiet.

Naphthalene Crude—

Drained Creosote Salts	£4—£6 10s. Quiet.
Whizzed or hot pressed	£9 per ton. Little business.

Naphthalene—

Crystals and Flaked	.. £13—£16 per ton in Yorkshire and London respectively. More inquiries.
Pitch, medium soft	.. 55s.—60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160	.. 19s. per gall. Market less firm.
Heavy	.. 12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

There has been a fair demand for dyestuffs during the past week. Prices remain constant. A number of intermediate products have been reduced in price.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	.. 1s. 7d. per lb.
Acid H.	.. 4s. per lb 100% basis d/d.
Acid Naphthionic	.. 2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	.. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic	.. 9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	.. 1s. per lb. d/d.
Aniline Oil	.. 7¾d.—8½d. per lb. naked at works.
Aniline Salts	.. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	.. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	.. 1s. 1d. per lb.
p-Chlorphenol	.. 4s. 3d. per lb. d/d.
p-Chloraniline	.. 3s. per lb. 100% basis.
o-Cresol 19/31° C.	.. 4½d. per lb. Demand steady.
m-Cresol 98/100%	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloranilino	.. 2s. 3d.—2s. 11d. per lb.
Dichloraniline S. Acid	.. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	.. £85 per ton.
Diethylaniline	.. 4s 7d. per lb. d/d., packages extra, returnable.
Dimethylaniline	.. 2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene	.. 9d. per lb. naked at works.
Dinitrochlorbenzol	.. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	.. 3s. per lb. d/d
Monochlorbenzol	.. £63 per ton.
β Naphthol	.. 1s. 1d. per lb. d/d.
α-Naphthylamine	.. 1s. 4½d. per lb. d/d.
β-Naphthylamine	.. 4s. per lb. d/d.
m-Nitraniline	.. 5s. 3d. per lb. d/d.
p-Nitraniline	.. 2s. 3½d. per lb. d/d.
Nitrobenzene	.. 5¼d.—5½d. per lb. naked at works
o-Nitrochlorbenzol	.. 2s. per lb. 100% basis d/d.
Nitronaphthalene	.. 11d. per lb. d/d.
p-Nitrophenol	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 4s. per lb. d/d.
p-Phenylene Diamine	.. 10s. 3d. per lb. 100% basis d/d.
R. Salt	.. 2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 3d. per lb. 100% basis d/d.
o-Toluidine	.. 8½d. per lb.
p-Toluidine	.. 3s. 6d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. 3d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P	.. £45 per ton.
Acid, Acetyl Salicylic	.. 3s. 2d.—3s. 5d. per lb., according to quantity. Good demand. Price firm.
Acid, Benzoic B.P.	.. 3s. 6d. per lb. Larger supplies available.
Acid Boric B.P.	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	.. 19s.—21s. per lb.
Acid, Citric	.. 1s. 5¾d. per lb., less 5% for ton lots. Business sub-normal.
Acid, Gallic	.. 3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	.. 7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic	.. 1s. 6d.—2s. per lb. Weak market.
Acid, Tannic B.P.	.. 3s. per lb. Market quiet.
Acid, Tartaric	.. 1s. 1¼d. per lb. less 5%.
Amidol	.. 9s. per lb. d/d.
Acetanilide	.. 2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
Amidopyrin	.. 13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone	.. 15s.—15s. 6d. per lb. Quiet market.
Benzonaphthol	.. 5s. 3d. per lb. Small inquiry.
Bismuth Salts	.. A steady market. Prices according to quantity:
Bismuth Carbonate	.. 12s. 9d.—14s. 9d. per lb.
,, Citrate	.. 11s. 4d.—13s. 4d. ,,
,, Salicylate	.. 10s. 2d.—12s. 2d. ,,
,, Subnitrate	.. 10s. 9d.—12s. 9d. ,,
Borax B.P.	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Unsettled. Spot supplies short. Raw materials dearer. Market advancing. Average spot values:— Ammonium .. 1s. per lb. Potassium .. 10d. per lb. Sodium .. 11d. per lb.
Calcium Lactate	.. Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate	.. 4s.—4s. 3d. per lb. Very firm and scarce.
Chloroform	.. 2s. per lb. for cwt. lots. Very steady
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Formaldehyde	.. £54 per ton, *ex* works. English make in casks. About 8s. per cwt. extra for carboys.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Magnesium	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50%	.. 2s. 6d. ,,
Guaiacol Carbonate	.. 10s. 6d.—11s. 3d. per lb.
Hexamine	.. 3s. 6d. per lb. for English make. Market steady.

Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	English make offered at 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	1s. 6d.—2s. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	50s. per lb. Market better.
Synthetic	26s.—35s. per lb., according to quantity. English make. Strong demand.
Mercurials	Market flat.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	1s. 10d.—2s. per lb. Keen competition.
Methyl Sulphonal	26s. per lb.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 10½d.—3s. per lb. Not very active.
Paraldehyde	1s. 5d.—1s. 6d per lb. in free bottles and cases.
Phenacetin	6s.—6s. 3d. per lb. Price and demand steady.
Phenazone	7s. 6d. per lb. A shade firmer. Forward prices higher.
Phenolphthalein	6s 6d. per lb. Ample supplies.
Potass. Bitartrate—	
99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues heavy.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate	6½d. per lb. Keen competition keeps price low.
Quinine Sulphate	2s. 3d. per oz., in 100 oz. tins. Very heavy demand.
Resorcin	5s. 6d.—5s. 9d. per lb. Firmer. Scarce.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d.—3s. 11d. per lb.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 6d. per lb. Ample supplies. B.P. quality available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—	
Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Steady market, good demand.
Sod. Salicylate	Market more active. Powder 2s. 2d.—2s. 4d. per lb. Crystal at 2s. 4d.—2s. 6d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	15s. 6d. per lb. Easier.
Thymol	19s. per lb. Very scarce indeed. Still rising. Forward quotations 22s. per lb.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.
Aubepine	15s. 3d. ,,
Amyl Acetate	2s. 9d. ,,
Amyl Butyrate	6s. 9d. ,,
Amyl Salicylate	3s. 3d. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 10½d. ,,
Benzyl Alcohol free from Chlorine	2s. 10½d. ,,
Benzaldehyde free from Chlorine	3s. 6d. ,,
Benzyl Benzoate	3s. 6d. ,,
Cinnamic Aldehyde Natural	16s. ,,
Coumarin	20s. ,,
Citronellol	17s. ,,
Citral	9s.—9s. 6d. Price reduction due to selling competition.
Ethyl Cinnamate	13s. 6d. ,,
Ethyl Phthalate	3s. 3d. ,,
Eugenol	11s. ,,
Geraniol (Palmarosa)	35s. ,,
Geraniol	11s.—18s. 6d. per lb.
Heliotropine	7s. 9d. ,,
Iso Eugenol	15s. 9d. ,,
Linalol ex Bois de Rose	26s. ,,
Linalyl Acetate	26s. ,,
Methyl Anthranilate	9s. 6d. ,,
Methyl Benzoate	6s. ,,
Musk Ambrette	45s. ,,
Musk Xylol	14s. ,, Again cheaper
Nerolin	4s. 9d. ,,
Phenyl Ethyl Acetate	15s. ,,
Phenyl Ethyl Alcohol	16s. ,,
Rhodinol	57s. 6d. ,,
Safrol	1s. 10d. ,,
Terpineol	2s. 4d. ,,
Vanillin	26s. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 8d. per lb.
Bergamot Oil	19s. 6d. per lb.
Bourbon Geranium Oil	36s. 6d. ,,
Camphor Oil	75s. per cwt.
Cananga Oil Java	10s. 6d. per lb.
Cinnamon Oil, Leaf	6½d. per oz.
Cassia Oil, 80/85%	8s. 9d. per lb.
Citronella Oil—	
Java 85/90%	5s. 8d. per lb.
Ceylon	3s. 7d. per lb.
Clove Oil	7s. 6d. per lb. Firm.
Eucalyptus Oil 70/75%	2s. 1d. per lb. Price advanced on fair business.

Lavender Oil—	
French 38/40% Esters	30s. per lb. Very fair. Higher price expected owing to bad crops.
Lemon Oil ..	.. 3s. per lb.
Lemongrass Oil	.. 3d. per oz.
Orange Oil, Sweet	.. 13s. per lb.
Otto of Rose Oil—	
Bulgarian ..	.. 37s. 6d. per oz. Production below average.
Anatolian ..	.. 18s. per oz.
Palma Rosa Oil ..	.. 19s. per lb.
Peppermint Oil—	
Wayne County	.. 21s. per lb. Firm spot and forward.
Japanese ..	.. 14s. 3d. per lb.
Petitgrain Oil ..	.. 9s. 3d. per lb.
Sandal Wood Oil—	
Mysore	.. 26s. 6d. per lb.
Australian ..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Sept. 30th, they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on August 14th.

I.—Applications

Allan (Dodson). Manufacture of emulsions. 17,379. July 21.

Coles. Mixing, drying and calcining. 17,486. July 22.

Ekstrom. Preheaters. 17,694. July 24.

Galloways, Ltd., and Pilling. Apparatus for accumulating heat of exhaust steam 17,458. July 21.

Granton. Mills for mixing, disintegrating, dissolving, or colloidising materials. 17,483. July 22.

Hamilton. Filters. 17,524. July 22.

Huber. Furnace. 17,396. July 21. (U.S., 19.7.23.)

Wellington. Disintegrator machines. 17,740. July 25.

I.—Complete Specifications Accepted

3902 (1923). Bendixen. Emulsification of liquids which will not mix. (219,038.)

9269 (1923). Field. Apparatus for the formation and separation of solids from liquids or gases by heat interchange. (219,062.)

13,002 (1923). A.-G. der Maschinenfabr. Escher, Wyss, et Cie. Refrigerating plants. (199,008.)

16,609 (1923). Lorenzen. System and apparatus for utilising the heat of waste gases for driving turbines. (219,151.)

II.—Applications

Dellwik. Removing liquid from peat, wood, etc. 17,604. July 23.

General Electric Co., Ltd., and Smithells. Manufacture of coated metal filaments. 17,610. July 23.

Jones and Parker. Distillation of coal etc. 17,454. July 21.

Pieters. Continuous furnace for distillation of lignite etc. 17,621. July 23. (Fr., 23.7.23.)

Potts (Zeche M. Stinnes). 17,742. *See* VII.

Sutcliffe. Distillation of carbonaceous substances. 17,640. July 23.

II.—Complete Specifications Accepted

8537 (1923). Holmes, and Gas Light and Coke Co. Preparation of combustible materials. (219,059.)

10,293 (1923). Smith, and Wellman Smith Owen Engineering Corporation, Ltd. Apparatus for use in burning pulverised fuel. (219,076.)

10,348 (1923). Brightmore. Powdered fuel and like burners. (219,078.)

13,561 (1923). Collin and Co. Coke-oven plants. (197,968.)

16,549 (1923). Finley. *See* IX.

16,609 (1923) Lorenzen. *See* I.

31,235 (1923). Uehling. *See* XXIII.

III.—Complete Specification Accepted

10,592 (1923). Coke and Gas Ovens, Ltd. (Stall, Kuhn, and Fritzsche). *See* XIII.

IV.—Applications

Fritzsche and Society of Chemical Industry in Basle. Manufacture of substantive azo-dyestuffs. 17,545. July 22.

Johnson (Badische Anilin und Soda Fabrik). Production of diazo compounds. 17,439. July 21.

Jones, Morton, Morton Sundour Fabrics, Ltd., and Wylam. Dyes and dyeing. 17,807. July 25.

Knecht. Production of diazo and nitroso compounds. 17,862. July 26.

Zeche M. Stinnes. Production of phenols. 17,741. July 25. (Ger., 27.7.23.)

V.—Application

Lindsay (Barbour). Method of disintegrating vegetable and wood fibres etc. 17,642. July 23

V.—Complete Specifications Accepted

13,478 (1923). Kay. Machines for washing wool or for performing like operations. (219,128.)

23,422 (1923). Clavel. Treatment of threads, yarns, and fabrics of or containing acetyl cellulose. (206,818.)

28,155 (1923). Boeken. Process and means for obtaining fibre from the stalks of ramie and other woody plants. (219,226.)

VI.—Applications

Cassella und Co. Ges. Production of effect threads of cotton etc. 17,450. July 21. (Ger., 5.11.23.)

Jones, Morton, Morton Sundour Fabrics, Ltd., and Wylam. 17,807. *See* IV.

Standard Silk Dyeing Co. Washable dyed silk piece goods, and processes of dyeing same. 17,719. July 24. (U.S., 1.12.22.)

VII.—Applications

Meyerhofer. Production of hydrofluosilicic acid. 17,722. July 24. (Ger., 1.10.23.)

Meyerhofer. Production of soluble carbonates or hydroxides from insoluble carbonates, oxides, or hydroxides. 17,723. July 24. (Ger., 2.8.23.)

Potts (Zeche M. Stinnes). Purification of crude ammoniacal liquors. 17,742. July 25.

IX.—Application

Coles. Cement. 17,488. July 22.

IX.—Complete Specification Accepted

16,549 (1923). Finley. Bituminous cement aggregate composition. (219,150.)

X.—Applications

Flodin. Methods for producing metals and metal alloys low in carbon. 17,919. July 26. (Sweden, 27.7.23.)

Hutchins. Electro-deposition of metals. 17,715. July 24.

Soc. l'Air Liquide Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Autogenous welding of aluminium, magnesium, and their alloys. 17,841. July 25. (Fr., 1.4.24.)

X.—Complete Specifications Accepted

7846 (1923). Saklatwalla. Manufacture of alloy steel and iron. (196,260.)

8888 (1923). Westwood. Siemens' open-hearth furnaces. (219,061.)

XI.—Applications

Ashcroft. Electric batteries for conserving and utilising energy. 17,440. July 21.

Smith. Electric batteries. 17,678. July 24.

XII.—Application

Brimley, Dickinson, and Nigerian Products, Ltd. Extraction of oil from palm fruit etc. 17,378. July 21.

XIII.—Application

Hocking. Manufacture of red lead. 17,419. July 21. (Hungary, 16.8.23.)

XIII.—Complete Specification Accepted

10,592 (1923). Coke and Gas Ovens, Ltd. (Still, Kuhn, and Fritzsche). Apparatus for use in connexion with the extraction and removal of resin from solution in acid. 219,089.)

XIV.—Complete Specification Accepted

28,898 (1923). Kempter. Apparatus for the washing of india-rubber and the like. (207,189.)

XV.—Complete Specifications Accepted

7750 (1923). Lloyd. Method of hydrolysis in glue and gelatine manufacture. (219,052.)

24,017 (1923). Baxter. Means for agitating washing, liming, or tanning solutions. (205,067.)

XVII.—Complete Specification Accepted

21,565 (1923). Ragg. Clarification and decolorisation process for the manufacture of white sugar. (219,194.)

XVIII.—Complete Specification Accepted

10,008 (1923). Wooldridge. Brewing. (219,068.)

XX.—Application

Busch and Von Wulfing. Manufacture of acid calcium lactate. 17,645. July 23.

XXI.—Applications.

Bannister. Colour photography. 17,596. July 23.

Jelley. Photographic sensitisers. 17,507. July 22.

Melin Machine Co., Ltd. (Schwartz Presse Akt.-Ges.). Photo-chemical lithography. 17,498. July 22.

XXIII.—Complete Specification Accepted

31,235 (1923). Uehling. Apparatus for detecting or estimating and recording combustible constituents in gaseous mixtures. (219,236.)

GENERAL NOTES

Inquiry into British Industry and Commerce

H.M. Government has appointed a Committee to inquire into and report upon the conditions and prospects of British industry and commerce, with special reference to the export trade, and to make recommendations in regard thereto. The Committee is constituted as follows :—Sir Arthur Balfour, K.B.E. (Chairman), Mr. John Baker, Sir W. H. Beveridge, K.C.B., Mr. Henry Boothman, Mr. W. T. Charter, Mr. C. T. Cramp, Mr. Hugh Dalton, Sir Harry Goschen, K.B.E., Mrs. M. A. Hamilton, Mr. F. A. Hargreaves, Sir Norman Hill, Bart., Sir John S. Hindley, Mr. David Landale, Sir W. Clare Lees, O.B.E., Mr. P. J. Pybus, C.B.E., Mr. Arthur Shaw, Sir Allan Smith, K.B.E., and Sir Hubert Llewellyn Smith, G.C.B. The chief points to be discussed are the present position of British overseas trade and its future, the state of British productive capacity and its organisation (labour, capital and management), and the relations between those engaged in production. Communications relating to the Committee should be addressed to the Secretary, Mr. Walter Carter, Board of Trade, Great George Street, London, S.W. 1.

Official Trade Intelligence

The Department of the Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number :—*Australia :* Asphalt and bituminous concrete (139) ; *Chile :* Earthenware and essences (158) ; Textiles (159) ; *China :* Paints (B.X./1052) ; *India, Burma and Ceylon :* Glass paper, emery paper and emery wheels (140) ; *Netherlands :* Leather (146 and 147) ; Ironware (148) *Peru :* Paints (B.X./1088) ; *Poland :* Leather and chemicals (152) ; Leather and tanning materials (153) ; *South Africa :* Centrifugal pumps and motors (258) ; *Sweden :* Chemicals (154).

PUBLICATIONS RECEIVED

The Rubber Conference, Brussels, 1924. Official Report of the International Rubber Conference held in Brussels in April, 1924, together with the papers read and the discussions thereon. Pp. 218. London: Rubber Growers' Association (Inc.), 1924. Price 5s.

Report on the Industries and Commerce of Spain, dated March, 1924. By Capt. U. de B. Charles, C.B.E. Department of Overseas Trade. Pp. 79. H.M. Stationery Office, 1924. Price 2s. 6d. net.

Publication of the Department of Commerce, Bureau of Foreign and Domestic Commerce. Washington: Government Printing Office, 1924 :—

The German Dyestuffs Industry. By T. W. Delahanty. No. 126. Pp. 62. Price 10 cents.

Publications of the United States Department of Commerce. Washington: Government Printing Office, 1924.

Elimination of Waste. Simplified Practice. Pp. 8. Price 5 cents.

Publications of the United States Geological Survey. Department of the Interior. Washington: Government Printing Office, 1924 :—

Gold and Silver in 1922 (General Report). By J. P. Dunlop.

Mineral Resources of the United States, 1922, Part I. Pp. 595—635.

Gold, Silver, Copper, Lead, and Zinc in the Eastern States in 1923.

Mines Report. By J. P. Dunlop.

Mineral Resources of the United States, 1923, Part I. Pp. 1—7.

Production of Sulphate of Ammonia for 1923. Pp. 11. New York: The Barrett Co.

Das Leitvermögen der Lösungen. Parts II and III. Handbuch der Allgemeinen Chemie IV. 2s. 3d. By Prof. P. Walden. Pp. vi+399. Leipzig: Akademische Verlagsgesellschaft m.b.H., 1924. Price, paper, 47 goldmarks; Bound, 50 gm.

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

VOL. 43 NEW SERIES — LONDON, AUGUST 15, 1924 — NO. 33

EDITORIAL

THE Ministry of Health is surely a little inconsiderate. Only a fortnight or three weeks ago two scientific professors commented somewhat adversely—so it seemed to us—on the merits of a preparation in which formaldehyde or a polymer of it played some part. The justification for their comments is to be determined by His Majesty's judicial department, and before the decision can be arrived at the Ministry of Health issues a report on food preservation, in which an attack is made on the unfortunate formaldehyde. The report states that it is "a preservative which is inimical to life and to vital processes of all kinds. It is a powerful protoplasmic poison" and so on. The committee in charge of this matter even goes so far as to recommend that the "treatment of meat or the addition of formaldehyde or any of its derivatives to food or drink should be absolutely and specifically prohibited," and states that this preservative may retard digestion even when present in food in comparatively great dilution and that its effect is probably cumulative. The application of chemistry to the service of man grows steadily in importance and, in relation to health and the cure of disease, there is no doubt that the chemist has already been responsible for achievements which are marvellous. Many of our most serious diseases are caused by the presence of bacteria and of other organisms, both animal and vegetable, in the system. The chemist and the physician are continually searching for a drug which will kill these organisms before it will kill the patient, even before it will seriously injure his health. Some of these drugs are singularly capricious in their tastes; there are dyes which will stain cotton and not silk, there are other dyes which will exercise strange selective actions of another variety. So there are drugs which kill one sort of organism and leave many others unaffected. What is one germ's meat is another germ's poison. At this time of the year the ravages of small animals in a garden point the way to making a fortune for the chemist who will deal with such pests. "That which the palmer-worm hath left hath the locust eaten; and that which the locust hath left hath the canker-worm eaten; and that which the canker-worm hath left hath the caterpiller eaten." But we fear formaldehyde is too dangerous a drug even for the garden.

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We have enjoyed reading a pleasant book by John O'London called "Is it Good English and Like Matters." The laws and conventions which regulate a living language such as our own have for many years interested us. The laws of grammar are to be found in many books, the majority of which are unreadable, the conventions are to be found in the writings of every author who tries to write in the manner of good writers. The laws and the conventions do not invariably agree. This is true of countries as well as languages: the British constitution is full of conventions which have no legal force, but the consequences of breaking them are so serious that in practice they are not disregarded. It is a mere convention that a bill in Parliament must be read three times in the House of Commons before it is passed there. The existence of a Prime Minister and a Cabinet, their functions and responsibilities, the powers of individual Ministers and the relations of the Government of the day to the Crown, are almost exclusively determined by convention. So too in the use of words in our language; the grammarians have given us their rules and regulations but the dominant power which compels us to avoid certain phrases or constructions is the public opinion of those who are supposed to be good judges of literary manners. John O'London's little book is well printed and costs only a florin; it is full of good points and is neither didactic nor pedantic. The author recognises the changes in fashion and the impossibility of restricting the liberty of writers in minute points. Every writer must be allowed a few fads of his own and these vary in accordance with the period and nature of his education, the choice of his favourite authors and his own idiosyncrasies. The standard of writing to-day is a high

one: we can recall very few authors of fifty or a hundred years ago who seem to be as fastidious as many of our present writers.

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A few weeks ago we read in this *Journal* a note on the chemistry of bread which included a reference to the composition of starch. We were naturally very glad to see in this month's Journal of *The Institute of Brewing* a considerable paper by Professor A. R. Ling on "Some Recent Contributions to our Knowledge of the Chemistry of Starch." Professor Ling has studied this question for many years and done much in company with other British chemists to extend our knowledge of this material. Mr. Cornelius O'Sullivan, Dr. Horace Brown, Mr. Julian L. Baker and Professor Ling have made an interesting contribution to our science. We intend to publish a summary of Professor Ling's paper at an early date, but those who have a knowledge of the chemistry of carbohydrates will do well to consult the original paper During the last twenty years how much additional understanding of sugars, starch and cellulose has been attained! With the progress made also on insulin and its effect on the carbohydrates in the animal world, we are getting to know the part played by carbohydrates in life, not only why they act, but also how.

* * *

It was a fortunate coincidence that, unknown to each other, both the Society of Chemical Industry and the Chemical Industry Club chose November 14 as the date for their respective dinners. So soon as this was found out a desire was expressed to have a combined dinner, instead of two separate ones, and this has now been agreed A preliminary announcement of the dinner appears in this issue, and the details are being arranged by representatives of the Society and the Club. There were two Kings of Brentford, but their kingdom was not a success, there are joint managers of some companies and joint secretaries of some societies, but we cannot recall any dinner presided over by two chairmen It is as awkward for two chairmen to get up at the same time and say, "Ladies and Gentlemen, the King," as it would be for two sergeants to drill simultaneously the same squad. Mr Coley, the genial Chairman of the Club, solved this delicate problem, which has wrecked many a combined effort, by generously consenting to play the second fiddle. He can well afford to do so for his position in the Club is unique. He was the founder of it, the prime cause of its existence; he is the Chairman of it, and presides over its meetings with skill and tact, carefully avoiding partiality on the one hand, and impartiality on the other hand, and he will in the future retain in the hearts of his fellow members that affection which is the due of a really clubbable man It will be good for the Society and good for the Club, to have greater community of interest than has prevailed hitherto, the dinner will undoubtedly be a great success, and we shall expect from Mr. Woolcock, who will take the Chair, and from Mr. Coley, who will have the option on any other chair, speeches suitable for this memorable occasion.

CHEMISTRY AND THE STATE *

By SIR ROBERT ROBERTSON, K.B.E., F.R.S.

(Continued)

Health

The earliest legislation in respect of food dealt with articles from the Revenue standpoint rather than from that of safeguarding users against adulteration. Thus, the Adulteration of Coffee Act of 1718 refers to evil-disposed persons who make use of water, grease, butter and such-like materials for addition to coffee, "whereby the same is rendered unwholesome and greatly increased in weight, to the prejudice of His Majesty's Revenue and the health of his subjects." Similarly, the Tea Act of 1730 refers to the use of various materials and operations for sophisticating tea, "to the prejudice of the health of His Majesty's subjects and the diminution of the Revenue." The Tea Act of 1776, which deals specifically with the preparation of other leaves for use in imitation of tea, gives as an additional reason, "the injury and destruction of great quantities of timber woods and underwoods."

Since this legislation was mainly for the prevention of fraud on the Revenue, it was left to the Crown to ascertain the purity of the articles in question. To this end the Inland Revenue Laboratory, which was established in 1842 primarily for testing tobacco, became also the laboratory for the analysis of dutiable foods, such as tea, coffee, pepper. In this connexion it is of interest to note that the Government at times sought assistance from distinguished chemists not on its staff, as when Thomas Graham at University College, London, carried out for the Board of Inland Revenue an inquiry into the chemical means of detecting vegetable substances mixed with coffee for the purposes of adulteration. Among the early pioneers in the chemistry of food may be mentioned Dr. Hassall, who was the analyst of the "Lancet Sanitary Commission," and published the reports of that body on "Food and its Adulteration."

Besides the enactments with regard to certain dutiable foods referred to above, legislative action was taken with respect to bread, the Bread Act of 1822 dealing with the sale of bread in London and district, and that of 1836 with the sale of bread outside the London area. There was no provision for analytical examination of samples under these Acts, which still remain in force.

By the efforts of Lyon Playfair on matters of sanitation and the work of the Royal Commission on the Health of Towns of which he was a member, public opinion was being awakened during the 'forties to the social importance of the health of the community, a movement in which the Prince Consort took an enthusiastic part. This led to the Commission of 1869 and the foundation of the Local Government Board, through which the safeguarding of public health in England was systematically organised. From this Board and its successor, the Ministry of Health, a series of useful reports on questions of food have issued, most of which have involved chemical investigations.

* Presidential Address before Section B (Chemistry) British Association, Toronto, 1924.

In 1855 and again in 1856 a Committee was appointed by Parliament to inquire into the "Adulteration of Food, Drinks and Drugs." It was evident to these Committees that some provision for the chemical analysis of samples was necessary, but they made no provision for samples to be taken. This and other matters were provided for in an amending Act, which came into force in 1872. A Select Committee of Parliament was appointed in 1874 to inquire into the working of these Acts, and as a result of their report another Act, that of 1875, was substituted. By this Act the Local Government Board was given power to require evidence of competence from analysts, and the Inland Revenue (now the Government) Laboratory was appointed as the authority to which Courts of Law could refer disputed cases.

The Act of 1875 has been amended and extended by the Acts of 1879 and 1899, and other Acts have been associated or incorporated with it, such as the Margarine Act (1887) and the Butter and Margarine Act (1907), the whole series being quoted collectively as the Sale of Food and Drugs Acts, 1875-1907.

The provisions in the above Acts affecting chemists may be summarised as follows: (1) the appointment of public analysts by the local authorities is compulsory; (2) the Ministry of Health and the Ministry of Agriculture (when the interests of agriculture are in question) have power to step in if the local authority fails to utilise the services of the public analyst; (3) the appointment and dismissal of a public analyst by a local authority are subject to the approval of the Ministry of Health; (4) the analyst must afford the Ministry evidence of his competence for the work. It is the practice of the Ministry to accept for such purpose the Diploma of the Institute of Chemistry, together with the Certificate of that Institute in Therapeutics, Pharmacology and Microscopy.

The position of the Government Chemist in the administration of the Acts is as follows. (1) the Acts provide that in the hearing of any complaint in a court of justice the magistrates must, at the request of either party, and may themselves without any previous request, send the reserved portion of the sample to the Government Chemist for analysis. This provision is taken advantage of in a number of cases each year, and gives rise to a considerable amount of interesting work relating to methods of analysis, the alteration in food on storage, and the figures to be taken as standards for genuine articles. The necessity for such investigation is at once apparent in the case of milk, since samples cannot under ordinary circumstances reach the laboratory before the expiry of at least three or four weeks, and the fermentation that has taken place in this time has resulted in the loss of solid matter.

(2) The Acts provide for the examination at the Government Laboratory of samples of imported tea, margarine, and various dairy products, the object being (*a*) to prevent adulterated food of this character entering the country, and (*b*) to ascertain whether it conforms to the standards laid down for such food.

It may be pointed out that there is nothing in the United Kingdom corresponding with the series of food definitions and standards which exist in some of our Colonies, and in a marked way in the United States. The main provisions of these Acts are briefly that (1) no person shall mix any article of food with any ingredient so as to render the article injurious to health, and (2) no person shall sell to the prejudice of the purchaser any article of food which is not of the nature, substance and quality demanded by such purchaser. A few definitions and standards are, however, given in the Acts, and these have been added to by Regulations under the Acts, or by Regulations made under the Public Health (Regulations as to Food) Act, 1907, the Licensing Act, 1921, and the Milk and Dairies Act, 1922. Before regulations on questions of limits have been issued, it has been customary for the Crown to institute an inquiry into the particular subject.

A brief summary of the definitions and standards thus fixed is as follows:—(1) The strength of spirits must not be reduced more than 35 degrees under proof; (2) standards have been fixed for milk, separated milk, condensed and dried milks; (3) limits have been set up for water in butter, milk-blended butter and margarine, and for butter fat in margarine; (4) the addition to milk of water, preservative, colouring matter, separated or reconstituted milk is prohibited; (5) cream must not be mixed with a thickening substance, and the conditions with regard to the addition of preservative to it have been fixed.

In its care for the purity of drinking water the State has made several enactments. It may be said that this country led the way as the result of the great work of Frankland in devising means for determining the potable qualities of water, and in pressing for pure supplies. An enormous volume of useful work was carried out by the Royal Commission on Sewage Disposal of which Ramsay was a member. This sat from 1898 until 1914, when it dissolved, having projected further work on industrial effluents and their effect on river water, work which is just recently being followed up by an Advisory Committee to the Ministry of Agriculture and Fisheries.

The contamination of the atmosphere is a subject of concern to the Ministry of Health working under Acts from 1863 onwards. Limits have been set to the discharge of noxious and offensive gases, and the control is in the hands of a number of chemical inspectors, who have in addition carried out a large number of investigations of importance to general health and to industry. The contamination of the air in cities is watched by the Meteorological Office, which records the quantity of soot falling in different parts of the country. By such means the public conscience is being awakened to the necessity for the provision of a smokeless fuel, a subject engaging the attention of the Government Fuel Research Station.

Chemical control is also concerned with the question of danger to health arising in certain trades, such as that of the manufacture of matches, in which red was substituted by law for white phosphorus, with the limitation of lead in glazes, with the nature of the gases in mines, and with manufactures in which poisonous substances such as nitrobenzene and nitrous fumes are produced.

In 1900 there was a serious outbreak of sickness attributable to poisoning by arsenic, and a Royal

Commission was appointed to inquire into the cases and to ascertain by what safeguards the introduction of arsenic into food could be prevented. A very large amount of chemical work was carried out in connexion with this inquiry, and considerable attention was paid to the methods for the detection and examination of arsenic. Among those contributing specially to the problems may be mentioned Dr. George McGowan, the Government Laboratory, and a Joint Committee of the Societies of Public Analysts and Chemical Industry. At the Government Laboratory an electrolytic apparatus was devised in which the use of zinc for the production of hydrogen was not necessary. This apparatus has been modified by replacement of the expensive platinum cathode originally used by lead coated with mercury, which has been found to give very satisfactory results.

It was not until the end of 1916 that the control of the food supply of the country passed into the hands of a Ministry of Food. In the meantime much work of a scientific nature had been done in the way of endeavouring to educate the people on food values. A pioneer in this direction was Prof. W. H. Thompson, who occupied the Chair of Physiology in Trinity College, Dublin, and who became later Scientific Adviser to the Ministry of Food. He was unfortunately lost in the sinking of the Irish mail boat in which he was a passenger. Thompson communicated to the Royal Dublin Society early in 1915 an important paper dealing with the energy value and chemical constitution of foods, subsequently published as a pamphlet under the title of "The Food Value of Great Britain's Food Supply." The question of the food supply of the United Kingdom was receiving attention in 1916 from a Committee of the Royal Society which included among its members distinguished chemists, and at the request of the Board of Trade the Committee drew up a report on the food supply in which much of Thompson's work was incorporated. It is interesting to note that in the main the values given by Atwater in the "Chemical Composition of American Food Materials" were followed in the calculations. There can be little doubt that the decision of the Government to recover a larger proportion of the grain for human food in milling wheat, and to restrict the use in brewing and distilling of materials capable of use as food, arose from the suggestions put forward by this Scientific Committee.

The chemical examination of the enormous quantities of food, together with the inspection of the packing and the testing of materials used for the purpose, forwarded overseas from this country for the Army in the war was entrusted to the Government Laboratory. Chemists were established at the various receiving depots, and all goods delivered by contractors were inspected, and, if considered necessary, sampled and analysed as to their conformity with specification. The chemist reported upon each delivery before the Army authorities proceeded to issue it.

The Medical Research Council, now under a Committee of the Privy Council, deals with subjects coming within the province of biochemistry, and the organic chemist has here an opportunity for preparing substances which the knowledge now available indicates as likely to be of value in combating, for example, diseases due to blood parasites.

Agriculture

The connexion of the State with scientific agriculture goes back to the beginning of the nineteenth century. The period from 1770 to 1820 was one of great activity in agricultural development. It was then that several of the oldest agricultural societies were formed, and the Chair of Agriculture and Rural Economy founded in Edinburgh University.

The first Board of Agriculture was formed in 1793, and it was to this Board that Humphry Davy, himself one of its members, delivered during the years 1802-1812 the courses of lectures which were afterwards published under the title of the "Elements of Agricultural Chemistry." Davy in his introductory remarks dealing with the object of the lectures sets out clearly what he understood by agricultural chemistry—it "has for its object all those changes in the arrangement of matter connected with the growth and nourishment of plants; the comparative values of their produce as food; the constitution of soils; the manner in which lands are enriched by manure, or rendered fertile by the different processes of cultivation." This statement sets forth the position to-day, and in the progress that has been made towards the attainment of these objects the chemist has played an important part.

Although Davy quotes the results of his chemical work on a series of grasses, no great advance was made for many years, and when it did come it was at the instance of private enterprise. To John Bennet Lawes, the founder of Rothamsted, is due the initiation of experiments which began in 1834 and have continued uninterruptedly until to-day. Joseph Henry Gilbert joined Lawes in 1843, and the association of the two was not broken until Lawes' death in 1900. When Gilbert died in 1901, Sir A. D. Hall became director, and he was succeeded in 1912 by the present director, Sir John Russell.

The next experimental station in England was that founded by the Royal Agricultural Society, on the Duke of Bedford's estate at Woburn under the direction of Dr. A. Voelcker, and now carried on by his son Dr. J. A. Voelcker. The Royal Agricultural College at Cirencester was founded in 1845.

The development of the scientific study of agriculture was thus left largely to such institutions as that of Rothamsted, and to certain agricultural colleges which did not receive State aid.

The first legislative action on behalf of agriculture with which the chemist was concerned was an Act for the protection of the agriculturist against fraud from the purchase of inferior or worthless manures and feeding stuffs. By the Fertilisers and Feeding Stuffs Act of 1893, superseded by the Act of 1906, the seller of artificial fertilisers and certain classes of artificially prepared feeding stuffs was compelled to give with the goods an invoice guaranteeing the percentages of specified constituents on which the value of the article depended, and county authorities were required to appoint agricultural analysts for the purpose of checking the statements on the invoice by analysis of samples. The Board of

Agriculture also appointed a chief analyst who was required to analyse the reserved samples in cases where discrepancies were of such a nature as to lead to the possibility of proceedings in Court.

It will thus be seen that, with the exception of the encouragement given to the work of Davy, the first State action was not towards the development of agriculture, but for the repression of fraud. There were, however, movements from time to time in the direction of scientific inquiry into problems connected with agriculture, such as investigations into the effect of food and breed on milk, and into the efficiency of sheep dips, with both of which the Government Laboratory was closely associated.

No systematic educational work in scientific agriculture was attempted in Great Britain before 1909, when an Act was passed allocating annually the sum of £500,000 for "aiding and developing agriculture and rural industries by promoting scientific research, instruction and experiments in the science, methods and practice of agriculture (including the provision of farm institutes)." Under this Act, a system of agricultural research was framed, based on university and on research institutions like Rothamsted, and linked up with the agricultural colleges. The scheme formulated enabled the Development Commissioners appointed under the Act to form new institutes as well as to extend the existing ones. Rothamsted was largely extended, and increased facilities afforded for work on Plant Physiology (Imperial College), Plant Breeding (Cambridge University), Animal Nutrition (Cambridge), Dairying (Reading), Animal Pathology (Royal Veterinary College), and on similar subjects. In many of these the chemist was essential. Another part of the scheme was the foundation of scholarships awarded to selected graduates of universities tenable for a three-year course of research. In certain selected teaching institutions technical advisers for farmers were appointed, and researches not capable of being pursued at an institute were maintained elsewhere.

The provision of this scientific work for the benefit of agriculture is carried out by the Commissioners through the medium of the Board of Agriculture, with which policy is discussed and details arranged. It represents the first co-ordinated attempt by the State in the United Kingdom to secure a comprehensive scientific study of the problems of agriculture, and the first systematic endeavour to apply scientific method to the development of agriculture. Results followed at once, and as an illustration it may be pointed out that in the eight years from 1912 to 1920 Rothamsted issued, in spite of the adverse effects of the war, 75 scientific papers, published eight books, and contributed numerous articles for farmers and teachers, and the Cambridge Animal Nutrition Station also published 60 papers in the same period. Other institutes also contributed to knowledge on this subject.

During the war, agriculture in this country was affected in several ways—for example, by (1) shortage of the usual feeding stuffs for cattle, and (2) shortage of fertilisers, particularly potash and nitrogen, both as nitrates and ammonium salts. At the same time there was a demand for an increased production owing to the diminished supplies of essential foods from abroad.

The attention of chemists was directed to these points. Fortunately the research institutes provided by the funds of the Development Act referred to above were in existence and available for making investigations. Thus the staff at Rothamsted under Russell gave special attention to the shortage of manures and prepared monthly notes for the guidance of farmers, while the Animal Nutrition Institute at Cambridge under T. B. Wood provided monthly notes on the uses of available feeding stuffs. In the latter part of the war, conferences were held weekly at the Food Production Department in which research workers from the institutes took part. These meetings had such value that the Ministry of Agriculture and Fisheries have now constituted an Advisory Council in Agricultural Research at which the directors of the institutes meet periodically to review the progress being made.

When the war-time requirements of nitrogenous fertilisers are considered, it is significant that the production of nitrogen in the form of ammonia showed no increase in the first years of the war, and only a six per cent. increase in 1917 over 1913. The restriction of nitrate supplies for munitions caused a greater demand for nitrogen in the form of ammonia, and it may be expected that in the future even larger quantities will be needed. The Nitrogen Products Committee estimated that the possible demand in the near future for artificial nitrogenous fertilisers for the United Kingdom would be 100,000 tons of nitrogen, or four times the quantity used in 1913.

Of the fertiliser ammonium sulphate, we produced before the war five times as much as we required for our own use, but we imported also over 100,000 tons a year of sodium nitrate from Chile. During the war the importation of this salt was quadrupled and nearly all was taken up for munitions, being converted into nitric acid for the purpose of nitrating glycerine, cotton, toluene and phenol, and made into ammonium nitrate for the explosive amatol. All our explosives therefore depended on the importation of Chile saltpetre, a condition of affairs which gave rise to great anxiety. Although we still had sufficient ammonia, there was no plant available for oxidising it to give the nitric acid required. As no sodium nitrate could be spared for agriculture, its place was taken by ammonium sulphate, of which increasing quantities were used for manuring the soil to obtain increased productivity. At the same time this salt was being increasingly used for making ammonium nitrate, so that the time approached when, in place of the ample margin before the war, a shortage of ammonia was in sight.

The claim of munitions on sulphuric acid also materially reduced the quantity of ammonium sulphate as well as of superphosphate by about 40 per cent., and chemists had to devise means for using nitre-cake in its place in the manufacture of these fertilisers.

Anxiety as to the want of capacity of the country for fixation of atmospheric nitrogen had led in June, 1916, to the foundation of the Nitrogen Products

Committee, the results of whose labours will be found in a massive Blue Book full of information on statistics, on processes, and on the comparative merits of methods for developing power. A staff of chemists and physicists attached to the laboratory of this Committee was actively engaged on investigations on the conditions of manufacture of ammonia by the Haber process, as well as in determining the physico-chemical constants of the gases involved. Much valuable work was accomplished both on the combination of hydrogen and nitrogen and also on the oxidation of the product to nitric acid, so that the Committee was able to recommend the erection of a trial plant in February, 1917, and by October of that year the Department of Explosives Supply recommended the process worked out for adoption in a national factory, and a start had been made towards its erection at the end of the war.

This project was taken over by Synthetic Ammonia and Nitrates, Ltd., which has continued the research work and erected the large-scale plant. It is satisfactory to be able to announce that, instead of being about the only great nation not engaged in the fixation of nitrogen from the air, we have now in Great Britain a plant producing at the moment 150 tons of synthetic ammonia a week. From the point of view of agriculture as well as of national defence, this cannot fail to afford a fresh, if somewhat delayed, confidence.

The shortage of potash supplies was apparent soon after war broke out, since nearly all potash came from Germany. Attention was immediately drawn to other possible sources of supply and to means whereby the potash in stable combination in the soil might be made available. Russell at once called attention to the potash salts in the ash of sea-weed, bracken, hedge-clippings, wood-waste, and similar substances, and, he also advised the use of lime, and in certain circumstances of sodium salts, whereby potash in the felspars and clays became available.

Numerous suggestions put forward as to possible sources of supply of potash were inquired into. In one interesting case, where a small-scale plant was put into operation under the supervision of the Government Laboratory, a good yield of potash was obtained from felspar, but the process involved the production as a by-product of so large a quantity of an inferior quality of cement that unless a market could be obtained for this there was no possibility of working the process successfully.

A source of supply that was used to a certain extent was the flue-dust of furnaces, which was found to contain a fair though variable quantity of potash. Considerable developments were made by Mr. Kenneth Chance, of the British Cyanides Co., in the direction of obtaining from the ores dealt with in the United Kingdom a large supply of potash, and an extensive scheme of operation was contemplated before the Armistice.

Another direction in which supplies became restricted was in respect of phosphatic manures. Importation of bones, mineral phosphates, and guanos, owing to war conditions, could not be maintained, and, owing to the demand for sulphuric acid for essential munitions of war, the supply for manufacture of superphosphate was strictly limited. Hence attention was directed to the examination of the results obtained by using finely ground natural mineral phosphates and basic slag. These insoluble phosphates were found to possess a greater value as fertilisers than had been thought.

The shortage of food-stuffs for cattle arose partly from decreased imports, particularly of linseed, cottonseed and grain, and partly from causes within the country, as for example the dilution of flour with maize and other cereals and the milling of the grain to obtain an increased percentage of flour for human food, whereby the quantity of milling offals was reduced. The attention of chemists was at once directed to the question of new or hitherto little used food-stuffs. For some years prior to the war the importation into Continental countries, particularly Germany and France, of valuable oil-seeds had been rapidly increasing, thus providing oils for margarine manufacture and valuable cakes and meals as food for cattle. The case of palm-kernels, a valuable source of oil and cake, is a striking one, for British West Africa exported before the war about 230,000 t., of which 35,000 t. came to England and 181,000 t. to Germany, and a similar condition applied to copra, earth-nuts and sesame seed. These and many other seeds began to be diverted to the British market, and the cakes or meals, after examination of feeding value, formed a useful addition to the food supplies, as was illustrated by the great increase in the manufacture of margarine.

Home supplies were also explored, materials which had hitherto been discarded were tried, and waste material from a variety of sources was utilised. In all this the work of the chemist was essential. The elucidation of the composition of the material, of the digestibility coefficients of its various constituents, and of its feeding value was the contribution of the chemist to this great problem of the nation.

Since many of the war-time expedients mentioned above were of a makeshift character, it is not surprising that they did not survive when normal economic conditions arose. Thus, when sulphuric acid again became available, the troublesome use of nitre-cake was abandoned and blast-furnace flue-dust was no longer collected. It was disappointing that the nitrogen fixed in the large surplus stocks of explosives, both in the form of nitric esters and of nitrogen compounds, could not profitably be utilised. Many of the difficulties were overcome in the case of the nitric esters by the application of a process of alkaline hydrolysis, but the attempt was abandoned on account of the difficulties which arose during process in freeing the product from poisonous impurities and in putting it on an economic basis.

The war-emergency work has had some lasting effects, of which may be mentioned the development of a process for making "synthetic farmyard manure," the increased use of basic slag as a phosphate fertiliser, and the increased attention that is being devoted to the newer nitrogenous fertilisers, more particularly those produced by fixation of atmospheric nitrogen.

The lessons of the war have not, however, been entirely lost. The last report of the Development

Commissioners, for the year ended March 31, 1923, shows advance in every direction. In addition to the sum available from the Development Fund of the Act of 1909, it was possible to make increased grants owing to the money received under the Corn Production Acts (Repeal) Act, 1921. The special fund enabled grants to be made for additional research, as, for example, the extension of the advisory scheme in connexion with agricultural research, the provision of scholarships for children of agricultural workers, and the endowment of a Chair in Animal Pathology at Cambridge. In order to prevent overlapping and to secure co-ordination, the Development Commissioners are working in consultation with the Medical Research Council and the Department of Scientific and Industrial Research.

It may be said that the greater part of the work on agricultural chemistry since the war has been of a fundamental nature, the results of which have not yet become capable of translation into agricultural practice, although they may be expected to exert ultimately a powerful influence on farming.

Other Activities

In addition to the activities that have been grouped under the respective headings, there are many others bearing on State problems which have occupied the attention of chemists.

Thus, expeditions, such as that of the *Challenger*, have been fruitful in results of chemical work. The investigations of Dittmar on the composition of sea-water and of Murray on mineral phosphates may be recalled in this connection.

For data on the chemical composition of rocks the Geological Survey is indebted to the work of Percy, Dick and Pollard, and for work on the formation of igneous rocks to Teall, Harker and Flett. The remarkable experiments of Sir John Hall on rock-formation at the beginning of the nineteenth century have been described in a recent British Association address. On several occasions the choice of building-stone, especially for the Houses of Parliament, has been before groups of geologists and chemists, especially with respect to the action of atmospheric impurities, and, although the causes of decay are fairly clear, its arrest still forms a difficult problem.

The difficulties in selecting colours sufficiently fugitive to prevent the removal of obliteration marks from postage and fiscal stamps were to a large extent solved by the activities of Warren de la Rue.

Investigations on such matters as the above for various Departments of State form part of the work of the Government Laboratory, which in addition, during the war, had to advise concerning the conservation of materials, the control of imports and exports by the War Trade Department, and on the nature of contraband goods.

Organised Applied Research

In the middle of 1915, at a time when our shortage of many essential materials brought out the need for the application of more scientific methods to our industries, if we were to succeed in competition with other countries after the war, the Department of Scientific and Industrial Research was founded. It set out to assist firms in an industry to co-operate with one another and employ a staff of scientific men to solve their problems and develop their industry, to assist other Government Departments desirous of having investigations carried out, to organise research into problems of practical utility of wide importance, and to foster the prosecution of researches in pure science. With the exception of the last, these aims can be considered as coming under the designation of organised applied research. The Department has always strongly insisted that it is this type of work only that it seeks to organise, the assisted worker in pure research being left entirely free to follow his bent. As regards scientific policy, the Minister in charge of the Department is advised directly by a Council of independent scientific men, and these are represented also on the various Boards and Committees entrusted with the supervision of such investigations as are directed by the Department itself.

Research Associations.—From the success attending applications of scientific research in military and industrial problems during the war, the lesson was drawn that our industries in peace-time should be infused with fresh and more vigorous life by methods which had proved their worth at our time of need. Foresight in these matters was necessary, since it behoved Great Britain, no longer with the industrial world at its feet, to make the utmost use of its resources, by adopting the methods that were most efficient and solidly based on science, in order to produce material that would maintain the tradition of the excellence of British goods. While it was recognised that the most powerful chemical industries maintained efficient research staffs, it was decided to encourage separate industries to organise themselves for the co-operative prosecution of research. To the associations erected under this scheme grants, for a term of years only, and usually on a pound-for-pound basis, are made from a fund of a million pounds voted by Parliament in order to demonstrate to the industries the advantage of investigating their own technical problems, for it was recognised that many industries would have to carry out research themselves before they could properly appreciate its application. In its last published Report the Department remarks on the continuance of these grants to the associations beyond the originally intended period of five years, as this period has proved insufficiently long for the equipment of laboratories and the effective launching of important investigations, especially during a time of industrial depression.

A very wide field is covered by the research associations. Among those that have been set up in which chemistry is important are associations for the textile industries, for rubber, leather, and shale oil, for flour and sugar, for non-ferrous metals, cast-iron, glass, refractories and Portland cement, and for scientific instruments and the photographic industry.

As the results obtained by the associations are primarily for the benefit of their constituent members, the onlooker has a chance of gauging the chemical work carried on only from the communications which, following an enlightened policy, the management of some of them permits to be published; and as many of these are contributions to "pure" chemistry, an example is afforded of the opportunity as well as

of the necessity for work of this kind in the case of investigations undertaken primarily for an industrial purpose.

It would be impossible to review the work of the research associations for all these industries, even if the data were available, and so reference will be made only to some of their publications, relating to textile fibres, cotton, flax, wool and silk, as the work published presents many intesting features. Thus there are being studied the products of the hydrolysis of cotton, with an obvious bearing on the constitution of cellulose, the chemical constituents of cotton waxes, and the action of micro-organisms on cotton fibres and fabrics. Flax, hemp and ramie fibres are being investigated as to their distinguishing characteristics and behaviour with reagents that affect their lustre and absorption of dyes. Wool has been found to have a selective action, whereby it absorbs the alkali from the soap used in scouring, and methods have been evolved for accurately following the action in practice. Similarly with silk, a systematic study is being made of the action of acids and alkalis on the components of this fibre. In the respective laboratories the chemical and physical properties of each of these fibres are being studied and correlated for the purpose of explaining, for example, their strength and lustre, and at a recent meeting of the Faraday Society the methods and results of workers in all these fibres were reviewed in a General Discussion.

A close scientific scrutiny is being applied to the tanning of leather, and the chemical and physical changes involved, together with a bacteriological study of the process. Equally important for this industry and for that of making photographic plates is the study of gelatin, whose chemical and physical properties are being elucidated, whilst work of benefit to pure science has been published on the effect of light on the photographic plate. The study of the chemistry of glass and the physical properties associated with changes in its composition is another another example of work that has been reported in the literature for improvement of an industry.

The record, as has been stated, must be incomplete but the subjects mentioned present the appearance of being valuable in the scientific study of material and process, and can scarcely fail to lead to the betterment of the respective industries.

Boards.—The Boards and Committees under the Department may be broadly divided into those which undertake the investigation of work of national importance, and those which undertake work of specific importance to Government Departments and correlate the scientific work that these carry out.

A large amount of chemical work is carried out by these Boards. The Departmental Research Boards and Committees dealing with chemical subjects are concerned with the cause of the deterioration of fabrics by organisms and light, and their fireproofing; with the changes that food undergoes under varying conditions of storage, and the constitution of fats; with the chemistry of the treatment of timber; with the survey of our coal resources and the economic usage of coal; with the production of alcohol and liquid fuel from waste vegetable matter; with the chemical aspects of the problems of adhesion, lubrication, restoration of museum exhibits; with building materials, paints, and the preservation of stone, and with the properties of several of the minor metals. For subjects of the magnitude and importance of some of these, staff and equipment have in several instances been provided on a large scale, and a growing number of monographs and communications to the literature issues from the respective Boards.

The Co-ordinating Board for Chemistry, like the similar Boards for other sciences, was founded for the purpose of securing interchange of information among Government technical establishments, seeing that outside interests are informed, when this is practicable, and arranging for researches not otherwise provided for. The Board carries out these duties in consultation with representatives of the Fighting Services and of other Government Departments materially affected, and with independent chemists, when departmental schemes of work are reviewed in the light of information that may be in the possession of any of the members of the Board. To this Board are referred questions of wider importance than are within the purview of any one Department, and it keeps under its consideration the development of the natural resources of the country. With further facilities for undertaking investigations, it will be in the position to extend such work and to arrange for subjects not otherwise provided for, as well as for those at present under investigation.

Assisted General Research

Apart from the indirect help afforded to the universities by means of Government Grants, direct assistance is given by the Department of Scientific and Industrial Research to research workers who may be students, or independent workers, and to important pieces of pure research. To these grants no conditions are attached; they are given for the extension of knowledge.

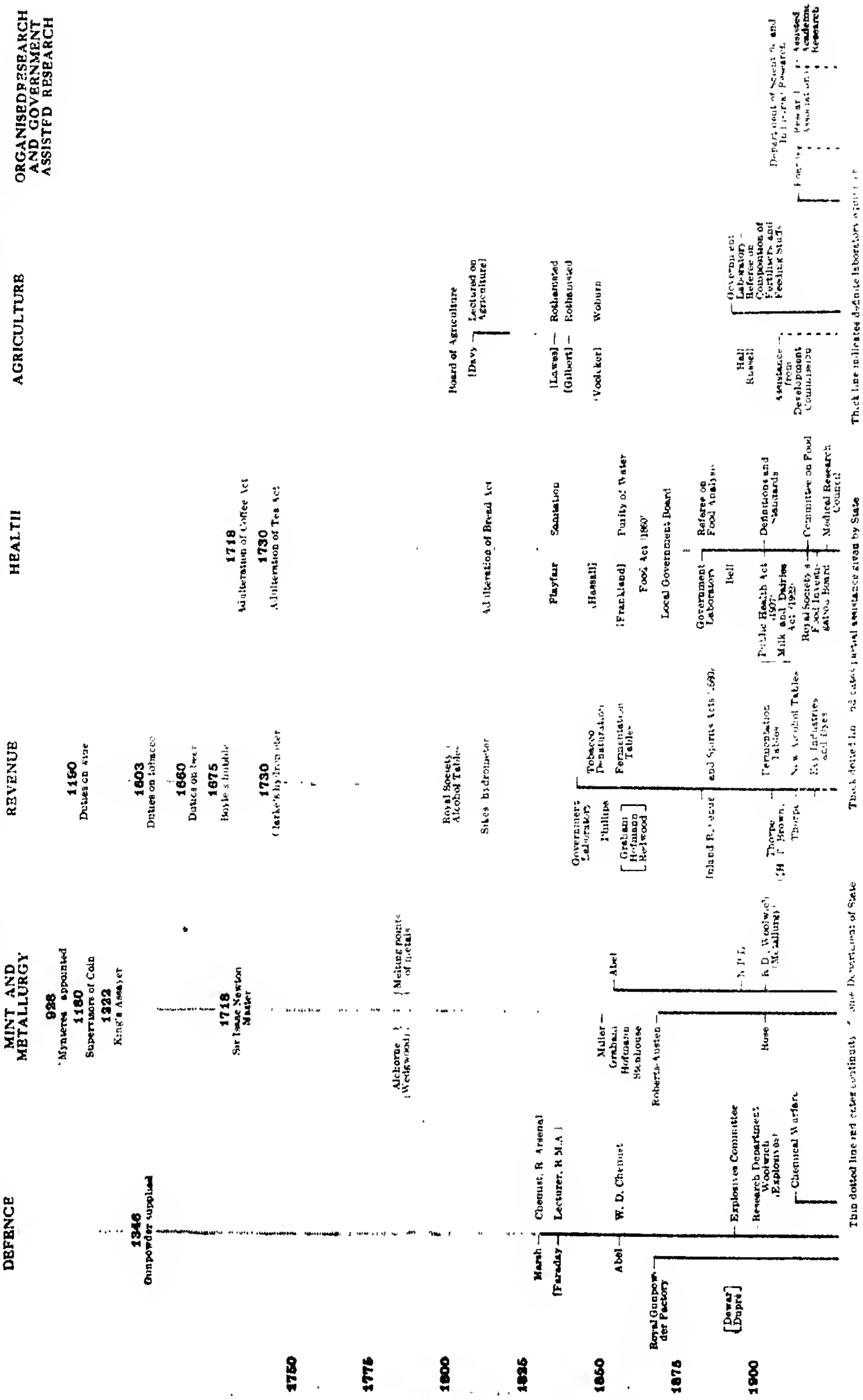
One of the objects of these grants is to encourage the supply of highly-trained scientific research workers to meet the growing needs of the Government, the industries of the country, and indeed of the Empire. The lack of such was felt acutely during the war, although now, for chemists with the usual qualification at any rate, the conditions have changed.

Students are given grants on the recommendation of their professor that they are a type likely to be greatly benefited by spending two years at research work after taking their degree. In this case the award is for promise and not for achievement, and the hope is entertained that the necessity for these grants will gradually disappear when university finance is on a sounder basis.

Grants are given to independent workers who have shown their capacity for research, and who are handicapped by lack of facilities. Further, for work of unusual importance, substantial financial assistance may be given when it appears desirable.

In this way comes recognition of the national importance of the highest type of scientific work, and to this, of course, no conditions are imposed as to the lines on which it should be carried out.

CHART SHOWING DEVELOPMENT OF STATE'S ACTIVITIES IN CHEMISTRY IN THE UNITED KINGDOM



SUMMARY

The State's appeal to chemistry has developed through the gradual recognition of the need for the application of that science to matters relating to its preservation, its currency, its financial support, its health, its food supply, its industries, and finally to academic science. A chart illustrating this development historically is appended to this address.

In the course of this development, advantage has been taken, if sometimes tardily, of the general advance in chemical knowledge, and frequent recourse has been had to the advice of well-known chemists of the day, and collectively of the Royal Society; thus for various purposes the following chemists, as officials or consultants, have in the past afforded assistance in the solution of specific problems referred to them, or by taking part in Commissions: Boyle, Newton, Davy, Faraday, Daniell, Graham, Hofmann, Redwood, Abel, Roberts-Austen, Percy, Dupré, Playfair, Frankland, Ramsay and Dewar. It has happened in several instances that as a result of these Commissions and references to chemists some definite chemical activity of the State has emerged.

It will be convenient in this summary to review the State's chemical activities before, during, and after the war.

BEFORE THE WAR

Defence.—For its defence, establishments for the production of explosives were early maintained, and when this ultimately took the form of a chemical manufacture the Government factory took the lead in devising efficient processes, while from the various State research establishments has issued during the last fifty years an important body of original contributions to the theory of explosives and to the knowledge of their properties.

Metallurgy.—The metallurgical progress of the country has always been a concern of the State by reason of its application to defence by land and sea, and close touch has been maintained with successive developments in the manufacture and use of cast-iron, wrought iron, steel and non-ferrous alloys. While the main advances in process have been made in the great iron and steel works, material contributions to knowledge in this sphere have been made by chemists in the Government service.

Revenue.—For its revenue, imposts were applied in early times, but with great uncertainty, until the charge was put on a scientific basis. Very accurate tables for the strength of alcohol were worked out under the supervision of the Royal Society at the end of the eighteenth century, to be superseded by revised ones issued only a few years ago, when, in addition, new tables were issued also by the Government Laboratory, for determining the gravity of worts before fermentation. The question of rendering alcohol unpotable, but still useful for industrial purposes, has occupied much attention. As some misapprehension still exists as to the availability of alcohol for industrial purposes, a statement has been included in which the main facilities are indicated. It was on account of the necessity for safeguarding the revenue that the Government Laboratory was primarily erected, although it now performs chemical work for all State Departments.

Health.—The three main steps with regard to public health and sanitation in this period were the forcing of these questions into prominence by Playfair, with the consequent Commissions and legislation leading to the formation of the Local Government Board and its successor, the Ministry of Health, which has many varied activities in preserving purity of air and water and protecting the workman in dangerous trades; secondly, the determination of standards for a safe water supply by the pioneering work of Frankland; and thirdly the appointment of public analysts by the local authorities, with the Government Laboratory as referee, for safeguarding the supply of food.

Agriculture.—Science was being applied to agriculture about the end of the eighteenth century, and at the beginning of the next Davy did pioneering chemical work for the Board of Agriculture. Private endeavour is responsible for the next development, State action being limited to the prevention of fraud in the sale of fertilisers and feeding stuffs. In 1909, however, the annual allocation of a sum of money to the Development Commission for the advancement of agriculture stimulated research in a large number of institutions engaged in the scientific study of problems in which chemistry enters.

Other Activities.—In addition to the chemical work reviewed in the foregoing sections, there is a variety of subjects connected with State Departments to which chemists have contributed, such as the composition of the sea, and the composition and physical chemistry of rocks and building-stone. At the Government Laboratory a large number of investigations have been conducted on matters directly referred from Government Departments.

DURING THE WAR

In all the activities described, the war requisitioned the work of the chemist, but, naturally, predominantly to meet the demands of active warfare.

Defence.—The attention that had been bestowed on the subject of propellants enabled expansion to take place with no important alteration in the technique of their manufacture, to which was adapted a new type of cordite, ultimately made on the largest scale, without using an imported solvent. For high explosives we were in much worse case, as these had not been made by the Government, and were manufactured in Great Britain only in small quantity. Their study at Woolwich led to a rapid evolution of new processes, substances, and methods of use. Thus a method was worked out for the manufacture of trinitrotoluene, and to save this substance a new high explosive, amatol, devised. This explosive, consisting of ammonium nitrate and trinitrotoluene, passed exhaustive trials and was ultimately produced at the rate of 4000 tons a week. The production of the ammonium nitrate for the mixture was in itself a stupendous undertaking. In the Research Department, Woolwich, the number of qualified chemists engaged in the study of explosives in all their aspects ultimately exceeded a hundred, while for manufacture and inspection

over a thousand were employed. The ideal set before himself by Lord Moulton in 1914, to produce nothing less than the maximum of explosives of which the country was capable, was realised, and they assumed a quality and character that caused them to be copied by our Allies, and in reliability proved themselves superior to those of the enemy.

Starting unprepared, and without the advantage of a well-developed fine-chemical industry, we were able ultimately to make a reply in the field of chemical warfare that was rapidly becoming more and more effective; at the same time, by study and often self-sacrificing experiment, protecting the soldier by the development of very efficient respirators. In this connexion and in that of explosives nearly every professor of chemistry in the country and many from overseas were engaged.

Metallurgy.—The enormous demand for metals led to an unprecedented concentration of the metallurgical industries on the needs of the State, and to an equal concentration of metallurgical science on investigation devoted to improvement in quality of materials for new and special war purposes. The work of the Aircraft Production Department, aided by many metallurgists and enigneers, on alloy steels, of the National Physical Laboratory on aluminium alloys, and of the Metallurgical Branch of the Research Department, Woolwich, on the heat-treatment of heavy forgings and on the drawing of brass, is typical of the successful effort made in every quarter. The knowledge thus gained was disseminated and has had a great and permanent effect on manufacture.

Health.—A committee of the Royal Society had been studying food values, and were able to afford the Food Controller, when he took office, valuable data bearing on the rationing of food. They had considered subjects which shortly became of much importance, such as a better recovery of flour in milling wheat. The chemical examination of the food for the Army in the war, carried out by the Government Laboratory, employed a large staff of chemists. For the supply of many fine-chemical substitutes used in medicine and surgery, formerly imported from abroad, such provisional arrangements had to be made as the organisation of many university laboratories on a semi-manufacturing basis.

Agriculture.—Effects on agriculture during the war were shortage of the usual feeding stuffs for cattle and of fertilisers. The chemists stationed at Rothamsted gave special attention to the shortage of manures and prepared instructions for the guidance of farmers; and several sources of supply of potash were exploited. As sulphuric acid was required for explosive work, fine grinding of phosphates and basic slag was found to be more efficient than was expected. Shortage also directed the attention of chemists to the use of little known foodstuffs.

Other Activities.—In many other activities in connexion with the war chemists were directly involved, such as in affording advice on the conservation of materials, on the numerous questions arising from the operations of the War Trade Department, on the restriction of imports and exports, and on matters of contraband.

After the War

The magnitude of the chemical effort, it can be claimed, was a factor in winning the war which must be reckoned as of importance only second to that of the bravery of our forces in the field. But it has left a lasting mark, and given to chemistry a value which, were it not for the rapidity with which the achievements of science are forgotten, ought to keep before the public its connexion with almost every phase of activity.

Defence.—To take our subjects in the same order, we may consider some of the effects of the energy spent on the production of munitions. The intensive study of explosives and of other chemical substances used in the war has led to a more complete knowledge of their chemistry, their physical and explosive properties, and has advanced chemical theory. These advantages are not of military importance only, but are reflected in the production of trade explosives, and the records of the Department of Explosives Supply afford examples of treatment of many problems of interest to the general chemical technologist.

A further benefit was reaped by chemists in every position, from the Professor to the youngest graduate, coming into direct contact with manufacturing methods and thus gaining insight into the applications of their science. It became apparent that there was a shortage of a type of chemist which had been developed in Germany, skilled in the transference of the chemical process from the laboratory to the works scale in the largest enterprises. A chemist of this type is one who, besides having a sound knowledge of chemistry and physics, has had experience in the materials of construction used on the large scale and in the operation of the usual types of plant for carrying out the operations of chemical manufacture, and who is capable of working out flow-sheets illustrating the process, and operating plant with every regard to economy. As a result of the war-time experience of our deficiencies in this direction has arisen the movement for erecting Chairs of Chemical Engineering in some of our universities. It is to be expected that from these schools, especially where the instruction is superimposed upon a full graduate course, will emanate men who will lead the way in the application of academic science to industry.

Metallurgy.—While the interest of metallurgical science in war material has fortunately fallen to a peace-time level, State participation in the support of scientific research remains far greater than before the war. In metallurgy it is exercised through the Department of Scientific and Industrial Research, with its organisations of the National Physical Laboratory and the Industrial Research Associations. The State maintains efficient research establishments for the Fighting Services, but it is significant that the largest of these is undertaking industrial metallurgical research on a considerable scale, for the benefit of the brass and other industries. State support and encouragement are undoubtedly powerful factors in the rapid progress now taking place in every branch of metallurgical science in this country, and there is scarcely any related industry which can fail to benefit.

Revenue.—Since the war the principal matters affecting the revenue are the higher duties, which

have rendered necessary a further denaturation of alcohol. Improved facilities have been granted for the use of alcohol for scientific purposes and in industry; regulations have been formulated for the use of power alcohol, and duties have been established on imported fine chemicals and synthetic dyestuffs.

Health.—The food shortage during the war called attention to the nature and quantity of our food supplies, and led to further investigations being undertaken by the Department of Scientific and Industrial Research on food preservation and storage. Committees are also working on the preservatives and colouring matter in food, and on the pollution of rivers by sewage and trade effluents. A great field is open in the co-operation of chemistry with medicine in the discovery of substances suitable for the treatment of the numerous blood parasites.

Agriculture.—So far as fertilisers are concerned, the lack of a supply of fixed nitrogen from the air which obtained throughout the war has now been rectified, and Great Britain for the first time is no longer exceptional among the nations by neglecting to provide itself with synthetic ammonia for agriculture and for munitions. Such war-time expedients as the use of nitre-cake instead of sulphuric acid for making ammonium sulphate and superphosphate and the recovery of potash from flue-dust have not survived, but there has been a gain in the further development of "synthetic farmyard manure" and the increased use of basic slag. The present activity in research in agricultural chemistry of a fundamental character is leading to a better understanding of problems of the soil and of plant and animal nutrition, and cannot fail to be of ultimate benefit to farming.

Organised Applied Research and Assisted General Research.—Established during the war as a result of an appreciation of the contrast between the successful application of scientific method to military purposes and the want of such application to many of our manufactures, the Department of Scientific and Industrial Research has extended over a wide field. Its main activities have been sketched in the directions of State encouragement to industry to apply chemistry to its problems, of State investigation of vital problems beyond the sphere of private enterprise, and of assistance to academic workers.

In the expansion that has occurred in the chemical sections of State Departments since the war, it is interesting to note the increase in the number of chemists that are employed. As far as can be gathered, the number of chemists working in departments maintained wholly by the State is 375 for the present year, compared with 150 in 1912, while in establishments to which the State affords partial support, such as those under the Development Commission and the Research Associations, the corresponding numbers are 150 and 50. In addition, grants are made to 145 research students and to 11 independent research workers, involving a yearly sum of about £50,000.

From the foregoing account of the connexion of the Departments of State in the United Kingdom with chemistry, it is possible to trace a gradual development and ultimately a change in attitude, in passing through the stages of compulsion, expediency, and assistance.

From motives of security the State was compelled to give heed to chemical matters involved in its defence; it was constrained to uphold the standard of its currency; and it was obliged to secure a revenue. As a consequence, the first chemical departments were set up in connexion with these activities, and from them have emanated notable additions to chemical knowledge, improvements in methods of manufacture, and specifications for Government requirements that have led to improved material becoming available for civilian use. Although mostly conducted with inadequate staff, the study of these questions, it can be claimed, proved of national advantage when the time of need arose.

In the next stage, the public conscience having been awakened by the pioneering work of Playfair, it appeared expedient to safeguard health by attention to sanitation, and, as the quality of food was unsatisfactory, to set up a chemical control. Although a start was made by Davy, progress in this subject passed to private enterprise, and a century elapsed before direct assistance was afforded to this important matter. Out of these activities come our present system of supervision over the purity of air, water, and food, and also the recent progress made in investigating problems of the soil.

The last and more recent stage is in the nature of a recognition that the State is under an obligation to assist science, and in this case the science of chemistry, on which so many important industries are based. It took the war to bring home the danger that, although the record of the country as regards discovery in pure science was unrivalled, its systematic application was too often left to other countries, with the result of lamentable shortages during war and the risk of many industries being ineffective in peace. A measure of Government intervention and action appeared requisite, and research became the business of a Government Department. Outside of the great firms which maintain progressive chemical staffs, the firms in numerous industries have been encouraged and assisted to co-operate in the betterment of their manufactures by the application of the methods of science, and from these associations and the organisations dealing with national problems begins to flow a stream of communications indicative of useful work accomplished. Nor is the foundation of it all neglected, for encouragement is given to workers in the academic field to follow out their ideas, whithersoever they may lead them, in accordance with the truth that "research in applied science might lead to reforms, but research in pure science leads to revolutions."

It is important to be able to record an advance in securing an interchange of information among Government Departments, and between their work and that of the universities, a matter which before the war was unsatisfactory, as it was mainly personal and sporadic. And it is a hopeful sign also that, although the knowledge and appreciation of the methods and capabilities of science are still generally wanting, there have been of late signs that these matters are coming to engage the attention of those who guide the policy of the State.

FORTHCOMING EVENTS

Aug. 9. NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS. Annual General Meeting, to be held in the Lecture Theatre of the Institute, Newcastle-on-Tyne, at 2 p.m.

Sept. 4 and 5. IRON AND STEEL INSTITUTE, Autumn Meeting at British Empire Exhibition, at 10.30 a.m. each day. (1) "Changes of Volume of Steels During Heat Treatment," by L. Aitchison and G. R. Woodvine. (2) "Investigations on the Herbert Pendulum Hardness Tester," by C. Benedicks and V. Christiansen. (3) "Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on some Magnetic Properties of Steel," by E. D. Campbell and G. W. Whitney. (4) "Pickling: The Action of Acid on Iron and Steel, and the Diffusion of Hydrogen Through the Metal," by C. A. Edwards. (5) "Examination of Iron from Konarak," by J. N. Friend and W. E. Thorneycroft. (6) "On the Nature of High-Speed Steel," by M. A. Grossman and E. C. Bain. (7) "Improvements in the Brinell Test on Hardened Steel, including a New Method for Producing Hard Steel Balls," by A. Hultgren. (8) "Present Position of the Theories of the Hardening of Steel," by W. Rosenhain. (9) "Effect of Free Surfaces on the Plastic Deformation of Certain Metals," by F. C. Thompson and W. E. W. Millington.

Sept. 8 to 11. INSTITUTE OF METALS. Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at Wembley.

The following papers will be read:—"A Method for Measuring Internal Stress in Brass Tubes," by R. J. Anderson and E. G. Fahlman; "The Application of the Ideal Solubility Curve to the Interpretation of Equilibrium Diagrams in Metal Systems," by D. H. Andrews and Prof. J. Johnston; "Seventh Report of the Corrosion Research Committee of the Institute of Metals," by G. D. Bengough and R. May; "Comparative Results on Copper-Silicon-Aluminium and Other Aluminium Alloys as Obtained on Separately Cast Specimens and Specimens cut from a Crankcase Casting," by E. H. Dix and A. J. Lyon; "The Determination of Sodium in Aluminium," by D. M. Fairlie and G. B. Brook; "The Extrusion of Brass Rod by the Inverted Process," by R. Genders; "Investigation of the Effects of Impurities on Copper. Part II—The Effect of Iron on Copper," by D. Hanson and Grace W. Ford; "The Relationship Between Tensile Strength, Temperature and Cold-Work in Some Pure Metals and Single Solid Solutions," by D. H. Ingall; "On the Effect of Progressive Cold-Rolling on the Brinell Hardness of Copper," by H. Moore; "Experiments on the Working of Nickel for Coinage," by Sir T. K. Rose and J. H. Watson; "Some Experiments on the Effect of Casting Temperature and Heat-Treatment on the Physical Properties of a High-Tin Bronze," by F. W. Rowe; "Some Experiments on the Influence of Casting Temperature and Mass on the Physical Properties of Admiralty Gun-Metal," by F. W. Rowe; "Studies in the Aluminium-Zinc System," by T. Tanabe; "Metal Spraying and Sprayed Metal," by T. H. Turner and W. E. Ballard.

NOTES FROM WEMBLEY

The attractions of the British Empire Exhibition continue in undiminished splendour, and visitors return again and again, ever finding fields and pastures new. Notes on some of the exhibits have been published from time to time in this *Journal*, but how incomplete they have to be! One could fill the whole year's issues of *Chemistry & Industry* and still go on. One would like to linger over the ever-changing stand of the British Dyestuffs Corporation, with its attractive models of plant for making intermediates and dyes, its fascinating array of colour. The giants of alkali industry claim attention, but must be passed; one must neglect the magnificent crystals of various alums on the stand of Peter Spence and Co., Ltd., the attractive blue of copper sulphate shown by James H. Dennis and Co., Ltd.; this time one must resist the attractions of the magnesia exhibit of the Washington Chemical Co.; J. and J. White, Ltd., allure in vain with their fine show of chromium compounds. A detour, to avoid more temptation, and there is Johnson, Matthey and Co., Ltd., with their display of precious metals in such a demure setting, their weights, platinum crucibles, silver nitrate, mercury, so many exhibits that tempt one to write on and on. But across the way an array of pipes calls insistently, and soon one is examining Doulton's exhibit, admiring their acid eggs, elegant in form and finish, their plant for the manufacture of nitric acid, their acid-resisting piping, single, double and treble, their excellent candle filters. There is an interesting vacuum filter on this stand, of earthenware also, but of large capacity and capable of withstanding considerable pressures: it is hoped to return to this filter later. But Doulton's exhibit guards the entry to an array of glassware.

At the stand of Chance Brothers and Co., Ltd., with their 100 years of experience, one expects to be interested, and one is not disappointed. Chemists all know this firm's resistance laboratory glassware, of which there is a goodly assembly, and everyone knows of Chance's sheet glass, coloured glass, rolled glass. There is the optical glass, seen everywhere nowadays ennobled in tortoiseshell, and of which, as of microscope slides and cover glasses, the firm were the pioneer manufacturers in this country. Of special note are "Calorex" glass, which cuts off about 80 per cent. of the heat of the sun, but transmits about 65 per cent. of the light, and "MAXimum" daylight glass, which is a combination of lenses and prisms which collects all available light and distributes it to the best advantage; the industrial utility of two such glasses is very great.

Near by, one can visit Ackroyd and Best, Ltd., of Morley, on whose stand is a series of miners' safety lamps, of which over a quarter of a million are in use. Of excellent mechanical finish, and provided with fittings and accessories (including most ingenious relighters) to ensure safety, easy cleaning, and easy handling, these lamps should be useful in many branches of the chemical industry, as they enable tanks containing explosive gases to be inspected or cleaned in safety. The firm also

makes resistance glassware for laboratory and lighting use and produces automatic tub greasers or oilers that should find application in connexion with conveying and similar plant.

Behind the gas section is the stand of the Thermal Syndicate, Ltd., of Wallsend-on-Tyne, whose exhibit will attract chemical manufacturers as well as chemists. "Vitreosil" pure silica ware, in general use in laboratories, is shown in its various forms, and there are "Vitreosil" basins and balloons for concentrating and distilling acids, carburising boxes for the heat treatment of small pieces, calottes for use in the Kessler plant, a large condensing coil, coolers, pipes and connexions for acid manufacture and large chemical ware for nitric and sulphuric acid and other condensing plants. These large pieces are evidence of the skill with which the difficult technical problems of manufacturing silica ware have been overcome.

In one corner of the Chemical Section is a very interesting stand—a key-industry exhibit. One cannot do justice to this stand, or to the exhibitors, Baird and Tatlock (London), Ltd. Before the writer is a handsome volume of nearly 1000 pages which is labelled "Vol. 1: Chemistry," and describes the firm's products. Three other volumes are devoted to Physiology, Biological Sciences, and Physics, and there are numerous special pamphlets dealing with the analysis and testing of oils, cement and paint, the determination of hydrogen-ion concentration, and other subjects. The stand can be said to be a synopsis of the catalogue, which is divided into sections dealing with laboratory fittings and equipment, furnaces, chemical apparatus, physico-chemical apparatus (measuring, calorimetric, optical, hydrogen ion and electrical), apparatus used in metallurgy and mining and cement testing, organic chemical apparatus including special apparatus for research work, and concludes with a very complete list of chemicals for laboratory work and a general index. The catalogue is a monument and the "B.T.L." stand is a worthy introduction to it. Both must be seen to be appreciated.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

It has now been arranged that the Autumn Dinner of the Society, already intimated to be held on November 14, will be a joint function under the auspices of the Society of Chemical Industry and the Chemical Industry Club. The Dinner will be held in the Edward VII. Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, and will be presided over by Mr. W. J. U. Woolcock, President of the Society. It is hoped that a large number of members of each of the bodies mentioned will, in due course, procure tickets for themselves and their ladies. Full details will be intimated later, but members are asked in the meantime to note the above date and place for the dinner.

CORRESPONDENCE

CHEMOR—THE POLICY RATHER THAN THE FORM

Sir,—There can be no doubt that, as several of your correspondents contend (and some of us illustrate!) we of the chemical profession are in need of either more profound knowledge of the science of language or expert guidance in its use.

If I fully understand Mr. Bousfield's (June 27) answer to my preceding communication (June 20) he is not disposed to press the point that the adoption of the word "chemor" would involve the coinage of a new and unneeded term for the science. I, on my part, am willing to concede that the majority of the words of this class ending in "or" are of Latin origin, direct or indirect (though there are exceptions, such as "sailor"), but I cannot see that that precludes our attaching the same suffix to a root of obscure origin if thereby we get a useful, discriminatory and euphonious word.

Mr. Bousfield points out that the "sister sciences" have practicians (or must it be "practicists"?) designated by words ending in "ist." True, as regards the majority, but must we disown from the family *arithmetic*, *astronomy*, *geometry*, *mathematics*, *philosophy*, and *theology*, because they prefer to give their children names with other endings? In applied sciences may we not even find the termination "or," for instance, in *surveyor* and *navigator*.

Indeed, if the chemist will insist [illegible] the [illegible] exact etymological parallels he wil[illegible] in line, not with his closest relative[illegible] casuist, the dentist and the palmist. I[illegible] will reflect upon the relations betwe[illegible] word[illegible] *art*, *artist*, *artistry*, *artisan*, *artifice*, [illegible] of *artificership*, or will compare *psychiatry*, [illegible] and *psychiatrist* with the corresponding terms ref[illegible]ring to other sciences, he will realise that actu[illegible] language is not as "logical" as if he could "remal[illegible] it to his heart's desire"—by Act of Parliament [illegible] otherwise. Let him even look at his own wor[illegible] "logical" and decide whether he *must* refer to t[illegible] science as "logicianry" or to the scientist a[illegible] "logist."

Furthermore, review of the discussion wil[illegible] that I have not proposed to abolish the [illegible] "chemist" nor even to prohibit its application to the "chemor" as well as the pharmacist. My point is that it is futile to expect the latter to abandon his claim to the word held in common with us, a claim that, as regards both time and province, extends far beyond the authority of the Pharmacy Act of 1869, but that we *can* invent and copyright a new term with the special definition we wish to reserve for ourselves.

If "chemor" is philologically unsound—as to which I remain unconvinced—there are alternatives. Mr. Bousfield's reference to physics is suggestive for the words *physicist* and *physician*, though derived from the same root, are quite distinct in meaning. So also are *artist* and *artisan*. Related to mechanics we have no less than three forms, *mechanic*, *mechanician* and *mechanist*.

"Chemic," though now unused appears once to have been employed as a synonym for alchemist

and might now be revived in a new sense. It is so distinctly obsolete in its old meaning as to carry no objectionable connotation. "Chemician" is the approximate analogue *arithmetician*, *logician*, *mathematician*, *mechanician* and *musician*, and we might also consider "chemicker," which would have the advantage of resembling the German word for chemist.

Conservative minds naturally react against *any* new word. But surely chemists need not be renitent in regard to such a matter. The language is ours. Why not mould it to our purposes?

When Sédillot, reviewing the work of Pasteur, introduced the word "microbe," exception was taken to it on the ground that in Greek *mikrobios* suggested rather short life than minuteness. Littré, though admitting this, nevertheless endorsed Sédillot's choice and advised him "not to trouble to answer criticisms but let the word stand for itself, which it will no doubt do." "As you justly remark," he wrote, "the question is not what is most purely Greek, but what is the use made in our language of the Greek roots." If a French lexicographer could take such a liberal view, why not a British chemist?—I am, Sir, etc.,

J. F. Snell,
Professor of Chemistry

Macdonald College, Que., Canada
July 26, 1924

OBITUARY

SIR GEORGE BEILBY

All those interested in scientific research and its application to industry will hear with great regret of the death, in his seventy-fourth year, of Sir George Beilby, LL.D., F.R.S.

Sir George was the son of G. T. Beilby, M.D., of Edinburgh, and received his scientific training at Edinburgh University. In 1869, at the age of nineteen, he commenced his industrial career with the Oakbank Oil Company. His pioneering work on the manufacture of shale oil is well known and the improvements he effected in collaboration with William Young gave new life to the industry to enable it to compete with imported petroleum oils. After some years of valuable work in this field Sir George turned his attention to new processes for the production of cyanides. In this he was again successful in building up a large and successful company working on his inventions, particularly one relating to the recovery of gold by the cyanide process.

While in Glasgow Sir George took a deep interest in educational matters and for many years was chairman of the governors of the Royal Technical College. In this capacity he was largely responsible for the development of the practical side of scientific training in the College and for enlisting the sympathy and help of other commercial magnates.

Throughout his industrial career Sir George was always interested in fuel economy and in the abatement of the smoke nuisance. His studies of the coal question led, in 1903, to a valuable report to the Royal Commission on Coal Supplies. In 1912–13 he served on the late Lord Fisher's Commission on Fuel and Engines for the Navy and it was his experimental work on which the findings of that committee were very largely based. The committee reported that the only way of securing a home source of fuel oil was to develop a new process for the carbonisation of coal at a much lower temperature than that employed in gas making. A great deal of pioneering work was later carried out under his direction at the Maryhill Works of the Cassel Cyanide Company and became of great value later in the early stages of the experimental work of the Fuel Research Board.

During the war, when the necessity for further work on fuel culminated in the formation of a Fuel Research Board, Sir George was appointed chairman and director. Under his direction the Fuel Research Station at East Greenwich was built and equipped for both laboratory and large scale investigations on the wide schemes adopted by the Government. About the middle of 1923, having placed this great national institution on a sound basis, he retired from active participation. As a consultant, however, he gave advice freely up to within a few days of his death. His last published work, on oil production in the Empire, was presented at the World Power Conference, though his illness prevented his reading it personally.

One important service which he rendered to the community was the institution of the thermal method for charging for town gas, the far-reaching advantages of which have already become apparent.

In the realms of pure science Sir George was always an active worker, and his many papers serve as models of careful scientific observation. His work on the microstructure and physical properties of metals, started as long ago as 1920, culminated some two years ago in a masterly work covering the whole period. His experience in this line of study enabled him to start an illuminating research on the structure of coke, the end of which is not yet in sight.

Sir George was elected a Fellow of the Royal Society in 1906 and received the honour of knighthood in 1916. He had honorary degrees conferred on him by the Universities of Glasgow, Birmingham and Durham. He acted as President of the Society of Chemical Industry (1899), the Institute of Chemistry (1909–12), the Institute of Metals (1916–18) and the Chemical Section of the British Association (1905).

Sir George Beilby was a man of the highest character. He was very reserved and sensitive, but from his friends and from all who came in contact with him in his work he won admiration and affection. His own straightforwardness and honesty of purpose made him severe on quacks, but the trier could always be certain of Sir George's sympathy and help. His death is not only a great loss to science but to all who have been near him in his work.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 1d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	7d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	45s per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	4s. 10d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton. Fair demand.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall. 60% O.P. Market dull.
Solvent	5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£46 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d.—6¾d. per lb. Quiet.
Crude 60's	1s. 9d.—1s. 11d. per gall., according to district. Still quiet.
Acid Cresylic, 97/99	2s 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—1s. 11d. per gall. Quiet.
Dark	1s. 10d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	8d.—9d. per gall. Quiet.
Unstrained	7d.—8d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d. per gall.
Pure	1s. 8d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	9d.—9½d. per gall. Few inquiries.
Middle Oil, Heavy Oil, Standard Specification	5½d.—6d. per gall in Lancashire 6d.—7d. per gall. in Yorkshire.

Naphtha—	
Solvent 90/160 ..	1s. 1d.—1s. 4d. per gall. according to district. Quiet.
Solvent 90/100 ..	1s. 1d.—1s. 4d. Quiet.
Naphthalene Crude—	
Drained Creosote Salts	£4—£6. Quiet.
Whizzed or hot pressed	£9 per ton. Little business.
Naphthalene—	
Crystals and Flaked ..	£13—£16 per ton in Yorkshire and London respectively.
Pitch, medium soft ..	55s.—60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160 ..	17s. 6d. per gall. Market less firm.
Heavy ..	12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

There has been a fair demand for dyestuffs during the past week. Prices remain constant. A number of intermediate products have been reduced in price.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 7d. per lb.
Acid H.	4s. per lb 100% basis d/d.
Acid Naphthionic ..	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. ..	1s. 1d. per lb. Improved demand.
Acid Sulphanilic ..	9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% ..	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C. ..	4½d. per lb. Demand steady.
m-Cresol 98/100% ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	2s. 3d.—2s. 11d. per lb.
Dichloraniline S. Acid ..	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol ..	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	2s. 10d. per lb. d/d.
Monochlorbenzol ..	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine ..	1s. 4d. per lb. d/d.
β-Naphthylamine ..	4s. per lb. d/d.
m-Nitraniline	4s. 9d. per lb. d/d.
p-Nitraniline	2s. 3½d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works
o-Nitrochlorbenzol ..	2s. per lb. 100% basis d/d.
Nitronaphthalene ..	10½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis
m-Phenylene Diamine ..	4s. per lb. d/d.
p-Phenylene Diamine ..	10s. 3d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate ..	2s. 3d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 3d. per lb. naked at works.
m-Toluylene Diamine ..	4s. 3d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P. ..	£45 per ton.
Acid, Acetyl Salicylic ..	3s. 2d.—3s. 5d. per lb., according to quantity. Good demand. Price firm.
Acid, Benzoic B.P. ..	3s. per lb.
Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 5½d.—1s. 6d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst ..	6s. 9d. lb. Resublimed quality 8s. per lb. Market firm; increasing demand.
Acid, Salicylic	1s. 6d.—1s. 9d. per lb. Market unsettled and difficult.
Acid, Tannic B.P. ..	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1¼d. per lb. less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
Amidopyrin	13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate ..	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate ..	12s. 6d. per oz. for English make.
Barbitone	15s.—15s. 6d. per lb. Quiet market.
Benzonaphthol	5s. 3d. per lb. Small inquiry.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate ..	12s. 9d.—14s. 9d. per lb.
,, Citrate	11s. 4d.—13s. 4d. ,,
,, Salicylate ..	10s. 2d.—12s. 2d. ,,
,, Subnitrate ..	10s. 9d.—12s. 9d. ,,
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Unsettled. Spot supplies short. Raw materials dearer. Market advancing. Forward quotations equal to 1s. 3d. lb. for potassium bromide. K.I.D. paid.
Calcium Lactate	Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate	4s.—4s. 3d. per lb. Very firm and scarce.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate ..	6s. 6d. per lb. Little demand.
Formaldehyde	£52 per ton, ex works. English make in casks.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	7s. per lb.
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50% ..	3s. 6d. per lb.
Sodium, 50%	2s. 6d. ,,
Guaiacol Carbonate ..	10s. 6d.—11s. 3d. per lb.
Hexamine	3s. 6d. per lb. for English make. Market steady.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor ..	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial ..	£36 per ton net.
Magnesium Oxide—	
Light Commercial ..	£75 per ton, less 2½%.
Heavy Commercial ..	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.

Menthol—	
A.B.R. recryst. B.P.	53s. 6d. per lb. Market better.
Synthetic	**26s.—35s. per lb., according to quantity. English make. Strong demand.**
Mercurials	Market flat.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	**3s. 6d.—3s. 7d. ,,**
White precip.	**4s. 7d.—4s. 8d. ,,**
Calomel	**3s. 11d.—4s. ,,**
Methyl Salicylate	1s. 10d.—2s. 3d. per lb. Keen competition.
Methyl Sulphonal	**26s. per lb.**
Metol	**11s. per lb. British make.**
Paraformaldehyde	2s. 10½d.—3s. per lb. Not very active.
Paraldehyde	1s. 5d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin	6s. per lb. Price and demand steady.
Phenazone	7s. 6d. per lb. A shade firmer. Forward prices higher.
Phenolphthalein	6s. 6d. per lb. Ample supplies.
Potass. Bitartrate— 99/100% (Cream of Tartar)	**88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.**
Potass. Citrate	**1s. 10d.—2s. 2d. per lb.**
Potass. Iodide	**16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues heavy.**
Potass. Metabisulphite	**7½d. per lb., 1-cwt. kegs included.**
Potass. Permanganate	6½d. per lb. Keen competition keeps price low.
Quinine Sulphate	**2s. 3d. per oz., in 100 oz. tins. Very heavy demand.**
Resorcin	5s. 6d.—5s. 9d. per lb.
Saccharin	**63s. per lb., in 50-lb. lots.**
Salol	**3s. 6d.—3s. 11d. per lb.**
Silver proteinate	**9s. 6d. per lb.**
Sod. Benzoate, B.P.	2s. 6d. per lb. Ample supplies. B.P. quality available.
Sod. Citrate, B.P.C., 1923	**1s. 11d.—2s. 2d. per lb., according to quantity.**
Sod. Hyposulphite— Photographic	**£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.**
Sod. Metabisulphite cryst.	**37s. 6d.—60s. per cwt. nett cash, according to quantity.**
Sod. Nitroprusside	**16s. per lb. Less for quantity.**
Sod. Potass. Tartrate (Rochelle Salt)	**75s.—82s. 6d. per cwt., according to quantity. Steady market, good demand.**
Sod. Salicylate	**Market more active. Powder 2s. 2d.—2s. 4d. per lb. Crystal at 2s. 4d.—2s. 6d. per lb. Flake 2s. 9d. per lb.**
Sod. Sulphide— Pure recryst.	**10d.—1s. 2d. per lb., according to quantity.**
Sod. Sulphite, anhydrous	**£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.**
Sulphonal	15s. 6d. per lb. Easier.
Thymol	19s. per lb. Very scarce indeed. Still rising.

PERFUMERY CHEMICALS

Acetophenone	**12s. 6d. per lb.**	
Aubepine	**15s. 3d. ,,**	
Amyl Acetate	**2s. 9d. ,,**	
Amyl Butyrate	**6s. 9d. ,,**	
Amyl Salicylate	3s. ,,	Cheaper.
Anethol (M.P. 21/22° C.)	**4s. 6d. ,,**	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	**2s. 10½d. ,,**	
Benzyl Alcohol free from Chlorine	**2s. 10½d. ,,**	
Benzaldehyde free from Chlorine	**3s. 6d. ,,**	
Benzyl Benzoate	**3s. 6d. ,,**	
Cinnamic Aldehyde Natural	16s. ,,	
Coumarin	**20s. ,,**	
Citronellol	17s. ,,	
Citral	9s. Price reduction due to selling competition.	
Ethyl Cinnamate	13s. 6d. ,,	
Ethyl Phthalate	**3s. 3d. ,,**	
Eugenol	**11s. ,,**	
Geraniol (Palmarosa)	**35s. ,,**	
Geraniol	**11s.—18s. 6d. per lb.**	
Heliotropine	7s. 9d. ,,	
Iso Eugenol	**15s. 9d. ,,**	
Linalol ex Bois de Rose	**26s. ,,**	
Linalyl Acetate	**26s. ,,**	
Methyl Anthranilate	**9s. 6d. ,,**	
Methyl Benzoate	**6s. ,,**	
Musk Ambrette	**45s. ,,**	
Musk Xylol	14s. ,,	
Nerolin	**4s. 9d. ,,**	
Phenyl Ethyl Acetate	15s. ,,	
Phenyl Ethyl Alcohol	**16s. ,,**	
Rhodinol	**57s. 6d. ,,**	
Safrol	**1s. 10d. ,,**	
Terpineol	**2s. 4d. ,,**	
Vanillin	26s. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	**15s. 6d. per lb.**
Anise Oil	**2s. 8d. per lb.**
Bergamot Oil	18s. per lb. Cheaper.
Bourbon Geranium Oil	**36s. 6d. ,,**
Camphor Oil	**75s. per cwt.**
Cananga Oil Java	**10s. 6d. per lb.**
Cinnamon Oil, Leaf	**6½d. per oz.**
Cassia Oil, 80/85%	**8s. 9d. per lb.**
Citronella Oil—	
Java 85/90%	5s. 8d. per lb.
Ceylon	3s. 7d. per lb.
Clove Oil	7s. 6d. per lb. Firm.
Eucalyptus Oil 70/75%	2s. 1d. per lb. Fair business.
Lavender Oil—	
French 38/40% Esters	30s. per lb. Very firm. Higher price expected owing to bad crops.
Lemon Oil	3s. per lb.
Lemongrass Oil	3d. per oz.
Orange Oil, Sweet	13s. per lb.
Otto of Rose Oil—	
Bulgarian	37s. 6d. per oz. Production below average.
Anatolian	18s. per oz.
Palma Rosa Oil	**19s. per lb.**
Peppermint Oil—	
Wayne County	21s. per lb. Firm spot and forward.
Japanese	14s. 3d. per lb.
Petitgrain Oil	9s. 3d. per lb.
Sandal Wood Oil—	
Mysore	**26s. 6d. per lb.**
Australian	**21s. per lb.**

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than October 14th, they are on sale at 1s. each at the Patent Office Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on August 28th.

I.—Applications

Carrier Engineering Corporation. Refrigerating systems. 18,316. July 31. (U.S., 7.8.23.)

Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges.). Electrodes for electrical precipitation of suspended particles from gaseous fluids. 18,026 and 18,091. July 28 and 29.

Moseley. Process for oxidising etc. materials. 18,366. Aug. 1.

Wayne Tank and Pump Co. Filtering apparatus. 18,182. July 30. (U.S., 4.4.24.)

I.—Complete Specifications Accepted

5309 (1923). Somerville and Williams. Adsorbent materials and the manufacture and application thereof. (219,352.)

10,264 (1923). Pike. Method and apparatus for producing calcining and clinkering material. (219,369.)

10,800 (1923). Drew and Laidlaw. Means for generating steam and combustion products under pressure for power purposes. (219,377.)

11,457 (1923). Erickson. Filters. (219,413.)

30,063 (1923). Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges. A.-G.). Apparatus for the electrical precipitation of suspended particles of gaseous fluids. (219,570.)

2220 (1924). Kantny. Apparatus for liquefying and separating gases. (219,599.)

II.—Applications

Anglo-Persian Oil Co., Ltd., and O'Brien. Refining mineral oils etc. 18,424. Aug. 1.

Barker, and Bernsford. Apparatus for separating coal from dirt etc. 17,924. July 28.

Du Boistesselin. Process for agglomerating coal dust etc. 18,101. July 29. (Fr., 29.9.23.)

Duckham, Finlayson, Smith, and Woodhall Duckham (1920), Ltd. Operating vertical retorts for carbonising fuel. 18,478. Aug. 1.

Milner and Munroe. 18,212. *See* XIXA.

Moeller. Treating peat etc. 18,482. Aug. 2.

Oil Development Trust, Ltd. Hydrocarbon containing material. 17,992. July 28.

Rushen (Koppers Co.). Coking coal. 18,242. July 30.

Rushen. Coking retort ovens. 18,248. July 30.

Tropel. Method of utilising vitriolic sludges obtained from refining of hydrocarbons. 18,199. July 30.

II.—Complete Specifications Accepted

7814 (1923). Krafft. Process for the purification of gases. (219,359.)

10,800 (1923). Drew and Laidlaw. *See* I.

10,895 (1923). Brünn-Königsfelder Maschinenfabrik der Maschinen- und Waggonbau-Fabriks-Akt.-Ges., in Simmering, vorm. H. D. Schmid and Fuchs. Fractional distillation of petroleum and similar liquid hydrocarbons. (196,624.)

11,318 (1923). V. L. Oil Processes, Ltd., and Lucas. Cracking of oils. (219,403.)

11,321 (1923). V. L. Oil Processes, Ltd., Lucas, and Loomx. Cracking of oils. (219,404.)

21,458 (1923). Linmann. Process of and apparatus for obtaining valuable hydrocarbons from material of inferior value. (214,910.)

III.—Application

Tropel. 18,199. *See* II.

III.—Complete Specifications Accepted

2440 (1923). Thornley, Tapping and Reynard. Method of obtaining stable aqueous emulsions of pitch and other unsaponifiable matters. (219,348.)

5308 (1923). Somerville and Williams. Process of refining commercial benzol. (219,351.)

10,895 (1923). Brünn-Königsfelder Maschinenfabrik der Maschinen- und Waggonbau-Fabriks-Akt.-Ges., in Simmering, vorm. H. D. Schmid and Fuchs. *See* II.

IV.—Applications

Carpmael (Farbenfabriken vorm. F. Bayer und Co.). Preparation of sulphaminoazo bodies and of diazo azo compounds therefrom. 18,034. July 28.

Farbwerke vorm. Meister, Lucius, und Brüning. Manufacture of condensation products of the anthraquinone series. 18,442. Aug. 1. (Ger., 8.8.23.)

Fierz. Manufacture of purified 1-nitro-2-methyl anthraquinone. 18,043. July 28.

Jones, Morton, and Wylam. Dyes and dyeing. 18,232. July 30.

Soc. of Chemical Industry in Basle. Manufacture of intermediate products. 18,440. Aug. 1. (Switz., 9.9.23.)

Soc. of Chemical Industry in Basle. Manufacture of dyestuffs. 18,441. Aug. 1. (Switz., 11.8.23.)

V.—Applications

British Celanese, Ltd., Ellis, and Greenhalgh. Treatment of acetyl cellulose products. 17,958. July 28.

Bruckhoff. Method of degreasing raw wool. 17,965. July 28.

Moeller. Treatment of waste paper. 18,483. Aug. 2.

V.—Complete Specifications Accepted

2554 (1923). British Celanese, Ltd., and Ellis. *See* VI.

20,111 (1923). King. *See* XIV.

VI.—Applications

Burgess, Ledward and Co., Ltd., Denner, and Scholefield. Dyeing artificial silk. 18,376. Aug. 1.

Hall and Silver Springs Bleaching and Dyeing Co. Processes in which artificial silk etc. is treated with hot liquors 18,293. July 31.

Johnson (Hussong Dyeing Machine Co.). Dyeing-machines 18,105. July 29.

Jones, Morton and Wylam. 18,232. *See* IV.

Standard Silk Dyeing Co. Dyeing silk black. 18,339. July 31. (U.S., 1.12.22.)

Thies. Process for boiling and bucking cotton and linen goods. 18,447. Aug. 1.

VI.—Complete Specification Accepted

2554 (1923). British Celanese, Ltd., and Ellis. Dyeing or colouring of products made with cellulose acetate. (219,349.)

VII.—Applications

Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler and Liebknecht. Process for manufacture of a product containing hydrocyanic acid. 18,449. Aug. 1.

Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler and Liebknecht. Process for producing hydrocyanic acid. 18,450. Aug. 1.

Meyerhofer. Process of producing hydrofluosilicic acid salts. 18,329. July 31 (Ger., 20.12.23.)

Meyerhofer. Decomposing alkali salts into hydroxides or carbonates and acids. 18,330. July 31 (Ger., 1.10.23.)

Meyerhofer. Production of metal compounds. 18,331. July 31. (Ger., 20.12.23.)

Ormandy and Peake. Treatment of leucite etc. 18,511. Aug. 2.

Soc. L'Oxylithe. Separation of elements of air. 18,243. July 30 (Fr., 31.7.23.)

VII.—Complete Specifications Accepted

12,129 (1923). Smith. Utilisation of waste lime from chemical works. (219,420.)

12,366 (1923). Jackson, Mellersh (New Jersey Zinc Co.). Manufacture of zinc oxide. (219,423.)

26,700 (1923.) Syndicat d'Etudes Chimiques. *See* XVII.

VIII.—Application

Naamlooze Vennootschap Philips Gloeilampenfabrieken. Manufacture of highly refractory bodies. 18,359. July 31. (Holland, 9.9.23.)

IX—Application

Rigby. Manufacture of cement. 17,951, 18,013, 18,028. July 28.

X.—Applications

Australian Minerals Recovery Co., Ltd. Manufacture of sponge iron. 18,272. July 31. (Australia, 15.9.23.)

Bosshardt. Open-hearth furnaces. 18,184. July 30. (Ger., *25.10.23.)

Greiner and Maschinenfabr. Esslinger. Processes for incorporating manganese with iron. 18,342. July 31.

Hamilton and Reid. Process of reducing metal oxide. 18,092. July 29.

Naamlooze Vennootschap Philips' Gloeilampenfabrieken. Process for separating hafnium and zirconium. 18,119. July 29. (Denmark, 30.7.23.)

Opie. Water concentration of ores etc. 18,347. July 31.

Soc. Electrométallurgique de Montricher and Thaud Production of magnetic steels with high content of silicon. 18,345. July 31. (Fr., 22.9.23.)

X.—Complete Specifications Accepted

1957 (1923). British Aluminium Co., Ltd., Gwyer and Phillips. Aluminium alloys. (219,346.)

15,433 (1923). Ruths. Means for utilising exhaust steam in iron works. (199,396.)

19,266 (1923). Baumert. Gas or oil heated smelting-furnaces. (219,494.)

XI.—Applications

Kendall and Three Stars Accumulators, Ltd. Electric batteries. 18,413. Aug. 1.

Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges.). 18,026 and 18,091. *See* I.

Powell. Primary electric cells. 18,099. July 29.

XI.—Complete Specifications Accepted

10,918 (1923). Knowles. Means for controlling the liquid level in electrolytic cells and the like. (219,381.)

11,065 (1923). McBlain. Electrical apparatus for generating ozone. (219,387.)

30,063 (1923). Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges. Akt.-Ges.). *See* I.

30,913 (1923). Ajax Electrothermic Corporation. Electric induction furnaces and other apparatus heated by induction. (218,967.)

XIII.—Applications

Giles and Wilson. Manufacturer of pigments and polishing materials. 18,133. July 29.

Hewitt (Sefton). Paints etc. and manufacture thereof. 18,334. July 31.

XIII.—Complete Specification Accepted

29,156 (1923). Cajar. Process for the manufacture of printing colours and ink. (219,562.)

XIV.—Applications

Anode Rubber Co., Ltd. Manufacture of rubber goods from emulsions. 17,948. July 28.

Anode Rubber Co., Ltd. (Klein and Szegvary). Method of concentrating etc. rubber emulsions. 18,353. July 31.

XIV.—Complete Specification Accepted

20,111 (1923). King. Rubberised fabric and method of making the same. (219,507.)

XV.—Complete Specification Accepted

9197 (1923). Hutchings Ltd., and Morrison. Tanning and manufacture of tanning materials. (219,347.)

XVI.—Complete Specifications Accepted

11,003 (1923). Richards and Hutchinson, and Agricultural Developments Co. (Pyrford), Ltd. Manufacture of nitrogenous fertilisers. (219,384.)

24,403 (1923). Malmsten. Apparatus for disintegrating and/or mixing artificial fertilisers. (219,537.)

XVII.—Application

Steffen. Precipitation of sugar lime from sugar solutions. 18,247. July 30.

XVII.—Complete Specification Accepted

26,700 (1923). Syndicat d'Etudes Chimiques. Process for the recovery of nitrogen and acetone from molasses and vinasses. (208,516.)

XVIII.—Complete Specification Accepted

26,700 (1923). Syndicat d'Etudes Chimiques. *See* XVII.

XIXa.—Application

Milner. Gas-generating fuels for treatment of foodstuffs. 18,212. July 30.

XIXb.—Application

Wayne Tank and Pump Co. Stabilised glauconite, and method of making same. 18,181. July 30. (U.S. 17.1.24.)

XIX.—Complete Specification Accepted

24,377 (1923). Perry. Sewage purification. (219,536.)

XX.—Application

Johnson (Badische Anilin und Soda Fabrik). Synthetic manufacture of methanol. 18,106. July 29.

XX.—Complete Specification Accepted

26,700 (1923). Syndicat d'Etudes Chimiques. *See* XVII.

XXI.—Applications.

Thornton. Multicolour kinematograph etc. films. 18,168. July 30.

Thornton. Colour photography and sensitised material therefor. 18,521. Aug. 2.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*Argentina:* Silk (182); *Austria:* Leather (166); *Ceuta (Morocco):* Iron (180); *Chile:* Earthenware, chemicals, tinplate, steel, enamelled ironware, hardware (183); *Egypt:* Oils (179); *France:* Tinplate, iron (167); *Italy:* Chemicals (171); *Netherlands:* Rubber, leather (172); Metal (175); *New Zealand:* Hardware (165); *Spain:* Chemicals (176); *Turkey:* Copper (A.X./1219); *Uruguay:* Phosphorbronze (A.X./1225).

PUBLICATIONS RECEIVED

MALAYAN AGRICULTURE IN 1924. Handbook compiled by The Department of Agriculture F.M.S. and S.S. Pp. ii+301. Singapore: Messrs. Fraser and Neave, Ltd., 1924.

DAS LEITVERMÖGEN DER LÖSUNGEN. Part I. By P. Walden. Handbuch der Allgemeinen Chemie IV. I. Pp. ix+381. Leipzig: Akademische Verlagsgesellschaft m.b.H., 1924. Price, paper 17 goldmarks; bound 21 g. m.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

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The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

VOL. 43 NEW SERIES | LONDON, AUGUST 22, 1924 | NO. 34

EDITORIAL

WE publish this week a characteristic contribution from Prof. H. E. Armstrong dealing with Prof. Bancroft's recent paper on the action of metals on nitric acid. It does not deal exclusively with this topic, others find their way spontaneously into the argument. After reading the article we were reminded, somewhat illogically, of a saying quoted in Boswell's "Johnson": "*Qu'il y a d'esprit! Il y a tant, répondit Mme. de Bourdonne, que je n'y ai pas vu de corps.*" Prof. Armstrong's universal plodding has not prisoned up his nimble spirits in his arteries; he retains some slight disapprobation of modern ionic views of chemistry, which he can ne'er express, yet cannot all conceal. When we say he can ne'er express it, we mean only that he cannot express it so definitively and so forcibly that it can be done once and for all. Just as formaldehyde is reputed to have a cumulative effect, so he believes that these small, almost innocuous doses of criticism will gradually destroy the pernicious influences and will keep alive a spark of genuine chemistry, which though now overladen by dull ashes of positive and negative signs, will some day blaze forth and illuminate the surrounding atmosphere. It is almost time that he kneeled down—not humbly—on his knees, and with distended lungs and cheeks blew the spark into a flame. We have a very hazy idea how in the ordinary households they managed to keep their home-fires burning before the days of matches; of course, they had tinder-boxes at one period, but the making of sparks and their conversion into flames must have been a laborious business, and it is obvious from the old poets that it was a calamity to let a wood fire so die out that it had to be relighted. We think it is Homer who speaks of preserving the spark in ashes so as to avoid a long journey to a distant neighbour in search of something to start a new fire. And what a business it must have been to transport it for a distance; the fashion of drinking tea and coffee could not have spread as it has done in damp climates but for the lucifer match! We appeal to Prof. Armstrong to shed the elusive and gentle poetry with which he envelops his views, to discard the metaphor and allusion which permeate his arguments and to give us his notions on metals and nitric acid in plain chemical words, whose rugged simplicity will enable even editors to understand them. Let him attack the Ionians in harsh Doric, and leave the soft Lydian airs to a more effeminate body of readers!

* * *

The conclusion of an agreement of some sort between Germany, France, Britain and several other countries is a matter of considerable interest to all industrial chemists. The particular agreement made a few days ago is considered by public men in this country as an achievement much to the credit of Mr. Ramsay MacDonald and the Government of which he is the chief. He has shown himself to be possessed of tact and patience; everyone was tired of the state of European politics which we had endured so long and the time was ripe for an alteration. Even so, a less capable man might easily have bungled the matter and left the situation in a dangerous state. The details of the agreement are difficult to understand and easy to criticise, but the spectators cannot follow the forces at work, the attractions and reactions, and they are bound in such matters to assume, not that the agreement is the one most suited to European politics, but that it is the best which is possible to persuade the parties to agree to. This is a vital distinction which is frequently forgotten: in our editorial wisdom we could easily have solved the problems of Reparations and the Ruhr, the Covent Garden strike or any other strike, and have persuaded the Bankers to lie down with the Bolsheviks; our only difficulty was that we could not have persuaded the parties most concerned to fall in with our solutions. Mr. Ramsay MacDonald and the Foreign Office have done well; but there are many other difficulties to be overcome before any satisfactory course of action will develop. In the manufacture of certain articles Germany will be a better customer than competitor; in the manufacture of many chemical compounds Germany may easily be a competitor to be feared and an insignificant customer.

There are economical problems of singular importance to be faced; there are, especially in Germany, some political dangers of great moment. European trade has been thrown out of gear by the War; the most essential requirements of good trade, credit, confidence and stability, are lacking and it will take two or three years to establish these; everything is abnormal and unstable, the mark, the franc and the pound have no permanent relation to each other; a new equilibrium has to be established and we have all to become gradually accustomed to the new conditions whatever they are before trade can be in a healthy state again. Credit, confidence and stability are of slow growth; no nationalisation, no artificial treatment of national debts, no direct action of strikers, no revolutionary ideas can take their place. The agreement with Germany is to be welcomed to the extent to which it encourages credit, confidence and stability; probably this will be a very considerable extent, but it is too early to judge.

* * *

This week we publish for the first time a paper contributed to the Institution of Chemical Engineers. We are glad to do this and we hope that in the future the Transactions of the Institution will be as important and interesting as this one, a contribution by Professor Hinchley and Mr. Himus on "The Effect of a Current of Air on the rate of Evaporation of Water below the Boiling Point." The paper gives the result of about two hundred and fifty experiments and it appears that these were carefully carried out on a logical and scientific plan. The rate of evaporation of water in a pan over the top of which there is a current of air seems to be directly proportional to the difference between the vapour pressure of the water in the pan and the vapour pressure of water in the air. There is a definite rate of evaporation when there is no current of air, and between this limit and a speed of current of five inches per second the increase in rate of evaporation is approximately proportional to the speed of the current. The data are given with a degree of accuracy sufficient for many operations conducted on a large scale, and the various graphs are convenient for reference. The only experiments of this nature we have ourselves conducted, blowing a current of air over a hot cup of tea in a railway refreshment room, have invariably been so hurriedly carried out that accurate determinations have been practically impossible, even on those rare occasions when time permitted a completion of the experiment. We think plants exposed to much wind, especially very dry winds, have in some instances developed special devices for preventing an undue loss of water. The evaporation of liquids on a large scale, either in vacuo or at the normal pressure of the air, is now so common an occurrence that a careful study of the conditions is essential. The authors of the paper call attention to the scanty literature on this subject. An investigation on the lines they have adopted involves much time and attention, and what is more it involves some little thinking, so the paucity of literature is not surprising.

THE EFFECT OF A CURRENT OF AIR ON THE RATE OF EVAPORATION OF WATER BELOW THE BOILING POINT.*

By G. W. HIMUS, B.Sc., A.R.C.S., D.I.C. (Associate-Member), and J. W. HINCHLEY, A.R.S.M., F.I.C., Wh.Sc. (Member)

At a conference of the Chemical Engineering Group of the Society of Chemical Industry held in Glasgow in 1922, one of the authors discussed the subject of evaporation in general and put forward certain tentative formulæ. Systematic research in this subject has been planned for work in the new Chemical Engineering Laboratories of the Imperial College of Science and Technology. This paper is the first submitted, and deals in more detail with certain aspects of evaporation of water in currents of air.

It is a matter of regret that the so-called educational economy of the last few years has withheld a large proportion of the sum voted for the equipment of those laboratories. The apparatus with which this work was done was, in consequence, inadequate, but it is hoped that more sympathetic treatment may enable us in the near future to carry on the work with more satisfaction. We thought it better, however, to present the paper as it is, rather than to wait for the future when more refinements could be added to the apparatus.

To the chemical engineer, a knowledge of the rate of evaporation, and the ability to estimate that rate from a knowledge of the physical properties of the substances in hand, and the atmospheric and other conditions obtaining in the plant is a matter of considerable moment. Not only is the design of crystallising and drying plant directly dependent on such knowledge, but evaporation plays a by no means unimportant part in the working of cooling towers and other plant.

In spite of, or perhaps, because of the frequency with which such problems arise for solution, the literature of the subject is meagre. Investigation of an index of scientific and technical papers reveals the fact that information relevant to the point at present under discussion is relatively small. Of papers on evaporators and on their design and operation, there is no end. The meteorologist seems to be well supplied with information on the subject, while the hydraulic engineer, the agriculturist and the physiologist are also catered for. The chemical engineer, however, can find but little help, as the work either deals with evaporation as applied to a specific type of plant, or else is almost entirely mathematical, and in some cases seems to be devoid of experimental backing. Furthermore, in general, the conclusions of the mathematical analyses of the problem are apt to be couched in such form that they cannot be applied to practical problems. The paper concerns itself with evaporation from water surfaces at different temperatures under varying conditions of draught.

* Read at the Second Annual Meeting of the Institution of Chemical Engineers, July 16, 1924.

Experimental.

The evaporating pans used were made of sheet copper, all being of the same depth, viz., three inches, and supplied with heating coils of Ni-chrome wire, carried on half-inch silica tubes set along the lengths of the pans about a quarter of an inch from the bottom.

Four pans were employed, 3 in. × 12 in., 6 in. × 12 in., 12 in. × 12 in. and 6 in. × 18 in., the first with one, the second with two, and the third with four heating coils. The 6 in. × 18 in. pan had two coils only. The heaters in the 3 in. × 12 in., and the 6 in. × 12 in., were wound with 105 turns of wire in each; in the foot square pan, the inner coils had 105 and the outer 130 turns, while those in the 6 in. × 12 in. pan carried 150 turns.

A duct through which a current of air could be blown over the evaporating pan in use was provided. This duct was made in four sections of galvanised iron, each section being 2 ft. long, three of them 9 in. high by 1 ft. 6 in. wide. The remaining section, in one end of which was the fan creating the draught, was 18 in. square at the fan end and tapered to the same section as the other three sections. The end of the duct remote from the fan was left open. The photograph (Fig. 1) gives a general view of the apparatus.

Fig. 1

The section of the duct below which the pan was placed was provided with a window 1 ft. square in the roof, and one in each side 1 ft. by 6 in. In the bottom a hole was cut which sufficed to admit entrance of the upper edge of the evaporating pan, the remainder of the open space round the pan being closed by pieces of galvanised iron.

The draught was created by means of a fan driven by belt and pulley from a motor, means of adjustment of the speed within fairly narrow limits being provided by an external resistance. In order to obtain greater limits of variation of draught, a series of driving pulleys from about 4 in. to 18 in. in diameter was furnished.

The temperature of the water in the pan was determined by means of a mercury thermometer hung from a wire across the duct, the tubes containing the heating elements being covered by 40-mesh copper gauze bent into the shape of inverted U's—this to cause better distribution of convection currents in the water.

In several experiments the temperature at different points of water was taken, but was found to be substantially the same throughout, the difference from point to point being of the order of half a degree.

The evaporating pan when in use was carried on one pan of a balance, so arranged that the upper edge of the pan was just above the level of the bottom of the duct.

The general method of conducting the experiments was as follows:—

(a) The temperature of the water in the pan was brought to the desired point by regulation of the heater-current and was maintained steady or very nearly so. During this preliminary period the draught was on, the speed of the air-current being determined by means of a fan-type anemometer placed at the open end of the duct on the middle line thereof.

(b) The conditions having become steady, the pan of water was rapidly counterpoised, a stop-watch was started and the temperature of the water was noted.

(c) A known weight was then placed alongside the pan of water, the magnitude of the weight depending on the rate of evaporation, and the apparatus was observed, the time being noted when the balance again stood level. The temperature of the water was then taken again.

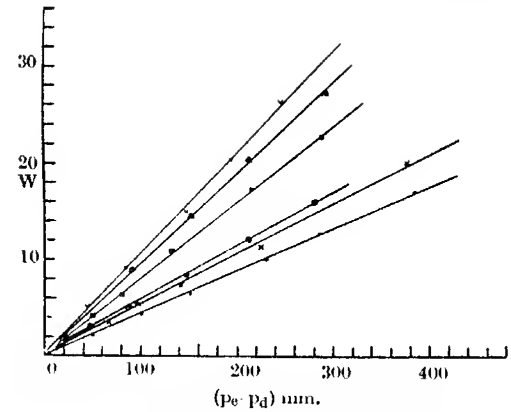
(d) Another weight was then placed alongside the pan, and the time taken for equilibrium to be established was noted. This was repeated a number of times, till a suitable weight of water had been evaporated.

(e) The amount of water evaporated in one experiment depended on the conditions, falling as low as twelve grammes in the case of the smallest pan without draught, and rising to as much as six to eight hundred grammes in the case of the largest pan. The accuracy of weighing was in the neighbourhood of 0·02 grammes.

(f) The dew point of the air of the laboratory was taken by means of a Hinchley hygrometer at least once during each experiment, and the barometer was read periodically.

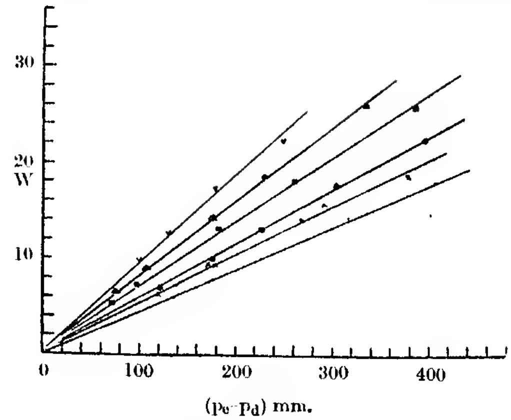
(g) The results were calculated to kilogrammes of water evaporated per square metre of surface per hour, and for each pan and each draught these rates were plotted against the difference between the vapour pressures of the water at the temperature of that in the pan, and at the dew point observed during the experiment.

(h) About two hundred and fifty experiments in all were carried out, a small number of these being in still air, these latter to test the validity of the formula published for evaporation in still air by Hinchley (*J.S.C.I.*, 1922, xli, 242 T).



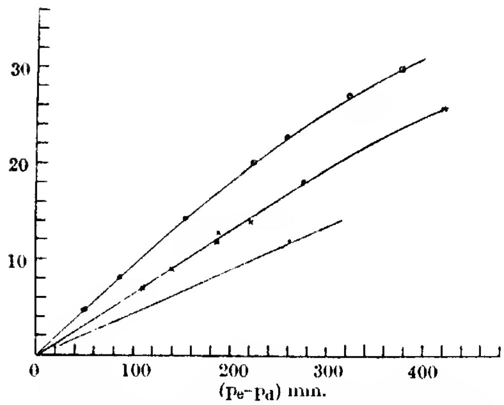
Evaporation in 3 in. × 12 in. pan. Transverse draught.
v Draught 5·12 metres per second.
Δ „ 4·60 „ „ „
□ „ 3·57 „ „ „
o „ 2·17 „ „ „
× „ 1·36 „ „ „
· „ 1·05 „ „ „

FIG. 2



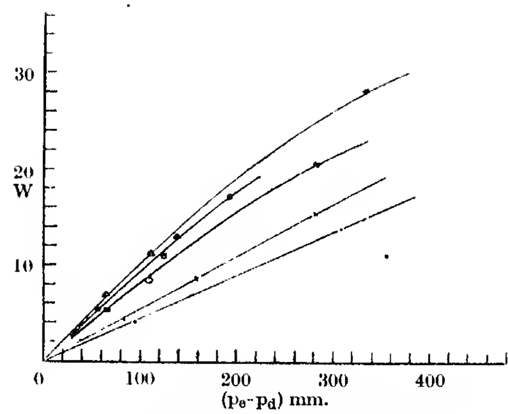
Evaporation in 6 in. × 12 in. pan.
v Draught 5·29 metres per second.
Δ „ 4·17 „ „ „
□ „ 2·87 „ „ „
o „ 1·92 „ „ „
× „ 1·41 „ „ „
· „ 1·06 „ „ „

FIG. 4



Evaporation in 3 in. × 12 in. pan. Longitudinal draught.
o Draught 4·60 metres per second.
× „ 2·71 „ „ „
· „ 1·06 „ „ „

FIG. 3



Evaporation in 6 in. × 12 in. pan. Longitudinal draught.
Δ Draught 4·33 metres per second.
□ „ 3·72 „ „ „
o „ 2·98 „ „ „
× „ 1·47 „ „ „
· „ 0·95 „ „ „

FIG. 5

(i) The details of a single experiment which serves to indicate the general run of the observations may be given :—

No. 121. Pan area ½ sq. foot (6 in. × 12 in.), draught transverse to pan. Barometer 758 mm. Correction factor to 760 mm., 0·998.

Time. Min. sec.	Water Temp. °C.	Loss in Weight.	Dew Point. °C.	Air Temp. °C.	Draught.
0	79·0	—	1·1	3	4·17
4 55	79·0	100	—	3	metres
9 55	79·0	100	—	3·2	per
14 55	78·6	100	—	3·2	second
	78·9	300	1·1	3·1	

Rate of evaporation, 26·0 kilos per square metre per hour.
corrected, 26·95 „ „ „ „ „ „
Vapour pressure water in pan .. .. .. 338 mm.
„ „ „ „ air .. .. .. 5 mm.
Difference .. .. 333 mm.
Rate of evaporation of water per 1 mm. difference = 0·078 kilos per square metre per hour.

(j) It will be observed that a correction has been made to the observed rate of evaporation for the deviation from 760 mm. of the barometer. This is in accordance with the correction indicated by Hinchley in the paper quoted above.

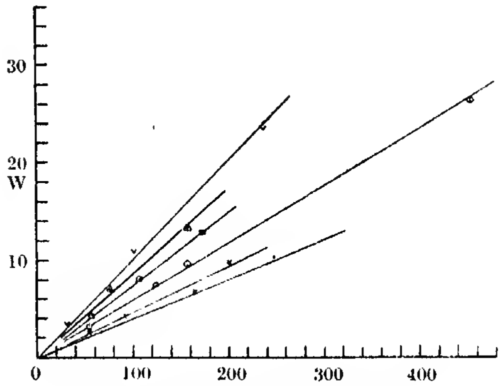
Throughout the following, the symbols used are as follows :—

W is the rate of evaporation in kilos per square metre per hour corrected to a barometric pressure of 760 mm.

p_e is the vapour pressure of the water in the pan in mm. of mercury.

p_a is the vapour pressure of the water in the air in the same units.

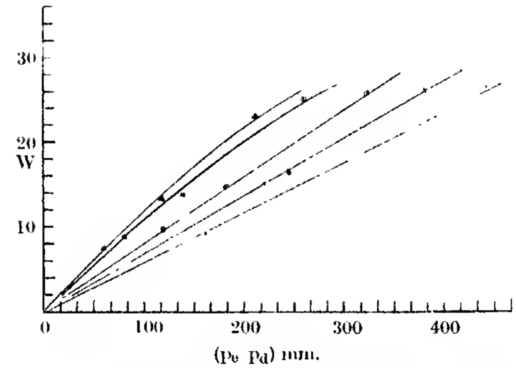
v is the velocity of draught in metres per second.



Evaporation in 12 in. square pan.

v Draught 5·70 metres per second.
△ ,, 4·95 ,, ,, ,,
□ ,, 4·05 ,, ,, ,,
o ,, 2·86 ,, ,, ,,
× ,, 1·60 ,, ,, ,,
. ,, 1·1 ,, ,, ,,

Fig. 6



Evaporation in 6 in. × 1 ft. 6 in. pan. Longitudinal draught.

△ Draught 5·36 metres per second.
□ ,, 4·38 ,, ,, ,,
o ,, 2·81 ,, ,, ,,
× ,, 1·56 ,, ,, ,,
. ,, 1·08 ,, ,, ,,

Fig. 7

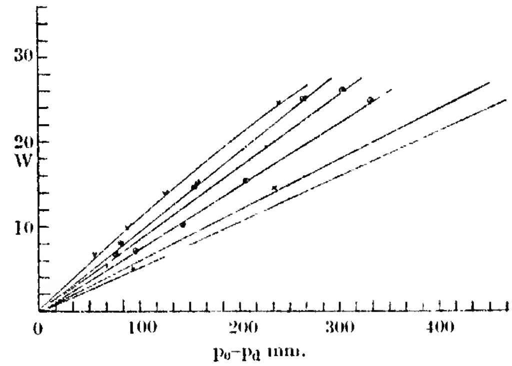
Results and Conclusions

(1) The Imperial College formula for evaporation of water in still air was found to hold good, viz.,

$$W=\left(\frac{p_e - p_a}{50}\right)^{1\cdot2}$$

(2) Over a range of draughts from 0·9 metres per second, and with water temperatures of from 20° to 70° C., the rate of evaporation is found to be, for practical purposes, in accordance with the law $W=a(p_e-p_a)$, where a is a coefficient varying only with the draught, and is equal to $0{\cdot}031+0{\cdot}0135$ v.

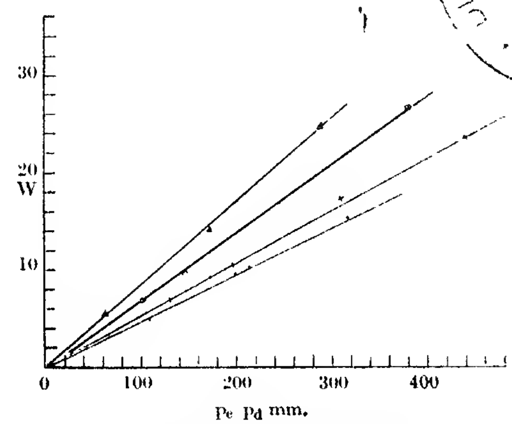
(3) Figures 2 to 9 show the experimental results plotted against a (p_e—p_a) basis, the rates being obtained at a number of fixed draughts in each pan. It is seen that the plots are substantially



Evaporation in 6 in. × 1 ft. 6 in. pan on right side of duct.

v Draught 5·78 metres per second.
□ ,, 5·02 ,, ,, ,,
△ ,, 4·08 ,, ,, ,,
o ,, 2·67 ,, ,, ,,
× ,, 1·72 ,, ,, ,,
. ,, 1·18 ,, ,, ,,

Fig. 8



Evaporation in 6 in. × 1 ft. 6 in. pan on left side of duct.

△ Draught 3·99 metres per second.
o ,, 2·88 ,, ,, ,,
× ,, 1·58 ,, ,, ,,
. ,, 1·15 ,, ,, ,,

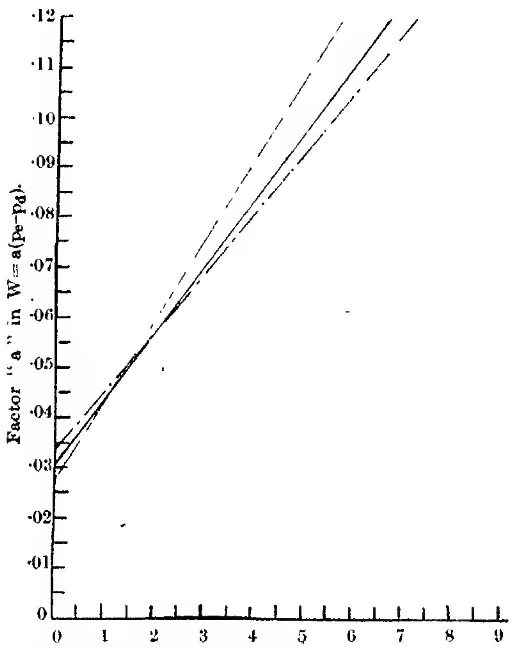
Fig. 9

straight lines, although at temperatures of over about 60° C., particularly with the larger pans, there is a deviation from the straight-line law. Such deviation may be ascribed to the fact that under these conditions the mean value of the dew point,

and therefore of p_d over the surface of the pan, may vary considerably from that of the air of the laboratory. The errors resulting from the assumption that the straight-line law holds good, will, however, under practical conditions of working, seldom exceed five per cent., as in drying-room practice, the temperatures and velocities will seldom rise as high as those of a number of the experiments in which these faults are apparent.

(4) The individual formulæ for the various pans studied are :-

3 in. × 12 in. pan, transverse draught	$W = (\cdot 028 + \cdot 016\ v)(p_e - p_d)$
Ditto, longitudinal draught ..	$W = (\cdot 030 + \cdot 013\ v)(p_e - p_d)$
6 in. × 12 in. pan, transverse draught	$W = (\cdot 034 + \cdot 012\ v)(p_e - p_d)$
Ditto, longitudinal draught ..	$W = (\cdot 031 + \cdot 016\ v)(p_e - p_d)$
12 in. × 12 in. pan	$W = (\cdot 027 + \cdot 012\ v)(p_e - p_d)$
6 in. × 18 in. pan	$W = (\cdot 034 + \cdot 012\ v)(p_e - p_d)$
Mean for all pans	$W = (\cdot 031 + \cdot 0135\ v)(p_e - p_d)$



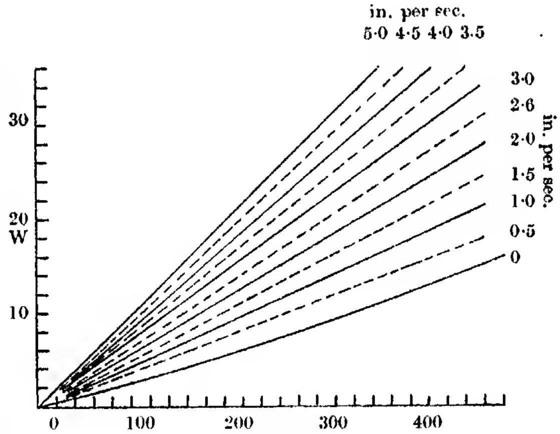
Showing variation with draught of factor "a" in $W = a(p_e - p_d)$.
—·—·— Average all pans.
— — — 3 in. pan. Transverse draught.
———— 6 in. pan. Transverse draught.

Draught. Metres per second.

Fig. 10

(5) It will be observed that, according to the formulæ above, in still air, the rate of evaporation should be directly proportional to the vapour pressure difference, whereas, in the absence of draught, it is found that the rate is proportional to this difference to the power of 1·2. This probably arises from the fact that in the absence of draught, the air over the pan will be in motion due to convection currents, the magnitude and effect of these currents rising with the temperature. It will be recalled that a similar case is met with in the formula for loss of heat from surfaces due to air contact: instead of the temperature difference, we have the temperature difference to the power of 1·23.

(6) According to the above formulæ, preheating of the inlet air to the duct should have no effect on the rate of evaporation, provided that the air be not heated to such a temperature that transfer of heat from it to the water surface takes place. This conclusion has not yet been experimentally verified.



Rates of evaporation calculated for various draughts, plotted against $(p_e - p_d)$. Formula $W = (\cdot 031 + \cdot 0135v)(p_e - p_d)$.
"No-draught" line is calculated from $W = \{[\cdot 02(p_e - p_d)]\}^{1.2}$
W = Kilos. of water per sq. m. per hour.

Fig. 11

(7) It will be noticed that in the formulæ for the individual pans, the "no draught" and the "draught" constants vary, the former from 0·016 to 0·012, and the latter from 0·027 to 0·034. Furthermore, this variation is not regular, and seems to bear no relation to the size of pan. Despite careful checking of the work, it has not been found possible to account for this, but it is suggested that this may be caused, in part, at any rate, by the fact that the draught was inclined somewhat to the axis of the duct, the result being that the distribution of the draught relative to the water surface must have been different in different pans; in other words, the vertical component of the velocity varied in the different pans. A knowledge of the intensity of the draught at various points over the water surface would probably clear up this point, but apparatus for determining this satisfactorily was not to hand.

(8) Figure 10 shows the variation of the factor "a" in $W = a\ (p_e - p_d)$ with draught, (*a*) the average of all the pans, (*b*) the 3 in. and (*c*) the 6 in. pan with transverse draught.

(9) On figure 11 is plotted a series of graphs showing the rates of evaporation calculated from the general equation arrived at from the experiments,

against vapour pressure difference. It will be noted that the calculated draught evaporations are far above the no-draught results from the Imperial College formula, up to a vapour-pressure difference of 480 mm. and with draughts from 0·5 to 4·0 metres per second. The question, whether, at lower draughts than those plotted, the straight line law will give place to some law intermediate between the draught and no-draught formulæ could not be solved practically, owing to the difficulty of determining such very low draughts, but it seems obvious that the change from the curve to the straight line may occur when the vertical component due to turbulence becomes greater than that due to convections.

(10) The formula indicates that in the case of water solutions for which Raoult's law holds, the rate of evaporation may be evaluated accurately from a knowledge of the vapour pressure depression. This has not been tested in the present investigation, but passing mention may be made of the fact that the Imperial College formula for still air evaporation is found to apply to the evaporation of solutions of glycerine.

(11) Carrier (quoted by Hinchley in paper above) gives a formula for rate of evaporation, which, in metric units, is $W = 0{\cdot}0178\ (1+v/1{\cdot}17)\ (p_e - p_d)$.

The present formula if transposed into the same form becomes $W = 0{\cdot}031\ (1+v/2{\cdot}29)\ (p_o - p_d)$.

According to the Carrier formula, the rate of evaporation in a draught of 1·17 metres per second is double that in still air for the same vapour pressure difference, whereas the present formula shows that the effect of draught is almost exactly half this.

In the absence of knowledge of the exact apparatus and means by which Carrier determined his figures, it is not possible to suggest any definite explanation of the discrepancy.

(12) While admitting that the present formula is by no means an exact expression of the relation of the rate of evaporation to the physical conditions, it is hoped that the conclusions embodied in the present paper may find use amongst chemical engineers who have to solve evaporation problems.

Edge Effect.—The experiments suggest that an edge effect exists (*i.e.*, that a proportion of the area is protected from the currents of air at the edges of the pan), but that it was very small.

Vibration and Ripples.—At a point when ripples began to be definitely produced an increased evaporation was apparent. Vibration of the apparatus produced a similar result. At the higher velocities ripples were always in evidence.

Effect of the Dimensions of the Duct.—This effect has not been well investigated, but at high velocities and temperatures there could be no question of the effect on the curves.

Further Experiments.—Owing to the fact that p_d changes somewhat during the passage over the surface, and with a view to reducing this to small dimensions, a narrow pan was made (1 in. × 12 in.). The results with this pan were more irregular, the departure from the straight line appeared to be greater, and the velocity factor was higher.

Use of the Formula.—It is hardly necessary but it may be desirable to indicate how the formula may be applied in the design of evaporators and dryers. Having assumed the standard conditions at the inlet and outlet of the air, the rates of evaporation at these points may be estimated. The logarithmic mean of these results will give the average rate of evaporation throughout the plant and indicate the area of surface required for the conditions assumed.

We wish to thank The Sturtevant Engineering Co., Limited, for the gift of a large portion of the apparatus.

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WHY WAS I BORN SO SOON?

(With acknowledgments to Bernard Shaw)

By HENRY E. ARMSTRONG

" If Science was what Science seems,
And not the Science of our dreams,
How much we'd hate her—
But she ain't "
—*Kipling* (*revised*).

Some may well reply—" Why at all ? A more confounded nuisance never was. Worse than any kid, with his perpetual ' whys ' and heuretic twaddle. We agree with the Dauphin and dislike being consecrated with his rancid oil, let alone made to fight. Damn his Joan'ian ' voices,' urging us to think ; we want to be let alone, not worried to answer absurd riddles. We are happy in our ionised 'ell and don't wish for even a day off ; it has been made quite comfy by Sir James Dewar and Prince Conti, not to mention the saintly trinity, Arrhenius, Nernst and Ostwald, who have taught us to disregard water and chop logic with equanimity."

This by way of Shavian preface. When a riddle is posed, sometimes someone says—" Ask another," so let me follow such precedent and modestly ask—Is Wilder D. Bancroft a beaten-fraud and have I, all my life, been a born fool and the whole world chemical

a body of wiseacres; or is perhaps the leg in the other boot? Unless Bancroft and I *are* rank rotters, the mind chemical *is* in a peculiar state of suspended animation, needing some catalyst to awaken it from its long-continued condition of catalepsy. This, however, is no mere riddle but a serious problem in psychology—the psychology of the crowd sciential. We chemists think we are awfully fine fellows, whether or no we can roll a pill, superior to the vulgar herd—but it is to be feared that our 'superbity,' however much it may be Nobel'ised, has no reasoned foundation; not only "from the stalls and in the Press is an atmosphere of hypocrisy spread" but also from the lecture desk and the text-book.

Why do I bring the slim Bancroft upon the stage in such connexion, in connexion with myself? Why this outburst of spleen? The exciting cause is a long disquisition, entitled *Action of Metals on Nitric Acid*, by the said Wilder D., in the May issue of the *Journal of Physical Chemistry*, a copy of which he has most obligingly sent to me. I shall ask that it be buried or burnt with me. The opening sentence is significant:—

> "For nearly thirty years, I have carried the reduction of nitric acid by metals in my note-books as a major problem to be taken up as soon as possible and, at different times during that period, I have suggested it to graduate students as a desirable thesis subject—all in vain."

What the state of those note-books must be, exposed as they have been so long to the influence of so corrosive an acid, can be imagined, if we think of the youthful Ira Remsen's early experiment, when he placed a copper coin upon his father's bare mahogany and poured upon it a few drops of Aquafortis. As he says, the miraculous effect, not only upon the copper and the mahogany but upon his fingers and trousers and the carpet, was startling and one that he never forgot. Bancroft's soul, however, like that of the multitude, seems not to have been easily seared by the acid and, until this year, note-books notwithstanding, he has displayed no fiercely burning curiosity to explain its marvellous behaviour. Like the world chemical, he has had eyes to see, nay more, he assures us, he has desired to see; yet he has not seen; I will not use the language of Thermodynamics and say, which is absurd! but simply remark—that the ways of the workers in science are mysterious. Have I assisted in his conversion? Last year, in Cambridge, England, I cast my gauge at him and challenged him to consider the facts of chemical change in general *from an electrolytic standpoint.* He did not then accept battle but said—"he would go home and read." Apparently, he has not only read but also marked, learnt and inwardly digested, quite a little and in a way which would be flattering to my vanity had I any such element left in me. After telling us what the great Ostwald believed in 1899; that Mellor is distinctly non-committal but inclines to Ostwald; that Roscoe and Schorlemmer dodge the whole question (Chorus of Chemists: "And so do all of us"); the gospel according to Veley; how Howe plays safe with a vengeance—he refers to the work done by a former City firm, that of Acworth and Armstrong, at a time which is prehistoric to the pedagogues of to-day, the year of our gracious Lord one thousand eight hundred and seventy seven. After quoting with approval their statement:—

> "We regard the action of the metal as consisting simply in the displacement of the hydrogen of the acid,"

he adds the following, showing how his soul, like John Brown's, has gradually been marching on towards a state of sanity and understanding:—

> "This is, of course, a special statement of the electrolytic theory of corrosion, long before it was developed as a general theory by Whitney in 1903. A few years later, I pointed out that the most striking characteristic of an electrolytic action is that it occurs in two places—at the anode and at the cathode. This peculiarity can be made less marked by bringing the electrodes nearer and nearer together. When the distance between them vanishes, we have a chemical reaction in the ordinary sense of the word and not an electrochemical reaction. Any chemical reaction, therefore, which can be made to take place electrolytically, must consist of an anode and a cathode process. Considering the matter in this light, we see that there is a possibility of the anode and cathode processes interfering and of one perhaps masking the other."

The general results of the discussion are summarised in ten paragraphs, the first being:—

> "The action of nitric acid on metals can be considered profitably as a case of electrolytic corrosion, the anode reaction being the formation of the nitrate. This is the view advocated by Armstrong in 1877."

The second is:—

> "The nature of the metal shows itself in at least three ways; in the reducing power as measured by over-voltage; in the catalytic action of the metal; and in the catalytic action of the salt of the metal. These three factors are to be studied in detail"

It is not for me to say that the first is good—it is the issue to be disputed. The second, entirely Snarkian as it is, may be alright but seems to make confusion worse confounded, being compounded of fuming, furious, otherwise frumious, words, without any defined, accepted meaning (compare *Journal of General and Industrial Chemistry*, July, p. 763).

However, I have a sort-of-a-kind of Rip-van Winklish, Wellsian Sarnac (the Dream) feeling on thus being woken up, though after only forty-seven years, to find myself dubbed a prophet, with evidence before me that a logical idea can be got into a present-day chemist's mind: the probability of ever penetrating its thick cuticle had seemed too remote. It is fortunate my rescuer from a wilderness of oblivion should be the Giant Wilder, who publicly ranks, with Brutus, as an honourable man; his words, therefore, may well be adsorbed by the hitherto earless multitude. Granted poetic license, my grati-

tude could not be better expressed than in the Omarian lines :—

"A Book of Verses underneath the Bough,
A Jug of Wine, a Loaf of Bread—and Thou
Beside me singing in the Wilderness—
Oh, Wilderness were Paradise enow."

Provided the jug were big enough,* we might discuss Aquafortis to a finish and preach confusion to the many.

I feel that I owe an abject apology to Bancroft for my entirely previous behaviour. In extenuation, I can only plead that I was subject to much evil electrolytic communication in my early youth, not the least being, that in 1870 I happened into the position formerly held by Grove of gas-battery and "Grove-battery" fame. Often, with my own hands, I had to set up 50 Grove cells for use with a Duboscq projection-lantern and so sucked my fill of nitrous fumes and gained not only respect for the depolariser but began to ask myself what its function was.

Everything conspired then to my electrical 'temptation.' A set of Faraday's Researches was knocked down to me, at Stevens' Auction Rooms, together with one of Frankland's zinc ethyl digesters.

Still, it is a horrible thought, as marking our rate of progress, that my son, already a Past-President of the Society of Chemical Industry, has not been taught by his text-books to know what I knew before his synthesis was even begun. He will shortly visit Cornell (I venture no geographical indication of its location) and will, I trust, return from its tents imbued with a reasoned faith and carrying the message of a revised *entente chimique* from one to the other shore, so near but yet so far, of the great salted pond he will cross.

Smee, the inventor of the Smee cell, was one of my bosses; De la Rue another; he and Hugo Müller were at work, close at hand, at their silver chloride non-polarisable cell. To-day, no chemical student has anything to do with an electric-battery: poor soul, electrons are just fed to him from a wire, as food is to the Strasburg geese. Like the mechanic, he is being reduced to watching a machine, instead of doing things with his own hands. In my early youth I acquired a nasty way of myself burrowing for answers to some of the "Whys?" that came into my mind. Later on, Paley's Evidences and the Law Courts infused elementary notions of logic into my composition, at the same time making me suspect of all argument. My downfall was completed by compiling an introductory text-book of Organic Chemistry, the only branch of chemistry with logic in it and some sense of proportion. I may be pardoned mentioning these details but it is well to make clear that light—may be darkness in my case—only comes with pain and tribulation, through experience, not a degree-course. It is written :—

"One's feelings lose poetic flow,
Soon after twenty-seven or so."

This may be true of poetry but not of chemistry: the chemist only begins about that age to reflect and be worth his salt. Indeed, my faith was not declared and complete until 1885, when I adopted $C = \frac{E}{R}$ as my motto and not only sought to evaluate E but asserted that chemical change only took place when (at least) a three-component system was constituted: I could then safely predict that a mixture of hydrogen and oxygen would be found to be inexplosive. I already, at that date, put aside the Arrhenius speculation as without foundation in fact, taking particular objection to the absurd distinction drawn by the school between the two hydrides, HCl and H_2O. Hofmann, twenty years before, had taught me to appreciate their substantial identity in behaviour—but he *was* a chemist, with regard for facts.

Unfortunately, to-day chemists are not like boys—they will not be chemists: they elect, like sheep, to go astray. Their leaders are described to a T in *Lycidas*, particularly as interpreted by Ruskin in *Sesame* and *Lilies*, a book to be studied in preference to any chemical text-book.

The method of our schools—the product of our vile examination system, which makes both *Lehr* and *Lernfreiheit* impossible—is that of the turned-up trousers hem, not that of Zadig as expounded by Huxley in his incisive essay. The situation has been described before to-day :—

"Professionizing moral men

. . . . .

The poems bought in youth they read
And say them over like their creed,
All autumn crops of rhyme seem strange;
Their intellect resents the change."

Perhaps in 1932, even Bancroft will assert the absurdity of the Arrhenic faith and will be accepted of men. Last, will come, not merely the recognition of her beauty but of the almighty power as a chemical agent, when duly married, of fair Hydrone. Then, my shade will have to apologise for my horribly previous behaviour: I shall take care to leave him with a fully executed power of attorney.

Physicists are indulging in the highest flights of imagination as to the electronic structure of atoms, while chemists have no consistent theory of the commonest interchanges of molecules—of chemical change in general. Our backwardness in framing a comprehensive theory is a disgrace to our cloth. What happens to a metal in nitric acid matters little—what does matter is the fact, that the souls of our young chemists are being filched from them by the present race of teachers, who are but foisting dogma upon them; "blind mouths," indeed, withholding from their pupils the art and power of thinking for themselves, of thinking logically and with regard for truth. The present ways of education lead directly to the devil and dullness. No other conclusion is possible, if Bancroft be indeed a Daniel come to judgment, a credible witness.

* We have it from the Knight of Yadil, that wine was appropriately served to him in New York in a bedroom jug—as a natural detergent.

Then, tear him to pieces, ye tribe of idolators, if ye can; if ye cannot, repent ye of your ways, cast down your ikons, think what ye are doing and let others think.

Cory clearly foresaw our situation in writing :—

"Fair ladies, by your leave,
I would exhort you, spin and weave
Some frugal, homely cloth.
I warn you when I lead the tribes,
Law shall strip you; threats nor bribes
Shall blunt the just man's wrath."

NOTES FROM WEMBLEY

It is related that after Dickens had visited the "Great Exhibition" he wrote to a friend: "It is a dreadful thing to be obliged to be false, but when anybody says: 'Have you seen so-and-so?' I say 'Yes,' because if I didn't, I know he would explain it, and I can't bear that. . . ." Readers of the notes on the British Empire Exhibition that have been published from time to time in *Chemistry and Industry* may or may not feel with Dickens, but it cannot but be a general experience that so many "so-and-so's" are yet to be seen that visits have to be multiplied.

Lack of space last week prevented mention of an interesting exhibit on the stand of Messrs. Baird and Tatlock (London), Ltd., in the Chemical Section. The exhibit, due to Messrs. Ridsdale and Co., of Middlesbrough, illustrates the British chemical standards movement and the "Analoid" system of analysis. There is no need to emphasize the importance of accurate analysis for chemical research, but when a sample, say, of ore, is examined by several chemists, the need for standard methods is not always realised. Messrs. Ridsdale show nearly ninety standardised samples, and these are used widely at home and abroad, nearly 50,000 g. having been supplied in the eight years of existence of the movement. With every portion of standard, a certificate is supplied showing the co-operators, and the method and results of each analyst and the average result. The value of such standards is incontestable whether for chemist, manufacturer, buyer or engineer, and it is interesting that the movement is voluntary, the co-operators giving both service and material. The "Analoid" system of analysis is a standardised method for steel, iron and slag, the object being to minimise variable factors, and to obtain results more quickly, cheaply and simply.

One must be particularly tall to watch the dough go in and biscuits come out of the working bakery exhibited by Messrs. Baker, Perkins, Co., so thick is the crowd, and so unwilling is it to move. The smooth working of the plant is, indeed, fascinating, and gives reason to surmise that all the chemical plant made by this engineering firm at Peterborough is equally well-designed.

An interesting visit can be paid to the stand of Messrs. G. and T. Weir, Ltd., Glasgow, in the Palace of Engineering, whether to their display of pumps or to the smaller stand devoted to Monel metal and nickel. Specimens are shown illustrating the many uses of monel metal due to its resistance to alkalis, hot gases, most acids, saline solutions, extremes of temperature, corrosion and abrasion. All the ordinary operations of machining, welding, casting, polishing, etc., can be applied to the metal, which is used in making wire screens for paper mills, textile plants, glue manufacture, alkali works and gas works, as sheeting for hydro extractors, centrifugal dryers, dye vats, and in the form of bolts used in soap and alkali works. Its resistance to high temperatures and fire action has led to its use in glass furnaces, superheaters, valves and furnace stay bars, and it is particularly suitable for making pump impellers which must withstand the action of hot liquids at high velocity. In the chemical industry monel metal is finding wide application, and its freedom from tarnish is an additional recommendation wherever appearance is important.

Allen West and Co., Ltd., a firm which specialises in the manufacture of motor control apparatus, shows a large and comprehensive range of gear for the control of motors of all sizes, from small industrial machines to the large motors used on colliery winders and haulages. Oil-immersed, iron-clad, totally enclosed switchgear is shown as a 5-panel board and also separate units. The switchgear consists of a 375 amp. type "SM" circuit breaker for the incoming unit in the centre of the board, having a triple-pole isolating switch, and trifurcating box. A patent safety interlocking device is fitted, which prevents the removal of either the oil tank or cover while the isolating switch is on. It also prevents the closing of the isolating switch if either the oil tank or cover is removed. The break has a free handle and consequently cannot be held closed on an overload. On the left of the incoming panel is a type "SM" star delta starter, and a type "SM" auto transformer starter. The design of these starters is similar to the main incoming circuit breaker unit; they are used for starting up squirrel-cage induction motors. On the extreme right of the board is a type "SRI" combined stator and rotor starter, for starting up slipring induction motors; this is suitable for motors up to 30 h.p. It comprises a 3-pole contactor switch for the stator circuit with overload trips, the contactor operating coils acting as a no-volt release, and a multi-contact face-plate switch, with quick step-to-step motion, for cutting resistance out of the rotor circuit. Both the stator and rotor switches with the resistance are housed in the one case, whereby a very compact unit is obtained. The operation is by one handwheel only, and the stator switch cannot be kept closed on an overload or failure of voltage. This oil immersed switchgear is also shown made up for use in fiery mines and other places where the air is laden with dangerous fumes. Another interesting exhibit, also representing the latest practice, is the complete equipment for controlling a four motor crane. Other exhibits such as the complete equipment for controlling a 1500 h.p. winder motor, air break drum controllers, of the ordinary industrial type, for use in collieries, stamped steel resistances, lifting magnets, or special insulating material, are worthy of close inspection.

FORTHCOMING EVENTS

Sept. 4 and 5. **Iron and Steel Institute**, Autumn Meeting at British Empire Exhibition, at 10.30 a.m. each day. (1) "Changes of Volume of Steels During Heat Treatment," by L. Aitchison and G. R. Woodvine. (2) "Investigations on the Herbert Pendulum Hardness Tester," by C. Benedicks and V. Christiansen. (3) "Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on some Magnetic Properties of Steel," by E. D. Campbell and G. W. Whitney. (4) "Pickling: The Action of Acid on Iron and Steel, and the Diffusion of Hydrogen Through the Metal," by C. A. Edwards. (5) "Examination of Iron from Konarak," by J. N. Friend and W. E. Thornoycroft. (6) "On the Nature of High-Speed Steel," by M. A. Grossman and E. C. Bain. (7) "Improvements in the Brinell Test on Hardened Steel, including a New Method for Producing Hard Steel Balls," by A. Hultgren. (8) "Present Position of the Theories of the Hardoning of Steel," by W. Rosenhain. (9) "Effect of Free Surfaces on the Plastic Doformation of Certain Motals," by F. C. Thompson and W. E. W. Millington.

Sept. 8 to 11. **Institute of Metals.** Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at Wembley.

The following papers will be read:—"A Method for Measuring Internal Stress in Brass Tubes," by R. J. Anderson and E. G. Fahlman; "The Application of the Ideal Solubility Curve to the Interpretation of Equilibrium Diagrams in Metal Systems," by D. H. Andrews and Prof. J. Johnston; "Seventh Report of the Corrosion Research Committee of the Institute of Metals," by G. D. Bengough and R. May; "Comparative Results on Copper-Silicon-Aluminium and Other Aluminium Alloys as Obtained on Separately Cast Specimens and Specimens cut from a Crankcase Casting," by E. H. Dix and A. J. Lyon; "The Determination of Sodium in Aluminium," by D. M. Fairlie and G. B. Brook; "The Extrusion of Brass Rod by the Inverted Process," by R. Genders; "Investigation of the Effects of Impurities on Copper. Part II—The Effect of Iron on Copper," by D. Hanson and Grace W. Ford; "The Relationship Between Tensile Strength, Temperature and Cold-Work in Some Pure Metals and Single Solid Solutions," by D. H. Ingall; "On the Effect of Progressive Cold-Rolling on the Brinell Hardness of Copper," by H. Moore; "Experiments on the Working of Nickel for Coinage," by Sir T. K. Rose and J. H. Watson; "Some Experiments on the Effect of Casting Temperature and Heat-Treatment on the Physical Properties of a High-Tin Bronze," by F. W. Rowe; "Some Experiments on the Influence of Casting Temperature and Mass on the Physical Properties of Admiralty Gun-Metal," by F. W. Rowe; "Studies in the Aluminium-Zinc System," by T. Tanabe; "Metal Spraying and Sprayed Metal," by T. H. Turner and W. E. Ballard.

Sept. 15. **British Empire Exhibition.** Conferences of Engineering Societies, to be held in Conference Hall No. 4, at 10.30 a.m. Short papers on various Engineering Subjects will be read and discussed.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

It has now been arranged that the Autumn Dinner of the Society, already intimated to be held on November 14, will be a joint function under the auspices of the Society of Chemical Industry and the Chemical Industry Club. The Dinner will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

It is hoped that a large number of members of each of the bodies mentioned will, in due course, procure tickets for themselves and their ladies. A circular letter with further particulars and a form of application for tickets will be issued early in September, but members are asked in the meantime to note the above date and place for the dinner.

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The price of Volume VIII (1923) to members of the Society is 7s. 6d., and to non-members 12s. 6d., post free in each case.

Fellows of the Chemical Society have the privilege of purchasing the volume at the price of 10s. post free.

A set of Volumes II to VIII inclusive can be purchased by a member of the Society at the price of £2 2s 6d., and by a non-member at the price of £3 15s., post free in each case.

CHEMICAL SOCIETY'S ANNUAL REPORTS

The Council of the Chemical Society has decided to increase the price of future issues of the Annual Reports on the Progress of Chemistry, and the volume for 1924 (XXI) which will be issued next year will be sold to the public at 10s. 6d., plus postage. To members of the Society of Chemical Industry will be given the privilege of purchasing the volume at 9s., post free. Orders, accompanied by the appropriate remittance, should be sent to the Assistant Secretary, Chemical Society, Burlington House, London, W. 1, before the end of the present year.

DEATHS

Beilby, Sir George T., F.R.S. (Original Member), of 29, Kidderpore Avenue, Hampstead, London, N.W. 3, Former President of the Society. On August 1, 1924.

Berk, Frederick W. (elected 1893), of 1, Fenchurch Avenue, London, E.C., Chemical Manufacturer. On June 23, 1924.

Biggart, William L. (elected 1891), of 29, Catherine Street, Greenock, Public Analyst. On March 14, 1924.

Dobbie, Sir James J., F.R.S. (Original Member), of Fairlie Cottage, Fairlie, Ayrshire, late Government Chemist. On June 19, 1924.

Earp, William R. (Original Member), of Preston Brook, near Warrington, Chemical Manufacturer. On July 25, 1924.

Farrington, T. (Original Member), of 4, Waterloo Place, Cork, Ireland, Chemical Engineer. On May 2, 1924.

Lorleberg, Charles (elected 1909), of Messrs. R. W. Greeff and Co., Thames House, Queen Street Place, London, E.C., Director. On June 11, 1924.

ACADÉMIE DES SCIENCES

On June 23 M. Rateau communicated a paper by M. Dumanois, showing that tetraethyl lead used in aviation engines to prevent "knocking" enabled the volumetric degree of compression to be raised from 5 to 9. M. Mesnager communicated a paper by M. de Fleury on the use of light alloys for the pistons of internal-combustion engines, showing that it is not the thin piston but the piston which is sufficiently thick that is required in light metal. M. Lindet recorded that M. Hethe has obtained the glyceride myristine from milk fat by direct crystallisation in ether. He also stated that, according to M. Saillard, this year the molasses would contain more raffinose than in preceding years, and that this sugar seemed to form in the beets at the end of the season and during storage.

On July 16 M. Schloesing presented a note by MM. Hein and Andubert on the agglutination and coagulation of rubber latex, the object being to define the agglutinating and coagulating power of various agents so that the rubber could be classified and compared. Prof. Moureu described some work on the radio-activity of hot springs in Madagascar and Reunion. In general the gases of the springs are feebly radio-active, but the dissolved radium is present in double the usual quantity and in one spring thorium emanation was identified. It is known that the injection of serum from another species of animal may cause poisoning. In a paper presented by Dr. Roux, MM. Lumiere and Couturier showed that sera lose their toxic power when held in a vacuum, a conclusion which suggests that carbonic acid plays an important part. In fact, on subjecting sera detoxicated in a vacuum to the action of carbonic acid under pressure the sera recovered their toxicity. The conclusion was that the toxicity of normal sera was due to the physical state of the flocculate, the form of which depends on a labile fixation of carbonic acid on certain amido groups of the proteins, or on other elements present.

On July 21 Prof. Haller described work on the essential oil of the iris by MM. Langlais and Goby, who have isolated from it, in addition to irone, a series of fatty acids including caprylic, pelargonic, capric, lauric and other acids. M. G. Bertrand described researches tending to show that zinc is a growth factor for organisms in which it exists in small quantities. Dr. Roux described a gravimetric method, due to M. Fosse, for estimating cyanamide.

The following chemistry prizes have been awarded: Prix Montyon des Arts Insalubres, divided between M. B. André (2500 f.) and M. Lazennec; Prix Lacage (10,000 f.), for the best work on chemistry, to Prof. C. Matignon; Prix Jecker (10,000 f.), for progress in organic chemistry, to Prof. Simon, of the Natural History Museum; Prix Houzeau, to M. Chevenard; and the Fondation Cahours (3000 f.) to Mlle. S. Weil.

On July 28 Dr. Roux communicated a paper by N. M. Fernbach and Stoleru showing that the antiseptic power of hops was only shown in culture media having a sufficient hydrogen-ion concentration. This observation is of practical interest to the brewer, as it shows that the quantity of expensive hops necessary could be reduced by increasing the acidity, which in addition assists to stabilise the beer and aids the preservative action of the hops.

Prof. Moureu described the result of work by M. Job on the catalytic activation of ethylene by organo-metallic compounds, and also announced that Prof. Matignon had obtained oxalic acid from carbon monoxide and potassium carbonate heated to 470° C. under a pressure of 243 atmospheres.

On August 4 Dr. Roux discussed the conclusions arrived at by M. J. Regnier on the variation of the anæsthetic power of a solution of cocaine chlorhydrate as a function of the hydrogen-ion concentration. The anæsthetic power depends on the reaction of the solution; if this is alkaline, anæsthesia is more rapid and lasts longer.

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The annual meeting of this association has just been held at Liège (Belgium), under the presidency of M. Viala. The chemical section, presided over by M. Huybrechts, had a number of interesting papers. M. Lance described the substitution of carbon monoxide (produced in an auxiliary generator) for metallurgical coke in the blast-furnace, the object being to reduce the consumption of coke and to produce by-products such as liquid hydrocarbons and hydrogen. Prof. Grignard and M. Stratford discussed the cracking of petroleum. M. J. Pougnet described the action of ultra-violet rays and considered the allotropic modifications of bodies in false equilibrium, and M. Meunier showed that gaseous mixtures which react violently, *e.g.*, hydrogen and oxygen, methane and air, do not react when brought into contact with flame unless the proportion of the constituents of the mixture was confined within certain limits. Synthetic resins and their uses were discussed by M. G. Kimpflin.

From biological observations made with M. Mangin, M. Viala explained there was documentary evidence that the scale insect ("Phthiriose"), which caused great damage to the vine in Palestine, lived at the time of the Hebrews on the aerial parts of the vine. The scale insect, which is extremely sensitive to variations in atmospheric moisture, lives to-day, however, solely on the roots, thus showing the change in the climate of Palestine since biblical times. To aid its resistance against drought the scale insect lives in association with a fungus which grows around the wound made in the vine by the insect, over which it forms a protective covering.

NITROGEN FIXATION IN FRANCE

The National Industrial Office for Nitrogen recently established in France has been attached to the Directorate of Hydraulic Power, under the Ministry of Public Works.

CORRESPONDENCE

"METHANOL"

Sir,—The Federation of Swedish Chemical Industries hereby begs to draw your attention upon the following :—

Methyl alcohol has, as it is known, in many different countries caused and still causes a lot of poisoning cases. Especially in its pure state, the smell and the taste of methyl alcohol is so like the smell and the taste of ethyl alcohol, that a confusion can happen very easily. Already the denomination methyl *alcohol* may give rise to the supposition that one has to do with an article which eventually may be used as a substitute for ethyl alcohol and thus is good for drinking. Besides this a slightly indistinct or damaged label may cause a confusion. Certain countries have already become aware of the danger this implies and changed the name methyl alcohol to *methanol*, by which one may consider the most important cause of confusion as eliminated. The National Wood Alcohol Association has introduced the name methanol in the U.S.A. In Germany just as in England it has been partly adopted, for instance by the firm of E. Merck in Darmstadt. "Methanol" is no new denomination; it was introduced in 1892 at the International Nomenclature Congress in Geneva.

In Sweden, on account of the restrictions for selling of alcoholic drinks and their high prices, the abuse of substitutes of all kinds, including also methyl alcohol, has been rather frequent. It has even been proposed to dye the methyl alcohol in order to prevent confusion with ethyl alcohol. In order to preclude difficulties which may arise in the trade of methyl alcohol, as well as on account of the above mentioned social reasons, the Federation of Swedish Chemical Industries considers it to be its duty to recommend the adoption of the term *methanol*. The principal thing is that this is done in practice, *i.e.*, that the article bears the proposed denomination *everywhere* where non-experts are handling it, as for instance in manufactures, warehouses, during transport, etc.

All interested parties, producers as well as users, have declared themselves for the change of the name. Some of the former, besides, expressed the desire that the Federation of Swedish Chemical Industries should inform foreign professional circles about the change. Even the Swedish authorities and unions, *e.g.*, the Royal Swedish State Department of Health, the Royal Administration of the Swedish State Railway and the Pharmaceutical Society have declared that they will adopt the new denomination *methanol* which thus soon will be generally used in Sweden.

As the same reasons as in Sweden probably exist also in your country the Federation of Swedish Chemical Industries takes the liberty to inform your Society about this change and begs to ask you kindly to communicate it to the interested circles and contribute to the general adoption of the denomination *methanol* by publishing the above in your *Journal*.

Our association is addressing a similar communication to the respective unions in other countries.—
I am, Sir, etc., OTTO LEGIÉUR,
Sveriges Kemiska Industrikontor Federation of Swedish Chemical Industries
Stockholm, August 15, 1924

OPTICAL ACTIVITY AND POLARITY THEORIES

Sir,—An attempt has recently been made to relate the magnitude of the molecular rotation of an optically active substance to the "polarity" of the groups attached to the asymmetric atom (H. G. Rule, *J.C.S.*, 1924, **125**, 1121). It is claimed that, in general, "the replacement of a hydrogen atom in an optically active compound by a positive substituent displaces the rotation in the opposite sense to that due to a negative substituent, and that the magnitude of the displacement corresponds more or less closely to the position of the substituent in the polar series, so far as this can be judged from the limited data at our disposal."

The suggestion is an interesting one. Unfortunately, however, the meaning of the term "polarity," when applied to a group of atoms in a chemical compound, is not free from obscurity. Dr. Flürscheim (*J.C.S.*, 1909, **95**, 718), by comparing the strengths of substituted benzoic acids with that of benzoic acid $\left(\text{k polar} = \frac{\text{k meta} + \text{k para}}{2\ \text{k benzoic acid}}\right)$ deduced the following electropolar series: $-NH_2$, $-CH_3$, $-H$, $-OH$, $-Cl$, $-NO_2$; in which $-NH_2$ is regarded as a strongly positive group and $-NO_2$ as strongly negative.

Flürscheim's classification of these groups appears to have been generally accepted. Thus Prof. Robinson (Annual Reports of Chem. Soc., 1922, p. 98) writes that "the groups $-CH_3$, $-H$, $-Cl$, $-NO_2$ represent a descending series in regard to the electropositive character of the constituent atoms," and he explains the relative influence of these groups upon the case of hydrolysis of substituted benzyl chlorides as an example of *general polar effect*. The introduction of the $-CH_3$ group is supposed to render the molecule more electropositive and therefore more easily hydrolysed, whilst the introduction of the chlorine atom or $-NO_2$ group renders the molecule less electropositive and therefore less easily hydrolysed.

Flürscheim's view has also been endorsed by Prof. Lapworth. "There appear to be, for example, (*a*) general polar effects, certain atoms tending to raise or lower the affinity of the molecule as a whole for an electric charge." (Lapworth and Shoesmith, *J.C.S.*, 1922, **121**, 1392.)

On the other hand, according to the theory of induced alternate polarities, although the $-CH_3$ group must be regarded as positive in its *general* polar influence, the C-atom in this group is *negative* from induced polarity, $-\overset{-}{C}\overset{+}{H}_3$. In a similar manner the N-atom in the negative $-NO_2$ group has an *induced positive* polarity $-\overset{+}{N}\begin{smallmatrix}\nearrow O \\ \searrow \overset{-}{O}\end{smallmatrix}$. It would appear, therefore,

that the $-NO_2$ group may be described either as highly negative or as highly positive according as one happens to be thinking of its general polar influence or of its induced alternate polar influence. This circumstance renders the interpretation of the meaning of the phrase "polarity of groups" somewhat difficult.

From the introductory paragraphs of Mr. Rule's paper, in which he speaks of the work of Vorländer, Flürscheim, and Michael having "*prepared the way for the theory of induced alternate polarity put forward by Lapworth*," one draws the conclusion that when Mr. Rule refers to the "polarity" of a group attached to an asymmetric atom he is thinking of the induced polar influence of this group and not of its general polar effect. This impression is strengthened by a consideration of the order in which Mr. Rule places his groups: $-OH$, $-Cl$, $-CH_3$, $-H$, $-CO_2H$, $-CN$, $-NO_2$. This sequence, as Mr. Rule explains, can be arrived at by an examination of benzene substitution data.

On the other hand, Mr. Rule's statement that the very similar series: $-Cl$, $-OH$, $-CH_3$, $-H$, $-CO_2H$, $-CN$, $-NO_2$, can be deduced from "the influence of various groups on the dissociation constants of substituted acetic (or benzoic) acids" is a surprising one. For it is a familiar fact that chloroacetic acid resembles cyanoacetic acid in being stronger than the unsubstituted acetic acid; and that the three chlorobenzoic acids, like the three nitrobenzoic acids, all have higher dissociation constants than benzoic acid. In these cases the *general* polar effect evidently predominates over any other influences which may be at work. In other words, the effectiveness of the group in increasing the strength of the acid is in agreement with its position in Flürscheim's electropolar series: $-NO_2$, $-Cl$, $-OH$, $-H$, $-CH_3$, $-NH_2$, rather than with its position in the induced polar series: $-NO_2$, $-CN$, $-H$, $-CH_3$, $-Cl$, $-OH$.

Mr. Rule makes the further claim that the series $-NO_2$, $-CN$, $-H$, $-CH_3$, $-Cl$, $-OH$, can be deduced from the inductive capacities of compounds of the types C_2H_5X and C_6H_5X. But since, according to the data quoted by Mr. Rule, the influence of these groups upon the inductive capacities is in the order $NO_2 > CN > Cl > CH_3 > H$ it is not easy to see how this claim can be justified.

The first of the examples by which Mr. Rule illustrates his hypothesis of the relation between optical activity and the "polarity of groups" attached to the asymmetric atom is a series of derivatives of lævo-rotatory amyl alcohol.

($R = C_4H_9$)	$[M]_D$
$R.\ CH_2\cdot OH$	$-5\cdot19$
$R.\ CH_2\cdot NH_2$	$-5\cdot10$
$R.\ CH_2\cdot Cl$	$+1\cdot81$
$R.\ CH_2\cdot C_2H_5$	$+6\cdot23$
$R.\ CO\cdot OH$	$+18\cdot21$
$R.\ CH_2\cdot CO\cdot OH$	$+10\cdot35$

With regard to this series Mr. Rule remarks "it will thus be seen that $-CO_2H$, the only positive group contained in the list, stands at one extreme with the highly negative hydroxyl group at the other." As Mr. Rule here speaks of the $-CO_2H$ group as positive, it is natural to assume that he is considering its induced alternate polar influence.

Writing the series again from this point of view, we have

$R\cdot\overset{+}{C}H_2\cdot\overset{-}{O}H$	$-5\cdot19$
$R\cdot\overset{+}{C}H_2\cdot\overset{-}{N}H_2$	$-5\cdot10$
$R\cdot\overset{+}{C}H_2\overset{-}{Cl}$	$+1\cdot81$
$R\cdot\overset{+}{C}\overset{-}{O}\cdot\overset{-}{O}H$	$+18\cdot21$
$R\cdot\overset{-}{C}H_2\cdot\overset{+}{C}O\cdot OH$	$+10\cdot35$

It will be observed that in all cases, except the last, the group R is in combination with *positive* carbon. From the point of view of the theory of induced alternate polarities, $-CO_2H$ is thus by no means "the only positive group contained in the list." On the other hand, $-CH_2\cdot CO_2H$ may, in the language of the theory, be described as the only negative group which is directly combined with the radical R. If, therefore, there were any relationship between the molecular rotation of a compound and the induced polar effect of a substituting group, one would anticipate a change in the sign of the rotation, on passing from $R\cdot\overset{+}{C}\overset{-}{O}\cdot\overset{-}{O}H$ to $R\cdot\overset{-}{C}H_2\cdot\overset{+}{C}O\cdot OH$. No change of this character is observed and hence one may conclude that the magnitude of the rotation is not dependent upon the *induced* polar effect of the substituting group.

It is equally difficult to trace any relationship between the magnitude of the rotation and the *general* polar effect of the substituting groups. It would seem, therefore, that when Mr. Rule speaks of a relationship between optical activity and the "polarity of groups" he is attaching to the word polarity a meaning different from either of the meanings hitherto commonly associated with the word.—I am, Sir, etc.,

D. R. Boyd

University College,
Southampton

"COAL AND POWER"

The Neglect of Science

Sir,—The publication of "Coal and Power," Hodder and Stoughton Ltd., price 1s. nett, which we are informed is the "Report of an Inquiry presided over by the Right Hon. D. Lloyd George," and has the approval of Mr. Asquith, is rather interesting to the chemist and the chemical engineer. The press is already full of articles on the question, mostly written by politicians and other people whose knowledge of the subject is limited to their gleanings from the Encyclopædia Britannica, and the episode is only another reminder that it is time the average chemist woke up.

If we do not have the actual control as well as the publicity, not only of coal and power but of many other subjects vested in the technical man, whether he be, in the broad sense of the word, engineer, chemical engineer, or chemist, instead of the politician, the lawyer, the accountant and similar people, we are bound to come a crash. The

state of the colliery industry has given us sufficient warning for years past, and the iron and steel industries are drifting more and more to a serious crisis. The real reasons are very largely lack of scientific methods, including the neglect of the trained technical man, and the almost entire absence in industry until the last year or two of the co-operative spirit.

It is, of course, easy to laugh at "Coal and Power" from a scientific point of view—and any technical journalist could have written the "power" section as part of his daily work—but at any rate it shows the terrible conditions under which many of the miners are compelled to live, and the chaos in the industry due to mining royalties, high railway rates, and all kinds of circumstances which handicap the technical management of coal mines.

I have the greatest respect for any one who has to do with practical coal mining, a difficult, dangerous and heart-breaking job, but the fact remains there are enormous savings to be made in the colliery industry, of which of course the Report gives no indication. As already stated in a letter in your issue of July 18, the colliery boiler plants use about $6\frac{3}{4}$ per cent. of the coal raised, that is for average years, say, 17,500,000 tons out of 260,000,000 tons. The nett working efficiency of colliery boiler plants is 55·5 per cent., and individual plants are running at anything from say $32\frac{1}{2}$ to $72\frac{1}{2}$ per cent. efficiency, the lower figure being due to the egg-ended boiler, a few of which are still in use. Incidentally it may be stated this type of boiler was invented about 1750, and the average efficiency is much less than 40 per cent.

If scientific methods were adopted, the efficiency of colliery boiler plants could be raised to 70 per cent., and 3,625,000 tons of coal saved. Based on the examination of about 400 colliery boiler plants I should say, roughly, that the average installation consists of "Lancashire" boilers entirely in the open air, with a very moderately efficient covering over the top and none at all on the boiler fronts, no feed-water economisers, no superheaters, very badly leaking brickwork and poor working conditions for the firemen, very inefficient pipe coverings, leaky joints, and bad feed-water, although there is generally ample boiler capacity.

It is not to be wondered at therefore that the average efficiency is 55·5 per cent., and it gives some idea of the utter neglect of scientific principles of steam generation when we reflect that the average boiler-plant efficiency of all the industries of the country is only about 58 per cent., and collieries are therefore not very much worse than the average. But another serious loss of efficiency in colliery operation is the neglect to use refuse fuels, of which millions of tons have been thrown away in the shape of anthracite "duff," pit sweepings, washery "slurry," high-ash content material and coke breeze (from coke-oven equipment.) At least another 2,500,000 tons of coal could be released for sale if part of such refuse fuels were used under the steam boilers. Why have not the colliery industry opened research stations and solved these and other problems?

As already indicated, I do not want to give the impression that the colliery industry is much inferior in this respect to any other, but we are squandering our coal and other resources in every direction simply because technical men such as the chemist are either not employed at all, or else regarded as of little or no importance and paid accordingly.

I have no space to deal with many other items in the Report, but the advantages of the super-power station are grossly exaggerated, no mention is made at all of the "pass-out" or "bleeder" principle, and low-temperature carbonisation is almost ignored, although one very promising principle —that of carbonising coal in front of steam boilers, as in the Merz and MacLellan process in England and that of Pintsch in Germany—is mentioned, presumably because the Report is largely a popular and very slipshod appeal for the super-power station.—I am, Sir, etc.,

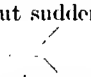
David Brownlie

A SUGGESTION

Sir,—Some little time ago you were kind enough to admit to the *Journal* a letter from me in which it was suggested that to allow of higher rates of movement of canal boats an "incurved collar" should be adjusted to the sides of canals to throw back the wash.

As cheap carriage, and quicker carriage, of heavy chemicals, and other materials, is of prime importance I am asking indulgence to make another suggestion, based on some laboratory experiments. The suggestion is to abandon the stern screw propeller for canals and use air expelled under moderate pressure from a considerable number of small openings arranged on the sides of the boat, or vessel, so that the air escapes in a direction *almost* in line with the side and slightly directed downwards.

Compressing the necessary volume of air is neither difficult nor expensive. The form of jet or opening that seems to meet most resistance from the water is one where the airpipe opens out suddenly into a cone or funnel of about 60°



Water full of air bubbles does not appear to have the same erosive power as the "solid" water driven by the propeller.

The water between the sides of the boat and the sides of the water container is filled with air bubbles which soften the swell and rush.

The arrangement of jets in slanting lines from about one foot under water to nearly the bottom of the boat sides would probably be the most efficient and the orifices of the air tubes half inch by one-eighth inch elipses ⬭ seem better than circles.

The best number of rows or series of these escape holes and their arranging and the pressure are matters requiring more elaborate experiments such as might be done at the N.P.L.

It will be agreed that by some means we must quicken canal traffic and when some start is made in this line possibly our derelict canals may be brought back to life.—I am, Sir, etc.,

W. R. Hodgkinson

Deep Cut, Hants
July 1924

PERSONAL AND OTHER ITEMS

The Canadian Institute of Chemistry has elected the following executive for the ensuing year. President, Dr. A. T. Charron; Vice-Presidents, Prof. R. Harcourt, J. W. Shipley, C. E. Wallen; Secretary, L. E. Westman; Treasurer, E. T. Sterne, and the following representatives were elected to the council to replace those retiring, Prof. E. H. Archibald, Vancouver; L. F. Cooper, Calgary; E. T. Sterne, Brantford; Prof. G. S. Whitby, Montreal, and F. Barnes, Shawinigan Falls.

At Oxford, Mr. A. J. Walker, B.A., Queen's College, has been elected to a scholarship for research in physical science of £200 a year for two years, to enable him to pursue research in organic chemistry.

The board of governors of the University of Toronto has awarded to S. C. Blaylock, general manager of the Consolidated Mining and Smelting Company of Canada, Trail, B.C., the McCharles prize for his work in connexion with the production of electrolytic zinc, and with the solving of the difficulty of treating complex lead, zinc and silver ore. Mr. Blaylock accepted the prize as Captain of the team, and it is to be distributed among the members of the staff. The money part of the prize has been given to the Trail Memorial building.

On August 15 the marriage was solemnised of Miss Eva S. E. Coleman, B.Sc., daughter of Mr. W. H. Coleman, and Dr. W. M. Cumming, senior lecturer in organic chemistry in the Royal Technical College, Glasgow.

The *Times* states that Glasgow Corporation, which opened a chemical department five years ago in association with the municipal gas works, made a profit last year of £270,000 from by-products.

On the occasion of the meeting of the British Association in Toronto, a special Convocation of the University of Toronto has conferred honorary degrees of Doctor of Science on Sir David Bruce, Sir Ernest Rutherford, Sir Charles Parsons, and Sir Edward Russell.

The following deaths are announced from Germany: Dr. K. Waldeck, technical director of the Nitrogen Stickstoffdünger- und Chemische Industrie A.-G., and R. Balhorn, founder of the Ruba soap works.

The death is announced of Sir Samuel Turner, founder of the firm of asbestos manufacturers bearing the same name.

J. H. Cremer, who died in July at Spartanburg, S.C., at the age of 80, had long been connected with the steel industry, and is said to have been the first to produce ferromanganese on a commercial scale in the United States.

We regret to announce the death of Mr. W. R. Bird, who was recently elected Chairman of the South Wales Section of the Society of Chemical Industry. Mr. Bird was returning from a motoring tour on the Continent when he was taken ill at Staines, and died after an operation. He was a director of Bird and Son, Ltd., Cardiff, tar distillers and oil importers, and was a willing worker in social and educational movements.

The centenary of the death of Karl Arnold Kortum, one of the last alchemists, fell on August 16.

Prof. Albert Hesse, for many years editor of the *Chemisches Zentralblatt*, has died in his fifty-eighth year. After studying natural philosophy at Münster, Berlin, and Göttingen, he gained his doctorate with a work on the terpenes. After a short time as chemical assistant at Göttingen he went into chemical industry, and contributed to the literature of chemical technology, being especially interested in ethereal oils. In 1902 he became editor of the *Chemisches Zentralblatt*. He was also known for his interest in economic and social questions in their relation to chemical industry.

With regret we announce the death, at the age of 64, of Prof. J. Wertheimer, dean of the Faculty of Engineering and Professor of Applied Chemistry in the University of Bristol. Educated at University College, Liverpool, and Owens College, Manchester, he was headmaster of the Leeds School of Science and Technology from 1887 to 1890, when he became principal of the Merchant Venturers Research College at Bristol. When Bristol University was founded and its faculty of Engineering absorbed the Technical College, Prof. Wertheimer became dean of the Faculty. He had published text books on chemistry, and had edited a series of technological works. In addition to valuable services to the University he served on various public bodies and, during the war, he organised the West of England industrial reserve for the production of munitions.

We regret to announce the death of Mr. Edward M. Johnson of the firm of Messrs. Locke, Lancaster and Johnsons, London, well-known as manufacturers of white-lead and other lead products. Mr. Johnson died on August 13 and was buried in Little Missenden Churchyard on August 16. The funeral was attended by many of his business friends, all of whom liked and respected him. He was 59 years of age.

GENERAL

Metallurgy in Belgium in 1923

The output of coal amounted to 22,916,070 tons (against 21,208,500 t. in 1922); coke, 4,156,700 t. (2,849,884 t., in 1922). The number of blast furnaces alight at the end of the year was 40, being 6 more than at the beginning of 1923, and 14 less than the total number alight on December 31, 1913; at the beginning of 1922 there were only 14 blast furnaces. The production of cast iron was 2,188,130 tons (1,605,620 t. in 1922); steel, 2,216,650 t. (1,497,610 t. in 1922); finished steel, 1,943,390 t. (1,409,990 t. in 1922), finished iron, 207,740 t. (180,252 t. in 1922). The production of zinc rose to 148,080 t. against 113,137 t. in 1922. The output of crude zinc by the Vieille Montagne Co. was 73,000 t. in 1923, compared with 63,000 t. in 1922. Amongst the products were 57,500 t. of sheet and worked zinc, and 24,600 t. of various zinc oxide and other oxide. Production by the same company included 11,400 t. of pig and 4400 t. of sheet lead, whilst the smelters produced 68,627 t. of sulphuric acid.

REVIEWS

The Simple Carbohydrates and the Glucosides. By E. Frankland Armstrong, D.Sc., Ph.D., F.R.S. (Monographs on Biochemistry, edited by R. H. A. Plimmer and F. G. Hopkins). Fourth Edition. Pp. xi+293. London: Longmans, Green and Co., 1924. Price 16s. net.

It is just fourteen years ago since the first edition of this monograph was published and the demand for three succeeding and enlarged editions shows not only the rapid development of the subject, but it is also a tribute to the manner in which the author has performed his task. The present edition has been thoroughly revised, and some 50 pages and two chapters added to the text. The author mentions Principal Irvine, Dr. T. P. Hilditch and Mr. Rex Furness as having given him many valuable suggestions. It must be distinctly understood that the monographs of this series do not aim at being full treatises on the subjects they deal with, the text being subsidiary to the bibliographical tables. This fact has been kept well in mind in any criticisms which the writer has been tempted to make of the present work.

There are few chapters in organic chemistry which present such fascination to the student as that dealing with the sugars, uniting as it does the work of the pure chemist and of the biochemist better than perhaps any other in the whole range of chemical literature. Nor can we forget that the story presented so ably in the present monograph is due to the researches of a single chemist, Emil Fischer. "The outstanding feature of his method," says Dr. Armstrong, "was his absolute devotion to experimental enquiry, the unwearying persistence of his efforts to attain a clearly foreseen goal, the gradual but always logical manner in which problems were approached, and the completeness of his attack. No one previously had set the same example of ordered, persistent enquiry." It certainly befits the case that the task of writing a monograph on the sugars should fall to the lot of one of Fischer's former pupils and assistants.

Fischer died in 1919, and he bequeathed to the world in general and to science in particular the rich legacy which is summarised in the present work. We owe to him the general scheme of the chemistry of the simple sugars as well as the conception of the glucosidic nature of the more complex members of the carbohydrate group. True lacunæ have been filled in here and there by other workers, but the frame work of the edifice is Fischer's and Fischer's only. Thus it would seem that with Fischer's death the subject of sugar chemistry passed from the hands of an individual into those of a community. Individual effort, however, still counts, and in this connexion it will not be invidious to mention the work emanating from the St. Andrews School, commenced by Purdie and continued by Irvine at St. Andrews and by Haworth at Newcastle, as well as that of C. S. Hudson in America. From both sources valuable results have already accrued, and we may anticipate a still richer harvest in the future.

Of the eleven chapters in this monograph the first four deal with the simple sugars (including the cycloses) and their derivatives; the fifth and seventh are devoted to the disaccharides and polysaccharides respectively; the sixth is concerned with hydrolysis and synthesis; whilst the subject matter of the remainder is under the following headings: The relation between configuration and biological behaviour, the natural and synthetic glucosides (two chapters), and the function of carbohydrates and glucosides in plants.

As regards the aldoses the bulk of the space is devoted to d-glucose and its derivatives, as being the best known typical member of the group. The ketoses are also dealt with though not at such great length. The author now favours the use of numerals instead of Greek letters to indicate the carbon atoms to which the oxygen ring is attached, thus avoiding confusion. Much importance is quite rightly attached to the evidence which has been brought forward of the existence of a new form of hexose, the γ-form, and in this connexion the writer is pleased to note that Irvine's recent suggestion is mentioned, namely, that the so-called γ-sugars may not be chemical individuals but simply the sugars acting as aldehydes and ketones. This suggestion receives support from the work of Ling and Nanji on the action of ammonia on glucose, as well as from some more recent work carried out in the writer's laboratory on the reduction of the sugars in which the presence of ammonia has been found necessary.

The existence of isomaltose is now regarded by the author as definitely established through the work of Ling and Nanji, but although mention is made of the isomaltose of Fischer which the author also isolated independently, no hint is given that the two sugars may be, and probably are, distinct substances. The hexatriose α-glucosidoisomaltose of Ling and Nanji should have been referred to under the trioses: it is even better characterised than isomaltose as it possesses a sharp melting point.

In dealing with a biochemical subject, the organic chemist is too apt to insist on the necessity of reactions proceeding by stages, forgetting that in the nature the dictum of the Greek philosopher, πάντα ῥεῖ applies. On p. 174 the early suggestion of E. Buchner and his co-workers that lactic acid or alternatively dihydroxyacetone are intermediate products in the alcoholic fermentation of the sugars is mentioned. The former was shown by Slator to be unfermentable by yeast, whilst the latter is only slowly fermentable. It may be pointed out, however, that many intermediaries have no actual existence at any given interval of time, *e.g.*, formaldehyde in the photosynthesis of the carbohydrates. They serve merely to indicate the paths through which the changes travel, and they can only be isolated when substances combining with them and removing them from the sphere of action are present. The author, however, evidently agrees with this view, for he states that dihydroxyacetone is probably fermented by yeast only after it has been converted into hexose, which is supported by Lebedeff's observation that the organic phosphate produced during the fermentation of dihydroxyacetone is identical with the hexose phosphate of Harden and Young.

The author states that the knowledge of the more complex carbohydrates having reached a stage when structural formulæ can be assigned to them with some degree of certainty, it has been felt desirable to introduce a new chapter dealing with so much of the chemistry of these substances as is required for the purpose. This statement disarms criticism. The new chapter covers 10 pages and is devoted entirely to structural considerations deduced from purely chemical work without reference to the action of enzymes. Most of the structural formulæ which have been proposed for the basal unit of cellulose are reproduced, including that of Irvine, tri-1 : 5 anhydroglucose. This latter requires that cellulose shall yield 70 per cent. of cellose, whereas the highest recorded yield which the writer has been able to find is 60 per cent. of cellose octacetate by Klein in 1912, which has been confirmed, although Karrer and Widmer state that cellulose contains more than 50 per cent. of cellose complex. There can be no doubt that cellulose yields on complete hydrolysis nothing but glucose as this has been established by Irvine. It would seem not improbable, however, that cellulose like starch consists of more than one polysaccharide. Hess, whose highly important work is not mentioned, brings forward evidence that cellose is a reversion product and also points out that cellulose itself is not a single substance.

With regard to starch, it is pointed out that the structural formula for the basal unit of amylopectin proposed by Ling and Nanji is a dimeric form of Irvine's triose formula for starch. No mention is made of the presence of hemicellulose in certain starch granules, notably in rice starch with which Irvine worked, as first pointed out by Sehryver.

Glycogen is dismissed in eight lines; it is said to take the place of starch in animals, but its sources in the vegetable kingdom are not alluded to. The other polysaccharides briefly noticed are inulin, mannan and xylan.

But few additions have been made to the highly suggestive concluding chapter on the function of carbohydrates and glucosides in plants. Physiologists have objected to the application of their word "hormone" by H. E. and E. F. Armstrong to denote substances such as hydrogen cyanide, hydrocarbons, alcohols, phenols, esters, ethers, etc., including as the author remarks, most of the substances which Overton and others have classed as solvents for lipoids—which are able to penetrate the walls of plant cells. Bayliss contends, for example, that the action of these substances should be looked upon as due to the removal of some obstacle which prevents access of an enzyme to a glucoside. That was certainly the way in which Overton [illegible] the phenomenon.

The [illegible] paragraphs in the chapter deal with the tannins and with the genesis of the carbohydrates in certain of the gramineæ.

In the bibliography the writer notices the omission of one or two papers cited in the text. The early editions of Czapek's "Biochemie der Pflanzen" and of Tollens's Kurzes Handbuch der Kohlenhydrate" are quoted instead of the latest editions.

In conclusion the writer would like to be permitted to add his tribute to the merit of Dr. Armstrong's monograph. It is a summary of the subject which will prove invaluable as a guide to the literature, not only for research workers, but also for those teachers whose lectures are based on original memoirs rather than on text books. Not the least important feature of the work is, moreover, the many suggestions which it contains, the value of which can only be appraised by the authority with which the author is able to speak on a subject which he has made his own.

Arthur R. Ling

Kurzes Lehrbuch der Chemie. By Werner Mecklenburg. Second Edition. Pp. xvi+793. Brunswick: F. Vieweg and Son, 1924. Price, paper 20 m., bound 23 m.

This book is based upon, and forms the thirteenth German edition of, Roscoe's "Lessons in Elementary Chemistry," which first appeared in 1866 and was translated, among other languages, into Chinese. Of the body little remains, but the spirit of Roscoe's book is preserved. The treatment is clear, with a practical tendency, and is descriptive rather than speculative. The theoretical portions are clear and adequate. The sections on the Phase Rule, in this connexion, are particularly good: cooling curves, the theory of double salts, reciprocal salt pairs, and alloys are dealt with very well. The description of the metals includes very brief accounts of the so-called "rare elements," and in this part the only thing which seems open to criticism is the treatment of the Periodic Law at the very end of the whole section.

The Organic section is very readable yet fairly detailed. Important technical details and the chemistry of daily life receive attention. This section is well balanced and up to date. The preparation of phthalic anhydride by air oxidation, the "impossible" compound triphenylmethyltetramethylammonium—$(C_6H_5)_3C{\cdot}N(CH_3)_4$—in which all five valencies of nitrogen are directly united with carbon, the compound $(C_6H_5)_2:N;O$, and the use of "tetralin" in artificial motor spirit (25 per cent. tetralin+25 per cent. alcohol+50 per cent. benzene), are all included. The book is well printed on good paper and the diagrams are clear.

J. R. Partington

Modern Electro-Plating: A Guide Book for Platers, Works Chemists and Engineers. By W. E. Hughes, M.A. Pp. vii+160. London: H. Frowde and Hodder and Stoughton, 1923. Price 16s.

This book, as its author states in his foreword, is essentially a collection of articles published from time to time in the official journal of the British Electrical and Allied Manufacturers' Association. Interested readers who followed these articles will be glad to have them in more permanent form. It was very unfortunate, however, that the author in arranging these in book form did not see his way to enlarge on the technological side of the subject.

The book is addressed particularly to platers, works chemists and engineers. Of these three classes, it will unquestionably be of most value to the second

named. It is difficult to imagine that the average electro-plater or even the average engineer would find very much assistance from the critical discussions of the work of other writers and investigators on the subject of the electro-deposition of metals with which this book is so freely interspersed. At the same time, to the works chemist, and particularly to the works chemist engaged in what may be termed "industrial research," the book contains very much of permanent value, and the critical descriptions of published literature on the subject will be very useful.

The chapter on the structure of electro-deposited metal fairly adequately fills a definite blank in existing text books on the subject, and is a subject with which the author is very well qualified to deal, since he has himself carried out some valuable investigations.

One serious defect of the book is the omission of any consideration of the precious metals, especially silver and gold. The electro-deposition of these two metals forms a very important section of the industrial electro-deposition of metals, and one is compelled to protest very vigorously against the undeservedly slighting references which are made in the one short paragraph in which silver receives mention at all. It is quite true that the basis of commercial silver plating is the "poisonous" cyanide of potassium, but the author does not hesitate to recommend essentially the same type of solution for copper. And one fails to see any really sound objection to the use of cyanide solutions under modern workshop conditions.

A further omission of importance is that of the deposition of alloys, particularly brass, a subject upon which the works' chemist or works' manager is very often in need of technical information.

In spite of these very obvious defects, however, the book is a welcome addition to the meagre literature of electro-plating.

W. R. Barclay

Kelly's Directory of Merchants, Manufacturers and Shippers of the World. 1924. Thirty-eighth edition. Vol. I, pp. ccci+2522. Vol. II, pp. cxviii+2158. London: Kelly's Directories, Ltd., 186, Strand, W.C. 2. Price 64s.

The new edition of Kelly's Directory includes all the well-known and useful features of previous editions. In volume I (the world, other than the British Empire), further information has been added to the section devoted to Russia, which, like the sections relating to other countries is provided with a sketch map showing the chief means of communication and some condensed information useful to traders. The second volume relates solely to the British Empire, in which the useful innovation has been made of including an alphabetical list of telegraphic addresses in Great Britain and Ireland. The information given appears to be remarkably comprehensive and the clear arrangement facilitates quick reference. The utility of Kelly's Directory is only fully realised when the copy is wanted while being used by someone else, and it is of value to many who are not traders.

REPORTS

Report on the Economic and Financial Conditions in Germany, April, 1924, by J. W. F. Thelwall, Commercial Secretary, Berlin, and On the Occupied Territories, by C. J. Kavanagh, Commercial Secretary, Cologne. Department of Overseas Trade. Pp. 190. H.M. Stationery Office, 1924. Price 5s.

The outlook in Germany was no more definite at the beginning of this year than it has been at any time since the war (*cf. Chemistry and Industry*, 1923, 683). During practically the whole of 1923 the country was cut off economically from the Occupied Territories and had to resort to far-reaching adaptations to meet the situation. Currency difficulties were great; the failure to establish the new gold mark led to the introduction of the rentenmark, a form of currency available only for home use and not quoted on the exchange, but which seems likely to fulfil its purpose of restoring normal conditions and paving the way to the introduction of a gold currency.

During the year German trading policy underwent a revision, and the restrictions on exports were drastically cut; a policy of protection hinders importation, but in this trade also some relaxation of the regulations has been made. The occupation of a large proportion of industrial Germany has made her dependent on imports even of some kinds of iron and steel goods. The textile industries did better in 1923 than in the previous year, exports showing an increase and imports a decrease. The export figures in the chemical and dyestuffs trades are comparatively good; the demand for potash salts and fertilisers showed an increase, but that for chemical and pharmaceutical preparations fell. Rubber goods, porcelain, earthenware and glass showed considerably increased exports. The total imports in 1923 were less than in 1922, but those of foodstuffs increased, as did also those of coal and coke, on account of reparations, deliveries and the Ruhr occupation.

In the report on the Occupied Territories is given an account of the chaotic conditions which prevailed during the Ruhr resistance and the currency debâcle. At present the territories are experiencing a phase intermediate between inflation and devaluation. The relations between the industrialists and the bankers are somewhat similar to those which arose in this country after the post-war boom; German manufacturers are not, however, saddled with large stocks, and once their financial problems are settled should find it easier to return to normal conditions. The value of the occupied areas lies chiefly in the coal-mining, metallurgical and chemical industries. Of the whole German coal resources, about 120 million t. per annum, 90 per cent., is now in occupied territory. This coal is the basis of German prosperity; about one-half is used in metallurgical industries, Lorraine also drawing on this source for coke. About 80 per cent. of the iron and steel works are situated in this area, which has a production equal to that of Great Britain. The Rhineland also draws on this district for supplies of coal-tar products.

Report on the Economic and Commercial Conditions in Turkey, April, 1924. By Col. H. Woods, O.B.E., Commercial Secretary, Constantinople. Department of Overseas Trade. Pp. 52. H.M. Stationery Office, 1924. Price 1s. 6d.

In the Turkish agricultural industry output was below normal in 1923, but prospects for 1924 are good. The Government has recently voted large sums to subsidise the industry, distributing seed and machinery gratuitously. Manufacturing industries have always been of minor importance, and military operations have resulted in the partial destruction of even the small industrial centres which existed before the war. The wine and spirit industry has been ruined by the introduction of a "dry" régime, and vine-growers have also suffered accordingly. The silk industry improved last year, but, as in all the manufacturing industries, lack of skilled labour, owing to the migration of Christians, has proved a great difficulty.

Trade in 1923 suffered from the political conditions as well as customs difficulties, and stocks of imports were kept as low as possible. The total imports were 458,744 t., and exports 350,484 t., most of this trade passing through Constantinople and Smyrna. The greatest value of imports was obtained from Great Britain, Italy coming second; the staple export from both countries to Turkey is cotton, and Italian competition in this line with British merchants has become severe. Detailed advice is given to assist British traders in selling their goods in Turkey.

Report on the Financial, Commercial and Economic Conditions in Rumania, March, 1924. By A. Adams, Commercial Secretary, Bucarest. Department of Overseas Trade. Pp. 66. H.M. Stationery Office, 1924. Price 2s.

The principal feature in the trade of Rumania during 1923 was the continued vitality of the importation of staple articles from Britain (*cf. Chem. and Ind.*, 1923, 776). Cotton textiles, sheet iron, iron bars, agricultural machinery and coal remained the chief articles in demand. The general conditions in the import trade have been such as to discourage big orders, and traders have generally taken the easiest terms of payment offered, which do not often come from British manufacturers. Chemicals are now difficult to obtain from Germany, and there should be a good demand for British chemical and pharmaceutical products if properly advertised. Coal imports dropped almost to zero during the war, but are now improving, though recent figures are not available.

The agricultural industry is making progress. Restrictions on cereal exports have been removed, giving an immense fillip to the trade, and the area under cultivation is increasing. The 1923 harvest was the best for some years.

The production of crude petroleum in 1923 was 1,509,804 t., showing an increase over previous years since the war. Export of crude oil is prohibited, and general restrictions are in operation in order that the country may obtain as much benefit as possible from the industry. Borings were made during the year to the extent of 114,705 metres. All mining properties in Rumania are to be held by the State. The coal production during 1923 is not yet known, but is expected to be larger than in 1922, when 2,116,000 t. was won. The production of salt in 1923 was 285,212 t. The sugar crop was good, and an export of 10,000 t. is anticipated. During the year 190,000 t. of Portland cement was produced, more than sufficient for local needs, which are, however, expected to increase. The metallurgical industries were hampered by the shortage of coke, as well as by financial difficulties. The problem of uniting the industries of Transylvania with those of the Old Kingdom are gradually being overcome, not only in the metallurgical industries but also in others of a more general nature.

Report on the Economic, Financial and Industrial Conditions in Finland, March, 1924. By C. H. Mackie, H.M. Consul, Helsingfors. Department of Overseas Trade. Pp. 68. H.M. Stationery Office, 1924. Price 2s.

In some respects the year under review was les satisfactory than 1922 (*cf., Chem. and Ind.*, 1923 1015). The large exports of that year were chiefl due to the depreciated currency of the country, bu since stabilisation was begun at the end of 192 the decrease in exports has been very marked. Export in 1923 were valued at 4385 million F. marks against 4468 million F. marks during the previou year. Great Britain takes more than one-third of t. exports from Finland. Imports in 1923 were valu at 4607 million F. marks, against 3970 million marks in 1922. Germany supplies about 30 per cen of the imports, Great Britain about 18 per cent., an the United States about 12 per cent. Great Britai is the chief supplier of coal, coke and textiles. Th demand for coal rose steadily during 1923, 524,670 t being imported, more than twice the total in 1922 a somewhat smaller demand is expected during th current year. Most of the chemicals imported ar obtained from Germany, which also supplies th bulk of the colours and colouring matters.

Industry experienced an uneventful year, findin great difficulty in obtaining sufficient working capita The boom in the textile industry in 1922 gave wa to a depression last year, when accumulated stock had to be worked off. The high cost of productio has led to a decrease in the export trade in glass, an factories are no longer working to capacity. Som paper mills are doing well, but others have had t suspend operations.

Dr. L. Benda, to whom was due the preparation of salvarsan, trypaflavin and similar compounds, recently celebrated his 25th year of service with Cassella und Co., Frankfort.

COMPANY NEWS

THE MAGADI SODA CO., LTD.

The proposals of Brunner Mond and Co., Ltd., for the reconstruction of the Magadi Soda Co., Ltd., have now been issued, and the chief points of the scheme are: A new company is to be formed with a share capital of £830,000, divided into 250,000 6 per cent. first preference of £1 each; 1,320,000 6 per cent. second preference of 5s. each; 600,000 12½ per cent. preferred ordinary of 5s. each; and 100,000 ordinary of £1 each. The new company is to issue £500,000 6 per cent. first mortgage debentures redeemable in 1945 at par, by means of a sinking fund commencing in 1929. For the first two years the debenture interest and dividend on preference shares are to be paid out of any profits for each year, but afterwards the interest and dividends become cumulative. Dividend on the preferred ordinary is only to be paid if earned and will be non-cumulative. Preference and preferred ordinary shares will have no voting right for the first two years, but voting power is given after that time on certain conditions. One director is to be nominated by the Governor of Kenya Colony, one by the present trustees for the first debenture holders, and the remainder by Brunner Mond and Co., Ltd. The names of the first directors have to be approved by the Colonial Office and by the Senior Official Receiver. The proposals for exchanging debentures and shares are: Each first debenture to be exchanged for a debenture in the new company for the same amount, all interest arrears being cancelled. Holders of second debentures and each unsecured creditor to receive the first preference shares equal in nominal value to 75 per cent. of the former company's indebtedness, all interest on second debentures and unsecured debts being cancelled. Each ordinary share to be exchanged for one second preference credited as fully paid; every twenty deferred shares to be exchanged for one second preference fully paid. Each holder of ordinary and deferred shares of the former company to have the right to subscribe in cash at par for the 600,000 preferred ordinary in proportion to holding of second preference. Provision is to be made for payment in full of certain creditors, such as the Government of Kenya Colony, Uganda Railway, etc.

The total amount of these debts is not to be more than £20,000, and will be provided by the new company. Brunner Mond and Co., Ltd., are to be allotted at par 100,000 ordinary shares to be paid for in cash, and such preferred ordinary shares as are not taken up by the second preference shareholders. Brunner Mond and Co., Ltd., will give guarantees to the satisfaction of the Official Receiver and the Colonial Government that the company will work the Magadi Soda Co.'s property to its full economic capacity. The scheme is subject to a lease being granted by the Colonial Office to the new company.

Mr. F. W. Babington, chemist in charge of the laboratory of Customs and Excise, Ottawa, is retiring on pension.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.

Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£29—£31 per ton according to quantity.
Carbon Black	7d.—7½d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	£56—£60 per ton according to quantity, drums extra.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	5d.—7d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	44s. 9d. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb. dearer.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton. Fair demand.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. ,, 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per ga[illegible]% O.P. Market dull.
Solvent	5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£46 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d. per lb. Quiet.
Crude 60's	1s. 9d.—1s. 11d. per gall., according to district. Still quiet.
Acid Cresylic, 97/99	2s 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—1s. 11d. per gall. Quiet.
Dark	1s. 9d. per gall. Quiet.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	8d.—9d. per gall. Quiet.
Unstrained	7d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d. per gall.
Pure	1s. 8d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	8½d. per gall. Not much business.
Middle Oil Heavy Oil Standard Specification	5½d.—6d. per gall in Lancashire 6d.—7d. per gall. in Yorkshire.

Naphtha—	
Solvent 90/160	1s.—1s. 3d. per gall. according to district. Market flat.
Solvent 90/190	1s.—1s. 1½d. per gall. Demand maintained.
Naphthalene Crude—	
Drained Creosote Salts	£4—£6. Quiet.
Whizzed or hot pressed	£9 per ton. Little business.
Naphthalene—	
Crystals and Flaked	£13—£16 per ton in Yorkshire and London respectively.
Pitch, medium soft	55s.—60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160	18s.—18s. 6d. per gall. demand.
Heavy	12s.—12s. 6d. Little busine

INTERMEDIATES AND DYES

In the following list of Intermediates delivered include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb.
Acid H.	4s. per lb 100% basis d
Acid Naphthionic	2s. 4d. per lb. 100% ba
Acid Neville and Winther	5s. 8d. per lb. 100% basis d
Acid Salicylic, tech.	1s. 1d. per lb. Improved
Acid Sulphanilic	9½d. per lb. 100% basis
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8¼d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4½d. per lb. Demand steady.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Deman moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Deman moderate.
Dichloraniline	2s. 3d.—2s. 11d. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s. 6d. per lb. d/d., pac ed extra, returnable.
Dimethylaniline	2s. 3d. per lb. d/d. Drums
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at w
66/68° C.	1s. 2d. per lb. naked at wo
Diphenylamine	2s. 10d. per lb. d/d.
Monochlorbenzol	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	4s. 9d. per lb. d/d.
p-Nitraniline	2s. 3½d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at work
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	10½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis
m-Phenylene Diamine	4s. per lb. d/d.
p-Phenylene Diamine	10s. 3d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 3d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 3d. per lb. naked at works.
m-Toluylene Diamine	4s. 3d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£45 per ton.
Acid, Acetyl Salicylic	3s. 2d.—3s. 4d. per lb., according to quantity. Good demand. Price firm.

Acid Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 5½d.—1s. 6d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	6s. 9d. lb. Resublimed quality 8s. per lb. Market firm; increasing demand.
Acid, Salicylic	1s. 6d.—1s. 9d. per lb. Market unsettled and difficult.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1¼d. per lb. less 5%.
...dol	9s. per lb. d/d.
...anilide	2s. 1d.—2s. 3d. per lb. for quantity. Demand slow.
...pyrin	13s. 3d. per lb. Neglected. Stocks low.
...n. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
...a. Carbonate B.P.	£37 per ton.
...b Sulphate	12s. 6d. per oz. for English make.
...o.	15s.—15s. 6d. per lb. Quiet market.
...phthol	5s. 3d. per lb. Small inquiry.
...Salts	Prices according to quantity.
Carbonate	12s. 9d.—14s. 9d. per lb.
" Citrate	11s. 4d.—13s. 4d. "
" Salicylate	10s. 2d.—12s. 2d. "
" Subnitrate	10s. 9d.—12s. 9d. "
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
...romides	Unsettled. Spot supplies short. Raw materials dearer. Market very firm and advancing.
Ammonium	1s. 3d.—1s. 6d. per lb.
Potassium	1s. 1d.—1s. 4d. per lb.
Sodium	1s. 2d.—1s. 5d. per lb.
...lcium Lactate	Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
...oral Hydrate	4s.—4s. 3d. per lb. Very firm and scarce.
...loroform	2s. per lb. for cwt. lots. Very steady.
...ote Carbonate	6s. 6d. per lb. Little demand.
...ldehyde	£52 per ton, ex works. English make in casks.
...rophosphates—	Fair business passing.
...cium, soluble and ...itrate free	7s. per lb.
...on	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. "
...uaiacol Carbonate	10s. 6d.—11s. 3d. per lb.
Hexamine	3s. 6d. per lb. for English make. Market steady.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	English make offered, 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. "
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£25 per ton, less 2½%. Price reduced.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	62s. 6d. per lb. Market rising rapidly.
Synthetic	26s.—35s. per lb., according to quantity. English make. Strong demand.
Mercurials	Market flat.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. "
White precip.	4s. 7d.—4s. 8d. "
Calomel	3s. 11d.—4s. "
Methyl Salicylate	1s. 10d.—2s. 1d. per lb. Keen competition.
Methyl Sulphonal	26s. per lb.
Metol	11s. per lb. British make.
Paraformaldehyde	2s. 10½d.—3s. per lb. Not very active.
Paraldehyde	1s. 5d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin	6s. per lb. Price and demand steady.
Phenazone	7s. 6d. per lb. A shade firmer. Forward prices higher.
Phenolphthalein	6s. 6d. per lb. Ample supplies.
Potass. Bitartrate— 99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues heavy.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate	7½d. per lb.
Quinine Sulphate	2s. 3d. per oz. in 100 oz. tins. Very heavy demand.
Resorcin	5s. 2d. per lb.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d. per lb.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 6d. per lb. Ample supplies. B.P. quality available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite— Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Steady market, good demand.
Sod. Salicylate	Market more active. Powder 2s. 3d.—2s. 5d. per lb. Crystal at 2s. 5d.—2s. 7d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide— Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	15s. 6d. per lb. Easier.
Thymol	19s. 6d. per lb. nominal. Very scarce indeed. Still rising.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubopine	15s. 3d. ,,	
Amyl Acetate	2s. 9d. per lb.	
Amyl Butyrate	6s. 9d. ,,	
Amyl Salicylate	3s. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 10½d. ,,	
Benzyl Alcohol free from Chlorine	2s. 10½d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate	3s. 6d. ,,	
Cinnamic Aldehyde Natural	16s. ,,	
Coumarin	19s. 6d. ,,	Cheaper.
Citronellol	17s. ,,	
Citral	9s. ,,	
Ethyl Cinnamate	13s. 6d. ,,	
Ethyl Phthalate	3s. 3d. ,,	
Eugenol	10s. 6d. ,,	Cheaper.
Geraniol (Palmarosa)	35s. ,,	
Geraniol	11s.—18s. 6d. per lb.	
Heliotropine	7s. 9d. ,,	
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose	26s. ,,	
Linalyl Acetate	26s. ,,	
Methyl Anthranilate	9s. 6d. ,,	
Methyl Benzoate	6s. ,,	
Musk Ambrette	45s. ,,	
Musk Xylol	14s. ,,	
Nerolin	4s. 9d. ,,	
Phenyl Ethyl Acetate	15s. ,,	
Phenyl Ethyl Alcohol	16s. ,,	
Rhodinol	57s. 6d. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. 4d. ,,	
Vanillin	26s. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	
Aniso Oil	2s. 6d. per lb.	Cheaper.
Bergamot Oil	17s. 6d. per lb.	Again cheaper.
Bourbon Geranium Oil	36s. 6d. ,,	
Camphor Oil	75s. per cwt.	
Cananga Oil Java	10s. 6d. per lb.	
Cinnamon Oil, Leaf	6½d. per oz.	
Cassia Oil, 80/85%	8s. 9d. per lb.	
Citronella Oil—Java 85/90%	5s. 8d. per lb.	
Citronella Oil—Ceylon	3s. 7d. per lb.	
Clove Oil	8s. per lb.	Firmer.
Eucalyptus Oil 70/75%	2s. 1d. per lb.	
Lavender Oil—French 38/40% Esters	30s. per lb.	Very firm. Higher price expected owing to bad crops.
Lemon Oil	3s. per lb.	
Lemongrass Oil	3d. per oz.	
Orange Oil, Sweet	13s. per lb.	
Otto of Rose Oil—Bulgarian	37s. 6d. per oz.	Production below average.
Otto of Rose Oil—Anatolian	18s. per oz.	
Palma Rosa Oil	18s. per lb.	Cheaper.
Peppermint Oil—Wayne County		Firm spot and forward.
Peppermint Oil—Japanese	16s. per lb. nominal.	Market rising rapidly.
Petitgrain Oil	9s. 3d. per lb.	
Sandal Wood Oil—Mysore	26s. 6d. per lb.	
Sandal Wood Oil—Australian	21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before October 28th they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on September 11th.

I.—Applications

Broadley. Drying, grinding, mixing, etc. machine 18,930. Aug. 9.

Carlino. Means of pulverising and separating cereals, minerals, etc. 18,921. Aug. 9.

Loew. Filters. 18,711. Aug. 6.

Sterling. Apparatus for treating vapours from plants employing a gaseous heating medium. 18,689. Aug. 6.

I.—Complete Specifications Accepted

15,563 (1923). Dredge. Heating ovens for baking, roasting, drying and like purposes. (219,778.)

16,387 (1923). Fisher, Humphries and Co., Ltd., and Hutchinson. Rotary drying-cylinders. (219,787.)

16,861 (1923). Soderlund, Boberg, Testrup and Techno-Chemical Laboratories, Ltd. Drying processes and apparatus. (219,792.)

II.—Applications

Brooke. Gas-purifiers. 18,756. Aug. 7.

Bunge. Coke-oven installations. 18,610. Aug. 5. (Ger., 6.8.23.)

Jackson (Koppers Co.). Coking-retort ovens. 18,748. Aug. 6.

Kohlenscheidungs Ges. Distilling bituminous substances at a low temperature. 18,716. Aug. 6. (Ger., 24.11.23.)

Minerals Separation, Ltd., and Wood. Manufacture of fuel briquettes. 18,750. Aug. 6.

Soc. l'Air Liquide. Purification of coke-oven gases etc. 18,793. Aug. 7. (Fr., 17.11.23.)

II.—Complete Specifications Accepted

2892 (1923). Moore and Hunter. Apparatus for manufacture of combustible gas or gases. (219,471.)

11,602 (1923). Becker. Coking retort ovens. (211,817.)

11,633 (1923). White (Aero Pulverizer Co.). Methods and apparatus for pulverizing coal or other fuel and feeding it for combustion. (219,739.)

14,871 (1923). Habets. Method of improving coke as fuel for stoves and the like. (219,772.)

17,768 (1923). Humphreys and Glasgow, Ltd. (Gartley and Evans). Means for controlling or operating water-gas apparatus. (219,805.)

19,941 (1923). Pehrson. Method of and apparatus for the distillation or gasification of combustible materials. (202,625.)

30,169 (1923). Moore and Hunter. Method of and apparatus for manufacturing combustible gas or gases. (219,865.)

30,170 (1923). Moore and Hunter. Method of and apparatus for manufacturing combustible gas or gases. (219,866.)

III.—Application

Kohlenscheidungs Ges. Refining tar. 18,717. Aug. 6. (Ger., 28.11.23.)

IV.—Complete Specifications Accepted

23,348 (1923). Johnson (Badische Anilin und Soda Fabrik). Manufacture and production of vat colouring matters. (219,830.)

26,037 (1923). Soc. Anon. des Matières Colorantes et Produits Chimiques de Saint-Denis, Wahl and Lantz. Manufacture of naphthoquinone derivatives. (206,142.)

27,069 (1923). Imray (Soc. of Chemical Industry in Basle). Manufacture of a new azo dyestuff. (219,846.)

V.—Complete Specifications Accepted

20,406 (1923). Hondrich. Solutions for waterproofing porous materials. (219,818.)

6100 (1924). Marks (Naamlooze Vennootschap Hollandsche Kunstzijde Industrie). Process for preparing artificial silk. (219,898.)

VI.—Applications

Mycock. Apparatus for treating fabrics with liquor. 18,936. Aug. 9.

Toggin. Dyeing, scouring, etc. yarns. 18,937. Aug. 9.

VI.—Complete Specifications Accepted

13,809 (1923). Lord. Dyeing, washing, scouring, bleaching or impregnating of skeins or hanks of yarn. (219,768.)

14,377 (1923). Hohenloher Seifenfabriken Akt.-Ges. Process of washing and cleaning fabrics and other materials. (198,681.)

VII.—Applications

Llewellyn, Spence and Spence and Sons. Treatment of aluminous materials. 18,656. Aug. 6.

Sheffield. Manufacture of salt. 18,544. Aug. 5.

VII.—Complete Specifications Accepted

8956 (1923). Verein für Chemische und Metallurgische Produktion. Processes for the manufacture and production of pure sulphuric acid. (195,960.)

20,132 (1923). Jucker und Co. Chemische Fabrik. Recovering chromic salts from residues containing chrome. (201,942.)

VIII.—Applications

Ekert. Process of producing glass and porcelain ware. 18,601. Aug. 5.

Feldenheimer. Process for improving colour etc. of clays. 18,837, 18,838. Aug. 7.

IX.—Complete Specification Accepted

20,406 (1923). Hendrich. *See* V.

X.—Applications

Carline. 18,921. *See* I.

Ekert. Alloys for bearings etc. 18,602. Aug. 5.

Harris. Treatment of molten metals or alloys for separation or purification purposes. 18,919. Aug. 8.

Kratky. Cerium alloy. 18,966. Aug. 9.

Penner. Aluminium solder. 18,823. Aug. 7.

X.—Complete Specifications Accepted

5885 (1923). Marks (American Smelting and Refining Co.). Process of producing metallic tin. (219,719.)

12,091 (1923). Chemische Fabrik Griesheim-Elektron. Method of casting magnesium or magnesium alloys. (219,753.)

XI.—Application

Hartman. Ozone generator. 18,701. Aug. 6.

XI.—Complete Specifications Accepted

16,315 (1923). Fullers United Electric Works, Ltd., and Fuller. Galvanic batteries. (219,785.)

28,853 (1923). Reinhardt et Cie. Diaphragm for electrolytic processes. (207,801.)

XIII.—Applications

Campbell and Lloyd. Manufacture of white lead. 18,914. Aug. 8.

Goldschmidt Akt.-Ges. Production of paints. 18,749. Aug. 6. (Ger., 9.8.23.)

Leadbeater and Towler. Manufacture of printing etc. inks. 18,942. Aug. 9.

XIV.—Applications

Bigger and Falls. Rubber substitutes. 18,977. Aug. 9.

Goldschmidt Akt.-Ges. Process of improving rubber. 18,802. Aug. 7. (Ger., 9.8.23.)

Naugatuck Chemical Co. Process for treating rubber. 18,815. Aug. 7. (U.S., 8.8.23.)

Naugatuck Chemical Co. Process for retarding deterioration of rubber etc. 18,825. Aug. 7. (U.S., 8.8.23.)

Wills. Vulcanisation of rubber. 18,794. Aug. 7.

XIV.—Complete Specifications Accepted

11,249 (1923). Russell. Vulcanisation of rubber. (196,924.)

11,962 (1923). Warren. Method of and means for producing metallic surfaces on rubber compounds containing sulphur. (219,749.)

27,765 (1923). General Rubber Co. Processes and apparatus for concentrating rubber latex and similar materials. (218,965.)

27,992 (1923). Luff and North British Rubber Co., Ltd. Method for the production of decorative or other effects in vulcanised rubber. (219,853.)

XVI.—Application

Dosch and Smith. 18,615. *See* XIXB.

XVII.—Complete Specification Accepted

24,920 (1923). Hamburger and Kaesz. *See* XVIII.

XVIII.—Complete Specification Accepted

24,920 (1923). Hamburger and Kaesz. Process for the preliminary treatment of molasses for use in the manufacture of yeast. (209,034.)

XIXA.—Application

Carline. 18,921. *See* I.

XIXB.—Applications

Bock and Spearing. Apparatus for softening water. 18,969. Aug. 9.

Dosch and Smith. Nicotine substitutes for insecticides. 18,615. Aug. 5. (Canada, 8.2.24.)

Wayne Tank and Pump Co. Water-softening apparatus. 18,616. Aug. 5. (U.S., 4.4.23.)

XX.—Applications

Ransford (Cassella und Co.). Manufacture of 4-amino-3-oxybenzene-1-arsinic acids. 18,739. Aug. 6.

Ransford. Manufacture of arsinic acids of the aromatic series. 18,740. Aug. 6.

XX.—Complete Specification Accepted

17,390 (1923). Farbwerke vorm. Meister, Lucius und Brüning. Manufacture of carboxylic-acid chlorides. (200,511.)

XXI.—Application

Leirg, Pokorny and Ross. Colour photography. 18,907. Aug. 8. (Austria, 9.8.23.)

XXI.—Complete Specification Accepted

25,465 (1923). Schapovaloff. Photographic printing-process for the production of coloured images. (205,501.)

XXII.—Application

Unger. Safety explosives. 18,715. Aug. 6. (Sweden, 18.8.23.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department, and quoting the specific reference number:—*Belgium*: Medical and pharmaceutical supplies, Industrial chemical products (189); *Belgian Congo*: Iron and steel, Hollow-ware (A.X./1239); *Beyrout* (*Syria*): Silk yarns, skins (207); *British India*: Portland cement, metal (Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); Iron and steel (Directors of the Madras and S. Mahratta Railway Co., Ltd., 25, Buckingham Palace Road, Westminster, London, S.W. 1); *British West Indies*: Silk (185); *Denmark*: Pig iron, steel (192); *Egypt*: Leather (B.X./1142); *France*: Copper sulphate (193); *Italy*: Hides, metal (197); *Jugoslavia*: Tin (198); *Mexico*: Cement (213); *Nether-*

lands: Hides (202); *New Zealand*: Hardware (188); *Sweden*: Tinplate (206); *United States*: Rubber (209); Leather (B.X./1156); *Uruguay*: Iron (A.X./1237); Paper (B.X./1161).

Dystuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during July has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 515, of which 316 were from merchants or importers. To these should be added 35 cases outstanding on July 1, making a total for the month of 550. These were dealt with as follows: —Granted, 363 (of which 330 were dealt with within seven days of receipt); Referred to British makers of similar products, 135 (of which 106 were dealt with within seven days of receipt); Referred to Reparation Supplies available, 40 (all dealt with within two days of receipt); Outstanding on July 31, 1924, 12. Of the total of 550 applications received, 476 or 87 per cent. were dealt with within seven days of receipt.

Nickel in South Africa

According to the *South African Journal of Industries* a sedimentary bed has been discovered carrying a nickel ore of up to 25 per cent. The bed is up to three feet in thickness, and though not yet developed appears to be permanent in character. The ore seems to occur in the form of an entirely new mineral —a magnetic iron-nickel oxide. Sulphur is absent, and the mineral reduces easily, running down into a metallic button carrying about 54 per cent. nickel. If the deposits open up well, this mine should prove valuable.

Chemists and Students of Chemistry in Germany

The number of chemists employed by industrial concerns in Germany increased from 3089 in 1913 to 3781 in 1923, and 4010 in 1924. The number of students is 6·5 per cent. less in 1924 than in 1923.

Canadian Trade Notes

The E.B. Eddy Co., Hull, Que., is expending $2,000,000 in increasing the capacity of newsprint plant and reconstruction of sulphite pulp mill. The newsprint paper output will be increased from 50 to 100 tons per diem.

Arrangements are being made for the erection of a sugar beet factory in the Red River Valley, Manitoba. It will have a capacity of 18,000 tons of sugar. The beets will be obtained from 6000–8000 acres of land. H. C. Miller, of Denver, Col., one of the leading consulting engineers of U.S.A., who is connected with a well-known engineering firm specializing in beet sugar plants, has made a careful survey of proposed locations.

Australian Union of Chemists

According to the *Chemical, Mining and Engineering Review*, the Munitions Supply Chemists and Physicists' Association has applied for registration under the Commonwealth Arbitration Act. Membership is restricted to persons (1) employed under the munitions supply board as chemists, metallurgists or physicists, or in any administrative post, (2) possessing at least the British degree of B.Sc. in chemistry or physics, and association of the Australian Chemical Institute or its equivalent.

PUBLICATIONS RECEIVED

The Theory and Application of Colloidal Behaviour, edited by R. H. Bogue. Vol. I. The Theory of Colloidal Behaviour. Pp. xxxi+444. Vol. II. The Application of Colloidal Behaviour. Pp. xxvii+445—829. First edition. New York and London: McGraw-Hill Book Company, Inc., 1924. Price £2.

The National Physical Laboratory, Collected Researches. Vol. XVII, 1922. Pp. iv+353. H.M. Stationery Office, 1922. Price 17s. 6d.

Report on the Finance, Industry and Commerce of the United States of America, dated April, 1924. By J. J. Broderick. Department of Overseas Trade. Pp. 136. London: H.M. Stationery Office, 1924. Price 3s. 6d.

Report on the Financial and Industrial Situation of Austria, revised to July, 1924. By O. S. Phillpotts, O.B.E., Department of Overseas Trade. Pp. 51. H.M. Stationery Office, 1924. Price 1s. 6d.

Standard Catalogue of Scientific Apparatus, 1923. Vol. I. Chemistry. Pp. xvi+954. London: Baird and Tatlock (London), Ltd., 1924.

Publications of the United States Geological Survey, Department of the Interior. Washington: Government Printing Office, 1924:—

Bauxite and Aluminium in 1923. By J. M. H. Mineral Resources of the United States, 1923, Part I. Pp. 23—45. No. I:3.

Fluospar and Cryolite in 1923. By H. W. Davis. Mineral Resources of the United States, 1923, Part II. Pp. 27—40. No. II:4.

Magnesium and its Compounds in 1923. By J. M. Hill and G. F. Loughlin. No. II:2. Mineral Resources of the United States, 1923. Part II. Pp. 7—21.

Mineral Resources of the United States in 1923, (Preliminary Summary), introduction by F. J. Katz. Statistics assembled by M. B. Clark. Pp. 130 A.

Strontium in 1923. By G. W. Stose. Mineral Resources of the United States, 1923, Part II. Pp. 23—26. No. II:3.

Pflanzenuntersuchungen:—I. Die Methoden der Pfropfung bei Pflanzen. By Hans Winkler. II. Methoden zum Studium der Regeneration der Pflanzen. By Bohumil Nemec. Handbuch der biologischen Arbeitsmethoden, edited by Prof. E. Abderhalden. Vol. 2. Part 5. Pp. xxvii+765—856. Berlin: Urban and Schwarzenberg, 1924. Price Gm. 4·20.

The Properties of Medium Carbon Steel with High Manganese Content. R. D. Report No. 61. Research Department, Woolwich, 1923. Pp. 13. H.M. Stationery Office, 1924. Price 1s. 6d.

The India-Rubber Journal. The 40th Year Souvenir Number, 1884—1924. Pp. 161—443. Vol. LXVIII. No. 5. London: Maclaren and Sons, Ltd., 1924. Price 2s.

Statistical Information compiled by Sperling and Co. Pp. 46. London and New York, 1924.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

VOL. 43 NEW SERIES — LONDON, AUGUST 29, 1924 — No. 35

EDITORIAL

IT has become so much a habit to inveigh vaguely against the causes of atmospheric pollution that one turns with a certain feeling of relief to Dr. Owens' sober statement on the automatic measurement of impurity in air. Dr. Owens records some curious facts. It could have been prophesied that he would find, almost invariably, a maximum of smoky haze on Mondays, with the revival of industrial activity after the weekend, but it is strange that at Kew, where the haze is distributed with uniformity over the week, there should be a maximum on Wednesdays, just as at Westminster Bridge, and at Blackburn. Again, in the Potteries, there is a maximum on Mondays, with a steady decrease until Sunday. For the cause, one must examine the industries of the district. Our readers, safe on holiday in Folkestone or Abernethy, Looe or Elgin, will feel but remote interest in the smoke problem, though only too ready to express opinions, hot and strong, about the rain. Yet it has been suggested that rain is formed by the condensation of water vapour on smoke particles suspended in the air. Dr. Owens remarks that air pollution will not be prevented until the public demands purer air. People have, however, become accustomed to smoky skies and this is the cause of the psychological problem that troubles Dr. Owens. If he can convince the public that there is a definite connexion between smoke and rain, he will not lack support.

The article which we publish on the state of the resistance-glassware industry deserves close attention. Apparently, British-made laboratory glassware is satisfactory in every respect and the price is less than that of similar wares made abroad, but we are told that British makers are gradually being squeezed out of the market. The reason for this regrettable situation is that the cost of British glassware of first-class quality is compared with that of inferior products imported from the Continent. As a result the inferior and cheaper article is purchased in preference. It would thus appear that first-class laboratory ware is not always wanted and that there are laboratories content with inaccurately graduated flasks and pipettes, with non-resistant beakers and containers, in short, material which cannot yield accurate results. If this conclusion is correct—and no other can be reached, judging from the article, it is indeed surprising. We are accustomed to think of the extreme care with which chemists work and the close scrutiny that they apply to every possible source of error. But, it seems that untrustworthy glassware is being used, since the British-made, accurate ware is being replaced by it. We cannot think that chemists will accept the implication and we hope that our readers will send us their views for publication.

The Soda Deposits of Lake Magadi are described in this issue. Their recent history is of interest: the deposits have been worked for several years by an enterprising company backed by strong financiers: nevertheless, the results have been disappointing to the shareholders. Messrs. Brunner, Mond and Co., Ltd., who are now acquiring these deposits, will be able to bring considerable technical experience and a world-wide organisation with them The importance of such natural deposits may be expected to increase every year. Not only soda, but all mineral deposits become increasingly valuable not so much because of the reduction in supply, but because of the increased demand resulting from a more numerous and more highly-civilised population in the world. We may see the same tendency in coal, in metallic ores, in clays and rocks. The world requires more of everything, and many deposits which at the present time cannot be worked at a profit will in twenty or fifty years be valuable properties. Some day we shall watch the erection of a huge evaporating plant for the conversion of the Dead Sea into various crystals of soda and potash salts: some day the London clay will be used as a source of aluminium; some day granite will be too valuable to use as a building stone. We may see the beginning of this tendency; our grandchildren will see it clearly.

THE AUTOMATIC MEASUREMENT OF ATMOSPHERIC POLLUTION *

By Dr. JOHN S. OWENS

The measurement of the degree of pollution of city air by smoke is one of the essential steps towards improvement, which usually follows a desire to better conditions realised to be bad. Thus whatever technical means are available for reducing the degree of pollution of the air they will not be put into operation—unless where a definite economy can be shown by their use until there is a demand on the part of the public for purer air. Such a demand would follow a full realisation of the extent to which our cities now suffer from this evil, and of its injurious effects, especially in cutting off sunshine.

The author has given much attention to the provision of means for measuring the degree of pollution of the air, partly because he felt that lying behind the technical problem was the psychological one hinted at above. Up till 1912 there were no reliable data on the degree of pollution of the air of different cities. Thus few cities would acknowledge that their air was badly polluted; they usually pointed towards some other city as being worse. At the International Conference on Smoke Abatement in London in 1912 the author put forward a resolution to the effect that little progress would be made in the prevention or reduction of smoke until some accurate data could be obtained as to its quantity, and suggested the appointment of a Committee to investigate this. A Committee was appointed at the meeting and from this has developed the present organisation termed "The Advisory Committee on Atmospheric Pollution" operating under the Air Ministry, collecting data showing the relative purity of the air of different cities, and generally investigating the subject.

While the more simple method of measuring deposit from the air was adopted as being immediately available it was realised that deposit told only a part of the story, since there remained behind the suspended impurity in the air. A method of measuring this was therefore worked out by the author, and in 1916 a single record instrument was devised in which two litres of air were filtered through a disc of filter paper, ¾ in. diameter, and the resulting discoloured spots obtained compared by means of a calibrated scale of shades. In 1917-18 this method was further developed into the automatic recording apparatus which is the subject of this paper. These instruments are fully described in the Third and Fourth Reports of the Committee.

The automatic recorder is primarily designed for measurement of smoke pollution in city air. The principle is similar to the single record instrument referred to, but in this case a large circular disc of thick filter paper, divided into 24 hours, is caused to revolve by a clock, while at intervals a small disc of ⅜ in. diameter is isolated near the edge of the filter paper by the pressure of a perforated plug, and through this disc two litres of air are automatically aspirated, leaving behind on the paper the impurities filtered out, which, since in cities they are mainly due to smoke, are practically black.

The interpretation of the results calls for a special scale of shades; such was made and numbered 1, 2, 3, 4, 6, 8, 10, 12, 15, 20. The scale was made by laying on successive washes of a standard lamp-black suspension on white paper, the number of washes being indicated by the number of the shade. Thus the scale became a linear one of quantity of impurity: Shade 2 indicating twice as much as Shade 1, and so on. Small perforations in the middle of each permitted the record to be examined surrounded by the shade to be compared with it. The values of the different numbers were obtained experimentally by weighing large discs through which known volumes of city air had been passed. In this way a numerical value could be given to the records in milligrammes of impurity per cubic metre, and having obtained a numerical value the comparison of different places and times became a simple matter.

Having obtained a number of records from such an instrument over a long period, say one year, the numerical values, either in shade numbers or milligrammes per cubic metre, are tabulated, and in this tabulation the days are divided into three groups—ordinary weekdays, Saturdays and Sundays. This is done because the conditions governing smoke production remain much the same between Monday and Friday, whereas on Saturdays factories usually work for half a day, while on Sunday they are mostly shut down. From such tables averages for a large number of days are prepared, so that curves may be plotted showing the average distribution of impurity over the 24 hours for each of these groups, and for different places, and a study of such curves brings out the relation between smoke pollution and human activities, often pointing to the chief sources.

In many cities where large quantities of smoke are produced, thick smoke hazes are not unusual; these do not arise from abnormal smoke production at the time, but from failure of the natural processes by which the normal smoke is removed as produced. Such failures usually occur during anti-cyclonic weather with very light, indefinite winds and an inversion of the temperature gradient, which prevents the escape upwards of the smoke.

In plotting curves obtained from the automatic recorder it was, therefore, found advisable to divide the days into two groups:—

Those in which, owing to some abnormal atmospheric conditions, the smoke haze was at some time very thick; designated "Days of much smoke haze" and referred to in what follows as "Z days," and

Those in which the smoke haze was not at any time abnormally thick; designated "Days of little smoke haze" or "ordinary" days.

This division is necessarily arbitrary, and the limit dividing the two was fixed at days having a maximum impurity at any time up to or over Shade 4—equivalent to 1·28 milligrammes per cubic metre.

The division adopted is therefore into days symbolised by:—"Z" or days of much smoke haze, and

Days of little smoke haze (not ranking as "Z").

* Paper read before Section A. (Mathematics and Physics) of the British Association at Toronto.

It is to be understood that variations in thickness or density of the smoke haze from day to day are usually determined more by atmospheric conditions than by changes in the rate of smoke production.

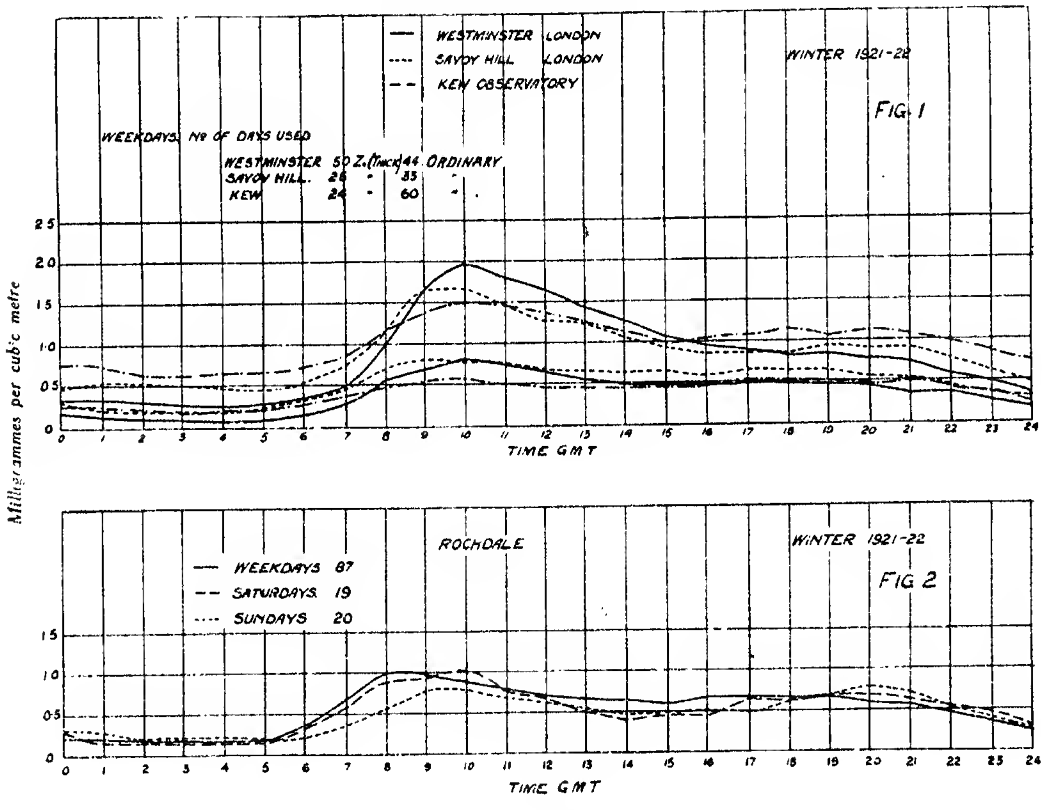
It will be of interest now to compare a few of these typical curves for different cities. It is evident that the distribution of quantity of impurity present in the air must depend upon the times and quantities of smoke emission. Thus industrial cities and residential cities would be expected to show considerable differences. Similarly the nature of the industry carried on must influence the result.

Curves are shown for London, as a mixed residential and manufacturing city, Rochdale, Blackburn, Glasgow and Stoke-on-Trent.

second but lower maximum, while at about 10 p.m. it rapidly falls away until about midnight again. This is quite typical of the London distribution. The Sunday curves are similar but the maximum is not reached in the forenoon until an hour or two later. There is no doubt that the rise between 6 and 7 a.m. starts from the lighting-up of fires, which make the greatest quantity of smoke soon after lighting. When fires are well established the smoke is reduced; therefore we find the quantity falling off in the afternoon, while the custom of having afternoon tea is probably responsible for the rise about 4 to 5 p.m. The average weekday maximum in winter reached about 2 milligrammes per cubic metre in Westminster, 1·3 at Savoy Hill, and 1·5 at Kew for Z

London

Suspended Impurity in the Air



The London curves of impurity are for Westminster, Savoy Hill and Kew Observatory, which is situated at Richmond, about eight miles to the west of the centre of the City.

The curve for weekdays only is shown as this illustrates the distribution sufficiently.

Referring to Fig. 1, the impurity is seen to be at its lowest between midnight and 6 a.m., after which it rises rapidly to a maximum between 9 and 10 a.m., then falls steadily until about 4 o'clock in the afternoon, when there is a tendency to rise slightly to a

days, while for other days in Westminster and Savoy Hill the maximum averaged about 0·8, and Kew about 0·6 milligrammes per cubic metre. In the summer the quantity is reduced greatly, the maximum for Westminster being under 0·5 milligrammes per cubic metre.

In Fig. 2 the average for the winter impurity for each hour of the day is plotted for Rochdale, for winter days, and the curve is here shown to illustrate the similarity in the distribution with London. No separation of the Z days has been made here.

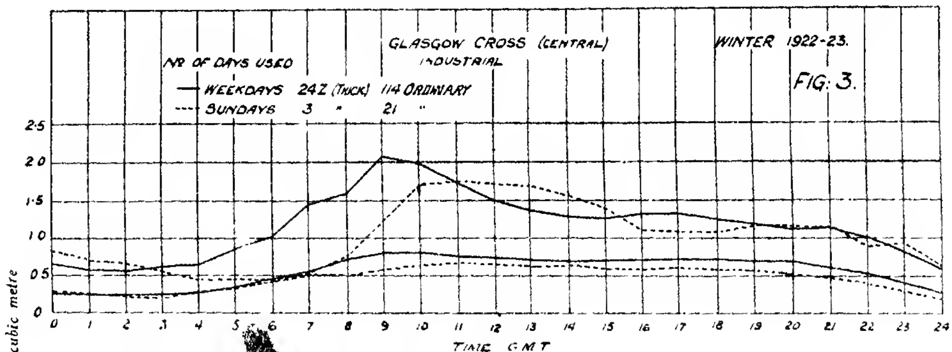
In Fig. 3 the curve for Glasgow Cross, an industrial district, is given for the winter 1922-23. The distribution over the 24 hours is very similar to that in London, except that the afternoon falling off for ordinary days is not so well marked, the impurity being maintained at a fairly high level until 8 to 9 p.m. The lag of one hour in the Sunday maximum is very well marked. Saturdays have not been separated from other weekdays here.

In all of these curves a large number of days have been averaged so as to get a curve fairly representative of the general distribution.

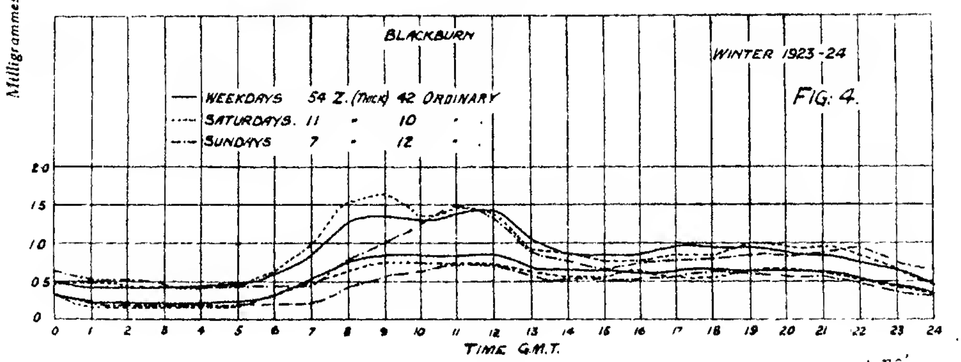
Curves for Blackburn are shown as they exhibit some departure from the type above referred to. These are prepared from records of 269 days of the year 1923-24, 136 being winter days—72 of which are ranked as Z, in the sense already defined. The curves themselves are somewhat smoother, indicatin steadier conditions. The distribution, however, h some important peculiarities of its own: for exampl the rapid rise of impurity in the morning commence in the summer about 4 a.m., and reaches its maximu on weekdays and Saturdays at 7 a.m., while o. Sundays the maximum is not reached until 10 a.n. Thus it would seem that the people of Blackburn are early risers on weekdays but take a long spell o Sunday mornings. Again, in the weekday an Saturday curves for both summer and winter there is a second maximum between 10 and 12 in the forenoon. This is particularly well marked in the winter curves (Fig. 4), where the second weekday maximum occurs at 12 o'clock on Z and ordinary days, and this is higher than the first maximum which occurs at 8 a.m. In both Z and ordinary weekdays the second maxi-

Glasgow

Suspended Impurity in the Air.



Blackburn



Referring to the curves in Fig. 4, the hourly distribution is broadly similar to that found in other cities, such as Glasgow and London. There is the same rapid increase in impurity rising to a maximum in the forenoon. There is then a gradual tendency to fall, followed by a subsequent rise to a second but lower maximum late in the afternoon.

The summer curve, not shown, indicates a uniformly lower impurity than the winter and the mum is higher than the first, and there is a four-hour interval between them. It would seem, therefore, that in Blackburn there are two main sources of smoke which make their maxima at different times. We get a clue to the position by examining the Sunday curves, which show no evidence of a double maximum in the forenoon. One is therefore inclined to conclude that the first maximum is due to industrial or factory furnaces and the second to dom... fires.

In support of this is the fact that while in the winter the second maximum is higher than the first for weekdays, in the summer the first is higher than the second. This fits in well with the theory that the second maximum is due to domestic smoke.

Another feature which is noticeable in the Blackburn curves is that the minimum impurity is not found until well after midnight, but this has been observed in other cities.

The Sunday curves fall in all cases below those for weekdays or Saturdays, indicating a greater purity of the air on Sundays due to suspension of factories. It is somewhat remarkable, however, that the curves for weekdays, Saturdays and Sundays lie very close together after the second maximum in the forenoon has been passed; the greatest difference in all cases is in the forenoon. This is particularly well marked in the Z winter days with thick haze.

The relation between the total smoke on Sundays and on weekdays is 2000 to 3077. This is based on the ordinary winter days, not ranking as Z, and if the Sunday smoke be assumed to be domestic while the weekday is domestic plus factory, the ratio of factory to domestic smoke becomes 1 : 1·85.

Stoke-on-Trent.

Stoke-on-Trent differs from the other cities in the nature of the industry carried on, which is mainly pottery; hence it is to be expected that the records would show marked peculiarities.

From Stoke-on-Trent there are records for a total of 222 days. Included in the records are 126 winter days, 82 of which were ranked as Z. Thus of the winter days recorded 65 per cent. had thick smoke haze, or, roughly speaking, Stoke-on-Trent appears to suffer from thick smoke haze on two out of every three days. This is perhaps not to be wondered at, as to prevent smoke in the pottery industry is most difficult.

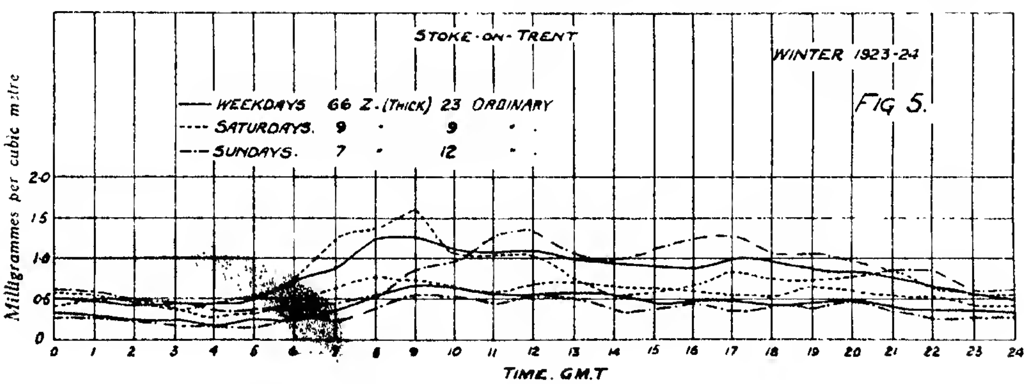
In Stoke the impurity begins to increase about 4 a.m. on weekdays and about 5 a.m. on Sundays. On summer weekdays and Saturdays a maximum is reached between 7 and 8 a.m., while in the winter on weekdays and Saturdays the maximum is somewhat later, between 8 and 9 a.m. On Sundays in the winter the maximum is delayed till about mid-day.

In both summer and winter the impurity is maintained at a high level during the whole afternoon, with remarkable oscillations, producing maxima at intervals during the whole afternoon. The impurity both in winter and summer does not decrease to any marked extent until about 10 p.m., and, as already mentioned, has its lowest value about 3 a.m.

Again, it is noticeable that the amount of impurity on ordinary winter Sundays is not markedly less than on weekdays, the ratio on Sundays and weekdays being 2022 to 2398. It is evident that here there are conditions which make it impossible to apply the method already used for ascertaining the relation between factory and domestic smoke as this method is based on a cessation of factory smoke on Sundays. The general inference one would draw from the curves for Stoke appears to be that the sources of smoke obey no general rule as to starting and stopping, and this is what might be expected when dealing with pottery kilns, the firing of which would not follow any strictly definite arrangement as to time, nor would the emission of smoke from such cease on Sundays.

There is definitely less smoke in the summer than in the winter as is shown by comparing the summer curves with those of the winter. This is doubtless due to the reduction in domestic smoke due to the warm weather.

A somewhat remarkable feature of all the Stoke curves for both summer and winter is the fact that in every case the Saturday forenoon maximum is the highest. This would be caused should there be a



Turning now to the curves in Fig. 5, there is a definite rise in each of the curves starting between 4 and 5 a.m. In each city, curves for which are shown, the minimum amount of impurity is about 3 a.m., while between midnight and about 6 a.m. the quantity does not rise much above the minimum referred to. This is therefore the part of the 24 hours which has the purest air.

custom of lighting kilns on Friday night or Saturday morning, and on enquiry this was found to be the case.

The incidence of atmospheric impurities on the different days of the week can be studied from these records, and it is found that there is a definite difference observable, already hinted at in the curves above referred to.

Table Showing for the Winter Months the Incidence of Thick Smoke Haze on the Different Days of the Week
That is, of days ranking as Z

	Stoke	M.O.S K.	West. Bdge.	Kew	Black-burn	Vic. St.
No. of Mondays ..	19	14	18	20	19	17
No. of Z days ..	16	7	9	3	11	9
Percentage of Z Days	84	50	50	15	58	53
No. of Tuesdays ..	18	15	18	14	19	19
No. of Z days ..	14	8	9	1	11	13
Percentage of Z days	78	53	50	7	58	69
No. of Wednesdays ..	17	15	19	16	20	14
No. of Z days ..	12	8	10	2	13	12
Percentage of Z days	71	53	53	12 5	65	86
No. of Thursdays ..	17	12	20	21	20	18
No. of Z days ..	12	5	8	4	8	14
Percentage of Z days	71	42	40	19	40	78
No. of Fridays ..	18	17	19	18	19	21
No. of Z days ..	12	9	8	3	11	10
Percentage of Z days	67	53	42	17	58	48
No. of Saturdays ..	18	15	19	21	19	14
No. of Z days ..	9	5	5	1	9	3
Percentage of Z days	50	33	26	5	47	21
No. of Sundays ..	19	12	19	21	19	15
No. of Z days ..	7	5	1	3	7	5
Percentage of Z days	37	42	5	14	37	33

In the accompanying table for six stations the total number of each of the days of the week available is given, that is the numbers of Mondays, Tuesdays, etc., for which there are records available, also the number of such days which rank as Z, as defined above, and finally a figure showing the percentage of Z days.

The results of the table have been plotted in Fig. 6, which brings out graphically the incidence of thick smoke haze.

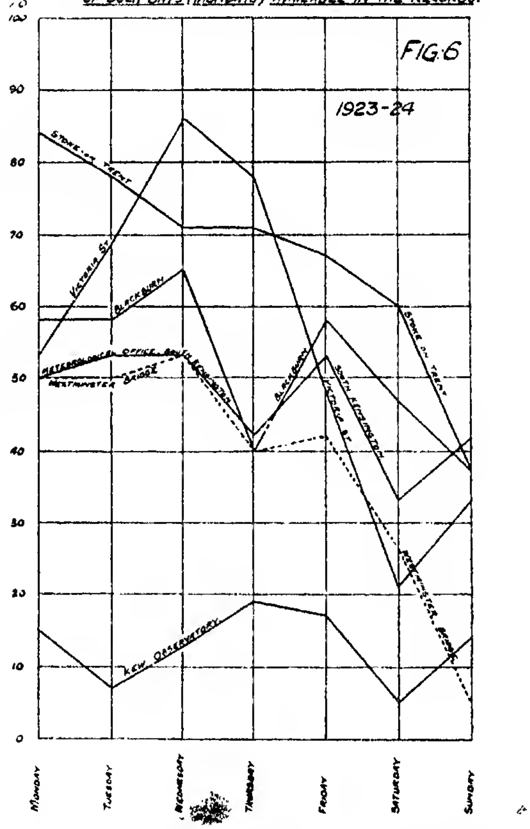
It is evident that there is a general tendency in practically all stations to a minimum of Z days towards the end of the week, and a maximum near the beginning. An exception to this rule is at Kew, which shows a slight maximum in favour of Thursday; in fact the days of thick haze are scattered comparatively uniformly over the week at Kew. In Victoria Street, Westminster, there is a maximum number of Z days on Wednesdays, with a minimum on Saturdays. At the Meteorological Office, South Kensington, there is a maximum on Wednesdays and Fridays, and a minimum on Saturdays. Westminster Bridge shows the same maximum on Wednesdays, but its minimum is on Sundays, the second lowest being on Saturdays. Stoke-on-Trent shows a maximum on Mondays and a minimum on Sundays, there being a practically steady fall during the week from Monday to the following Sunday. Blackburn has its maximum number of days with thick smoke haze on Wednesdays, and its minimum on Sundays.

Comparison Between Automatic Filter and Jet Dust Counter

The results obtained by the automatic recorder are based upon the discoloration of filter paper by the impurities filtered out of a measured volume of air. It was felt that, in cities the main source of impurity being smoke from burning coal, little error would be involved by taking this as black and basing the results on the degree of blackness of the paper.

Some test of the validity of this was advisable, however, and for this purpose it was compared with the results of another instrument devised by the author for enabling a microscopic count of the dust suspended in the air to be obtained, which count does not depend upon the colour of the particles. This latter instrument has been described fully elsewhere.* It depends for its action upon the projection of a narrow ribbon-shaped jet of air against a microscope cover glass at such a velocity that there is a marked fall of pressure, adiabatic expansion and cooling in the jet, resulting in condensation of the water present in the air upon the dust particles and upon the cover glass where the jet impinges. This results in the dust particles being projected against the cover glass by virtue of their greater density and their increase

CURVES SHOWING THE NUMBER OF THICK SMOKE HAZES (Z) FALLING ON A PARTICULAR DAY OF THE WEEK (SAY MONDAY) AS A PERCENTAGE OF THE TOTAL NUMBER OF SUCH DAYS (MONDAYS) AVAILABLE IN THE RECORDS.



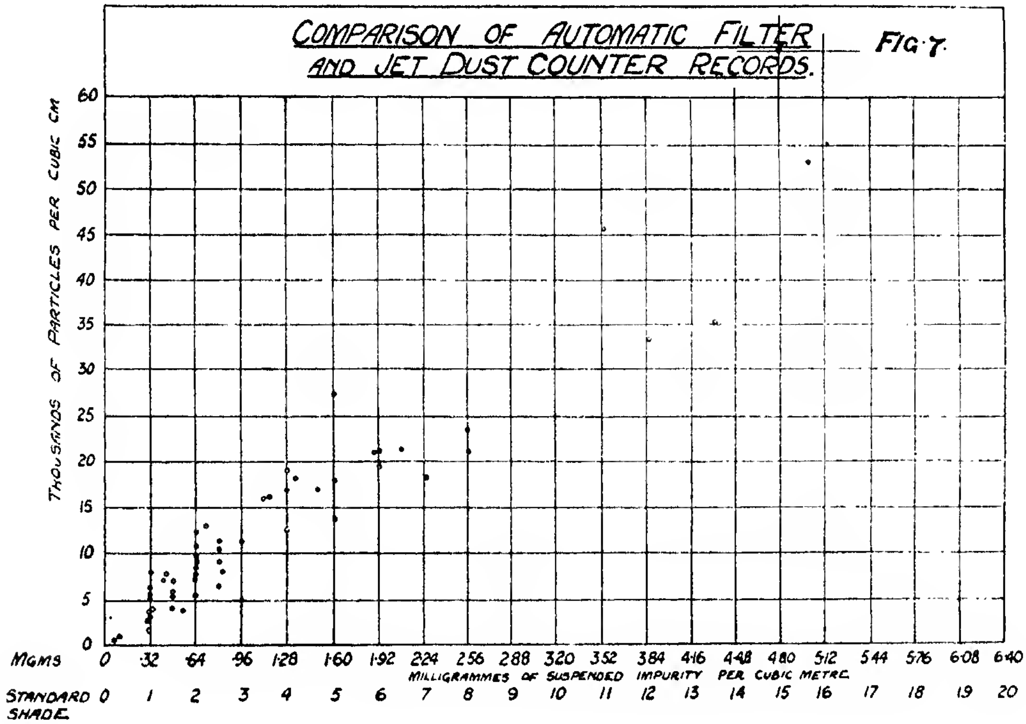
of mass due to condensed water. They adhere firmly to the glass, as the water evaporates immediately, leaving a linear track or record of dust. This track is examined microscopically, when the particles can be counted, measured and often identified.

In connection with the experiments being made for the Advisory Committee upon the obstruction of light by suspended matter in London a large number of simultaneous records have been taken both with

* Proc. Roy. Soc. A., Vol. 101, 1922.

the automatic recorder and the jet dust counter. The results of these records have been plotted in the form of a curve; the impurity, expressed in milligrammes per cubic metre, as obtained from the automatic recorder as abscissæ against the number of particles per cubic centimetre as determined by the jet dust counter. This is shown in Fig. 7.

gramme per cubic metre. It is not suggested here that this relationship will hold good for all types of dust as it obviously could not, nor is the automatic recorder, as originally designed, suitable for recording dust other than that produced by smoke. In particular cases of coloured smoke, such as that from refuse destructors, blast furnaces, metallurgical smoke and the like, the use of a suitably-colo ued filter paper would enable comparative records of impurity from such causes to be obtained.



Referring to the figure it will be seen that there is a reasonably constant relation between the number of particles per cubic centimetre, as determined by the dust counter, and the weight of impurity in milligrammes per cubic metre, as given by the automatic recorder. It is not to be expected that the relation would be absolutely constant as this would imply great constancy as to the size of particles at different times. While there is an evident tendency towards uniformity there is also definito departure from it, which is very evident during thick smoke haze. In such cases the average size of suspended particles is usually greater than during light haze, and this is probably due to the rapid accumulation of the smoke to form a thick haze which does not give time for settling out of the larger particles. Thus it is reasonable to expect that we shall find in rapidly formed smoke fogs larger particles than are normally present. The maximum diameter of smoke particles in the absence of thick smoke haze is about 1½ microns, while during thick smoke haze the maximum diameter rises to about 3 microns. Broadly speaking, however, the curve in Fig. 7 indicates that there is a constant relation such that in London approximately 10,000 particles per cubic centimetre correspond to 1 milli-

ELECTRICAL GAS PRODUCTION

Electrical gas production may prove a profitable proposition in those countries possessing abundant water power, by providing a use for the power output at night. Delicate temperature control is possible, and water-gas of a high degree of purity can be obtained. Fuels with high moisture and ash content could be utilised, the water being used for water-gas production and the hot ashes for raising steam. The purity of tho gas renders it very suitable for producing high temperatures, and for chemical reduction processes, as well as for its ordinary uses. With liquid fuels the advantages should be even more marked, largely on account of the temperature control, the cracking being thus regulated to facilitate fractionation of the products. In addition, the electrical apparatus has the advantage of long life.

THE SODA DEPOSITS OF LAKE MAGADI IN KENYA

The greater part of the World's supply of sodium carbonate is obtained by the chemical treatment of common salt, but in certain parts of the world there are natural deposits of sodium carbonate and bicarbonate which are worked. The deposit at Lake Magadi in Kenya Colony is the most notable, both as regards the extent of the deposit, and the purity of the material

In March, 1908, the Imperial Institute was consulted by the Colonial Office with reference to certain proposals then under consideration for the industrial development of the soda deposits of Lake Magadi, which lies in about the centre of the Rift Valley and not far from the border of Tanganyika Territory. The information available at the time was insufficient to show :—(1) whether the crust of soda on the surface of the lake was of uniform composition throughout, (2) the nature and extent of the underlying deposits on which the renewal of the supply of soda depended, and (3) whether there was any accumulation of residual impurities in the water present in the crust. It was decided that a further investigation should be directed to the valuation of the deposit, and this was undertaken by Mr. J. S. Coates, from whose report the following information has been extracted (*Bull. Imp. Inst.*, XXI., 3, 1923). The soda deposit covers the whole width of the trough for a length of 12 miles in the middle portion of the lake bed. Near the shore, the soda forms only a thin soft layer on the mud of the lake bottom, and is covered by a layer of liquor. At a distance of 200 yards from the shore, the soda crust had already a thickness of more than 6 feet. The crust was pierced by drilling in two places near the edge of the deposit and in neither case was any liquid substratum found, the soda lying in immediate contact with the mud of the lake bottom. The interstices and cavities, however, of the crystalline matter were filled with liquid. The density of the soda crust was estimated at about 76·4 lb. per cb. ft. Assuming a depth of 5 ft. of crust over an area of 22½ square miles—and this may be taken as a proved minimum—it follows that the amount of crude soda available is not less than 107,000,000 tons. Lake Magadi is therefore the largest known natural source of sodium carbonate.

Although it was shown by the analyses that the liquid from which this crystalline crust had separated contained in solution other salts, notably sodium chloride and sodium sulphate, the conditions were such that the separated crystals were practically pure trona, a mixture of carbonate and bicarbonate of soda or sesquicarbonate of soda ($Na_2CO_3.NaHCO_3.2H_2O$) which needed only to be freed by draining or washing from the adherent liquid to become a very pure material. A large number of hot springs arise along the margin of the lake, and discharge into it. The composition of these spring waters indicates that fresh supplies of sodium carbonate are being added constantly to the lake.

The technical side of the utilisation of the Magadi soda, at least in principle, would appear to be a very simple matter, since the crust after removal, merely requires draining, washing and roasting to convert it into soda ash (dry sodium carbonate) of a high degree of purity, which could be exported as such, or converted in Kenya into other sodium compounds required in commerce, such as caustic soda and soda crystals.

The following table gives :—(1) the average composition of Lake Magadi soda as computed from the thirteen analyses quoted in Mr. Coates' report ; (2) the probable average composition of soda ash made from Magadi soda ; (3) the average composition of commercial soda ash made : (*a*) by the Leblanc process, and (*b*) by the ammonia-soda process :—

	Magadi soda crust	Magadi soda ash	Leblanc soda ash	English ammonia-soda ash	Solvay soda ash
			Per cent.		
Sodium bicarbonate ..	33·84	—	—	—	—
Sodium carbonate	45·44	94·36	98·20	98·72	99·44
Sodium chloride	2·30	3·24	0·10	0·54	0·21
Sodium sulphate	—		0·60	0·20	—
Insoluble matter	1·66	2·40	0·11	0·09	—
Water	16·73	—	0·67	0·32	0·31

From these results it would appear that soda ash made from Lake Magadi soda might be slightly inferior to soda ash of commerce in containing a larger quantity of sodium chloride, but it must be remembered that in collecting the samples no precautions were taken to remove the adherent and entangled mother liquors.

The exploitation of the Magadi soda deposit was undertaken by the Magadi Soda Co., Ltd., which was formed in 1911, and which undertook the construction of a branch railway line, 93 miles in length, from the deposit to the Uganda Railway, thus connecting it with the port of Kilindini on the coast. The company also undertook the building of a pier and the dredging of approaches at Kilindini. The soda is excavated from the lake by means of a dredger specially designed for the work. The soda works at Kiu on the shore of Lake Magadi are equipped with two calciners for converting the crude material into soda ash, of which it is estimated that an output of 8000 t. per month could be attained ; but so far, the production has been much below this amount owing to many adverse factors. Factories for the conversion of the calcined soda into caustic soda, soda crystals and other products have been erected at Budge-Budge near Calcutta, India, and at Irlam, near Manchester, England, but the latter does not appear to have been used so far. Works have also been built at Kilindini. The quantity of calcined soda, in long tons, exported from Kilindini has been as follows :—1916-17, 2163 ; 1917-18, 4688 ; 1918-19, 12,007 ; 1919-20, 10,544 ; 1920-21, 12,829. The destination of the exports in 1920-21 was as follows :—United Kingdom, 894 t. ; India, 3329 ; South Africa, 270 ; Tanganyika, 4 ; Zanzibar, 28 ; Norway and Sweden, 4771 ; Austria, 710 ; Japan, 2474 ; China, 302 ; and other countries, 47 t., making a total export of 12,829 t. (For recent information on the situation of the Magadi Soda Co, *cf. Chem. and Ind.*, pp. 100, 150, 287, 671, 859 ; 1924.)

HARD RESISTANCE GLASSES AND THE PROGRESS OF LABORATORY GLASSWARE

With the passing of the 10th anniversary of the opening of hostilities on the Continent, we are reminded of the importance then attached to the immediate production of scientific glassware to meet the needs of laboratories and medical and surgical organisations. At that date we were almost entirely dependent on foreign supplies and much preliminary work had to be undertaken before manufacture could be started. It was found that Jena glass, which had come to be the accepted standard quality, was a zinc-sodium-aluminium borosilicate, whereas Kavalier's glass, almost as well known, was a calcium-potassium-sodium silicate. The latter, however, was less resistant and consequently development proceeded on the lines of Jena glass, the main object in view being chemical resistance combined with a reasonable resistance to heat shock.

As an outcome of investigations by individual manufacturers and the Glass Research Committee of the Institute of Chemistry, glasses similar to Jena glass were evolved and produced on the manufacturing scale, with the additional advantage, in the case of one at least, that it was adaptable for blowpipe work and platinum could be sealed in direct; its chemical resistance also was superior to any previously observed. These glasses were put into use for beakers, flasks, and other ware, whilst another glass of simpler composition, high in lime and alumina, with the exclusion of zinc, was employed for ampoules, for which neutral glass was required with good working properties in the blowpipe. Such glasses fulfilled immediate requirements and were in constant demand until the Continental supplies again became available.

The defects of the British-made glasses were then apparently more prominent and criticism was adverse in anticipation of better foreign supplies being forthcoming, a hope, however, which was not fulfilled except as regards price, and in the meantime improvements were being made, with the result that a superior British glass was placed on the market which retained to a great extent its resistance properties, but had an appreciably higher thermal endurance. Progress in America in the production of laboratory glassware proceeded on similar lines, the outstanding product having high resistance to heat shock, associated with a reasonable resistance to chemical attack.

This demand for better glass, necessitated greater expenditure on materials, and even more efficient furnace conditions for melting, all conditions which added to the cost of production.

A pre-war miner's lamp glass was held to be satisfactory if it withstood the test of being heated for 20 minutes in boiling water, and then plunged into water at 15° C. without fracture. Such glasses are sodium-potassium borosilicates with a high percentage of boric oxide, chemical resistance being of secondary importance. The best of the pre-war laboratory glasses failed when chilled from temperatures of 160°—200° C., under similar conditions, whereas the latest improved types have a thermal endurance of at least 220°—250° C., and under certain conditions even higher. Far greater reliability has thus been secured, and British-made glasses cover all requirements in this direction.

These improvements in heat resistance led to the application of laboratory glass for illuminating purposes and there are now five firms manufacturing laboratory glassware in Great Britain, and at least two others producing heat-resistant glass for gas globes, miner's lamp glasses, and the like, all suffering from over-production on the one hand, and unrestricted imports on the other.

Some idea of the variation of prices of eight common patterns of laboratory apparatus, taken from a standard catalogue, may be gathered from the following table :—

	1914 s. d.	1920 s. d.	1922 s. d.	1923 s. d.	% Increase
Beakers, squat 250 c.c. ..	4 4	8 6	12 0	10 3	143
,, ,, 400 c.c ..	5 9	10 6	15 0	12 9	122
Flasks F.B. 500 c.c. ..	6 3	12 0	16 6	14 0	124
,, ,, 1000 c.c. ..	9 0	20 0	27 0	23 0	155
,, R.B. 700/750 c.c. ..	7 6	17 0	23 0	19 6	160
,, Conical 200 c.c. ..	3 3	8 6	12 0	10 3	210
,, Extraction 200/250 c.c.	4 6	10 6	12 0	12 0	166
,, Kjeldahl L.N. 500 c.c.	7 3	18 0	25 0	25 0	246

Certain anomalies are noticeable when considering these increases, which arise from the fact that the 1914 prices include freight from the Continent, which in turn depended to a great extent on the manner in which the various patterns lent themselves to close packing, whilst changes since 1920 reflect the influence of costs on selling prices, these being governed by the difficulties of manufacture and the proportional demand. These increases may appear excessive, but are far less than the same increases which have occurred with Jena glass itself, the original 1914 prices of which have already been given above.

	1923 s. d.	% increase
Beakers, squat 250 c.c.	19 6	350
,, ,, 400 c.c.	24 0	320
Flasks F.B. 500 c.c.	20 0	220
,, ,, 1000 c.c	32 0	255
,, R.B. 700/750 c.c.	25 6	240
,, Conical 200 c.c.	12 8	290
,, Extraction 200/250 c.c. ..	16 8	270
,, Kjeldahl L.N. 500 c.c. ..	28 8	300

Best quality Bohemian resistance glass, of which the ingredients are less expensive, is from 15 to 20 per cent. less than the current British prices, whilst inferior qualities of laboratory glass are on the market at prices considerably less than these, in some cases less than half the British prices.

The question of price of laboratory supplies is often the prime consideration and although the British glassware has properties equal to that of the best, the cost is always compared with the common varieties of Continental origin. The figures recall the fact that, whereas the British product is competing satisfactorily both in quality and price with similar goods from abroad, it cannot compete with the articles dumped here, bearing no mark or

other certificate of origin. Every British manufacturer brands his goods, and guarantees their quality, but in spite of this, he is slowly being squeezed out of the market.

The same remarks apply to illuminating glass. Many of the gas globes obtainable from the usual sources of supply are merely common flint-glass, or an inferior resistance glass. The general public does not purchase the best quality, in fact very few facilities are offered by either the wholesale or retail trade to enable it to do so. Consequently, we read that British illuminating glass is unobtainable except at excessive prices, whereas the British manufacturers' price is approximately equal to the wholesalers selling price for the foreign glasses costing probably one-third or less than this.

Heat-resistant glasses recently placed on the market are reported to contain titania and zirconia, suggesting that higher thermal endurance necessitates higher cost of production.

Satisfactory combustion tubing has been supplied which is a soda-lime-alumina borosilicate, with a small proportion of potash. Demands for tubing suitable for blowpipe work have been adequately met and prices are low. This is a potash-soda-lime glass, also suitable for X-ray bulbs. The need for hard glasses suitable for sealing rare metals such as molybdenum and tungsten has been met, as also for glasses for high power thermionic valves.

The standardisation of laboratory glass has been effected to a limited extent, beakers and flasks receiving attention, and the bulk of the manufacturer's patterns conforms to these standards. In spite of this, however, flasks are still required to fit corks and beakers and to fit water baths of old origin, to quote only two examples. Lampblown ware, such as condensers, fractionating columns, of known design, although most suitable for standardisation have yet to be dealt with.

Volumetric glassware is subject to keen competition by reason of surplus stocks from the Continent. Accuracy in this case is of secondary consideration, although the value of a graduated vessel with uncertain errors is hard to conceive. In 1921, under the auspices of the N.P.L., "Commercial Grade" volumetric glassware was introduced by the British manufacturers, unstamped, but carrying their trade name and guaranteed to be within the Class B tolerances. This, however, is only in limited demand, as graduated flasks of unknown origin and accuracy are obtainable at less than half the price, while the difference with pipettes is even greater still, 50 c.c. at 12s per dozen being one-third the price of Class B quality guaranteed. Higher standards are also procurable from reliable manufacturers, accompanied either by their own certificates or by one supplied by the N.P.L. The methods of calibrating have been almost perfected, although there is still considerable room for improvement in the dividing machines, the bulk of which are slow and cumbersome.

The capacity of the country for the production of laboratory glass and resistance glass of all descriptions is now fully organised, but the future depends largely on the general trade of the country, and the recognition of the superior properties and reliable service of the British product. It is the Master Key Industry. Is it destined only to become a memory of the past?

A. V. Hussey

SMOKELESS FUEL

The Pure Coal Briquette Process: An Important Development

(From a Correspondent)

The members of the Society of Chemical Industry are familar, because of the various papers that have been read on the subject before the Society during the past few years, with the important part played by structure in the production of smokeless fuels by the carbonisation of bituminous coals. It is, of course, well known that to combine smokelessness with free ignition we can either partially decompose the volatile matter by low-temperature carbonisation, leaving about one-third in the residual fuel, or submit the coal to relatively high temperatures in such a manner that the residual fuel is extremely close-grained and cellular, resembling charcoal, and quite different from ordinary gasworks or metallurgical coke. The best example of this latter method is the Pure Coal Briquette carbonisation process, and considerable interest attaches to the statement recently made that Messrs. Sutcliffe, Speakman and Co., Ltd., of Leigh, who control this process, have now solved, after over five years work, the difficult mechanical problems of the 10-ton high duty briquette press necessary.

It will be remembered that the essential principles involved are the mixing of 80 per cent. roughly crushed coal with 20 per cent. coke breeze, and the briquetting of this non-swelling mixture at the enormous pressure of 10 tons per square inch so as to give a hard briquette without pitch or other binder, forming "pure coal" briquettes. These are then carbonised at relatively high temperatures of 1650° F., and as they have the great advantage that they do not soften, expand, or alter their shape, simple continous retorts of huge capacity up to 500–1000 t. can be used with internal heating. In this way are obviated some of the great difficulties of many low-temperature processes, low throughout, small and intricate retorts, and intermittent operation. Also the fact that only 1 per cent. of volatile matter is left in the fuel means that, whilst it is perfectly free burning, for the same reason as charcoal, all the volatile matter has been decomposed into valuable products, and one-third of it is not left to be burnt as mere fuel, as happens with ordinary low-temperature processes. That is to say a very high yield of gas, 10,000 cubic feet per ton, and of sulphate of ammonia, 40 lb., is obtained in addition to purely paraffinoid liquid products. Finally, because of the combined blending, briquetting, and subsequent carbonisation the product is so hard that it is superior to metallurgical coke, and the possibilities of the Pure Coal Briquette carbonisation processes are important, not only to the iron and steel industries, and for the operation of the blast furnace, but also, from the national point of view, for the production of solid smokeless fuel to replace coal for all purposes, liquid fuel, and sulphate of ammonia.

FORTHCOMING EVENTS

Sept. 1. INSTITUTION OF THE RUBBER INDUSTRY, *London Section*, The Engineers' Club, Coventry Street, Piccadilly, W., at 8 p.m. "The Acidity of Raw Rubber," by Dr. G. Stafford Whithy.

Sept. 4 and 5. IRON AND STEEL INSTITUTE, Autumn Meeting at British Empire Exhibition, at 10.30 a.m. each day. (1) "Changes of Volume of Steels During Heat Treatment," by L. Aitchison and G. R. Woodvine. (2) "Investigations on the Herbert Pendulum Hardness Tester," by C. Benedicks and V. Christiansen. (3) "Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on some Magnetic Properties of Steel," by E. D. Campbell and G. W. Whitney. (4) "Pickling: The Action of Acid on Iron and Steel, and the Diffusion of Hydrogen Through the Metal," by C. A. Edwards. (5) "Examination of Iron from Konarak," by J. N. Friend and W. E. Thorneycroft. (6) "On the Nature of High-Speed Steel," by M. A. Grossman and E. C. Bain. (7) "Improvements in the Brinell Test on Hardened Steel, including a New Method for Producing Hard Steel Balls," by A. Hultgren. (8) "Present Position of the Theories of the Hardening of Steel," by W. Rosenhain. (9) "Effect of Free Surfaces on the Plastic Deformation of Certain Metals," by F. C. Thompson and W. E. W. Millington.

Sept. 8 to 11. INSTITUTE OF METALS. Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at Wembley.

The following papers will be read:—"A Method for Measuring Internal Stress in Brass Tubes," by R. J. Anderson and E. G. Fahlman; "The Application of the Ideal Solubility Curve to the Interpretation of Equilibrium Diagrams in Metal Systems," by D. H. Andrews and Prof. J. Johnston; "Seventh Report of the Corrosion Research Committee of the Institute of Metals," by G. D. Bengough and R. May; "Comparative Results on Copper-Silicon-Aluminium and Other Aluminium Alloys as Obtained on Separately Cast Specimens and Specimens cut from a Crankcase Casting," by E. H. Dix and A. J. Lyon; "The Determination of Sodium in Aluminium," by D. M. Fairlie and G. B. Brook; "The Extrusion of Brass Rod by the Inverted Process," by R. Genders; "Investigation of the Effects of Impurities on Copper. Part II—The Effect of Iron on Copper," by D. Hanson and Grace W. Ford; "The Relationship Between Tensile Strength, Temperature and Cold-Work in Some Pure Metals and Single Solid Solutions," by D. H. Ingall; "On the Effect of Progressive Cold-Rolling on the Brinell Hardness of Copper," by H. Moore; "Experiments on the Working of Nickel for Coinage," by Sir T. K. Rose and J. H. Watson; "Some Experiments on the Effect of Casting Temperature and Heat-Treatment on the Physical Properties of a High-Tin Bronze," by F. W. Rowe; "Some Experiments on the Influence of Casting Temperature and Mass on the Physical Properties of Admiralty Gun-Metal," by F. W. Rowe; "Studies in the Aluminium-Zinc System," by T. Tanabe; "Metal Spraying and Sprayed Metal," by T. H. Turner and W. E. Ballard.

SOCIETY OF CHEMICAL INDUSTRY

CHEMICAL INDUSTRY DINNER

It has been arranged that the Autumn Dinner, already intimated to be held on November 14, will be a joint function under the auspices of the Society of Chemical Industry and the Chemical Industry Club. The Dinner will be held in the Edward VII Rooms of the Hotel Victoria, Northumberland Avenue, London, W.C. 2, and will be presided over by Mr. W. J. U. Woolcock, C.B.E., President of the Society.

It is hoped that a large number of members of each of the bodies mentioned will, in due course, procure tickets for themselves and their ladies. A circular letter with further particulars and a form of application for tickets will be issued early in September, but members are asked in the meantime to note the above date and place for the dinner.

BACK NUMBERS OF JOURNAL

The General Secretary will be glad to hear from Members or Subscribers who have copies of the *Journal* for January 5, 1923, or January 4, 1924, that they are willing to dispose of to the Society.

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The price of Volume VIII (1923) to members of the Society is 7s. 6d., and to non-members 12s. 6d., post free in each case.

Fellows of the Chemical Society have the privilege of purchasing the volume at the price of 10s. post free.

A set of Volumes II to VIII inclusive can be purchased by a member of the Society at the price of £2 2s. 6d., and by a non-member at the price of £3 15s., post free in each case.

CHEMICAL SOCIETY'S ANNUAL REPORTS

The Council of the Chemical Society has decided to increase the price of future issues of the Annual Reports on the Progress of Chemistry, and the volume for 1924 (XXI) which will be issued next year will be sold to the public at 10s. 6d., plus postage. To members of the Society of Chemical Industry will be given the privilege of purchasing the volume at 9s., post free. Orders, accompanied by the appropriate remittance, should be sent to the Assistant Secretary, Chemical Society, Burlington House, London, W. 1, before the end of the present year.

ROTHAMSTED LIBRARY

By the courtesy of the Lawes Agricultural Trust, any member of the Society of Chemical Industry on presenting a card from the General Secretary shall be allowed access to this Library. The rules of the Library preclude journals and periodicals from being sent out, and these are therefore always accessible.

A catalogue of the journals and periodicals is in the Society's Offices, at Central House, and may be consulted there by members.

DEATH

Bird, William R. (elected 1902), of 217, Newport Road, Cardiff, Director. On August 13, 1924.

THE BRITISH CHEMICAL PLANT MANUFACTURERS' ASSOCIATION

The fourth annual meeting was held on July 30, and Mr. L. M. G. Fraser, M.I.Chem. E. (the retiring chairman), in moving the adoption of the report and accounts, reviewed the demand for increased and more efficient production, and showed the need for the work of the chemical engineer. Caution was advised against the tendency to teach too much or extend the training too long. In the works, a good understanding of the principles of physics and mathematics was required rather than high attainments in these branches of science, for, although the mechanical sciences were largely exact sciences, all the problems of the chemical engineer were hedged about by the incalculable—sudden alterations at critical temperatures, unknown surface tension—and in such cases experience was the deciding factor.

The improvements in the construction of chemical apparatus could be broadly classified as follows:—(1) Better products obtained; (2) Lower working costs; (3) Cheaper apparatus; (4) Safer operations.

Better apparatus was being obtained by the use of known metals or alloys which had been tested under varying conditions, both under laboratory and works conditions, and there were alloys which prevented contamination of the material being manufactured without troubles of purification in the later stages, and which also gave longer life to the plant. The action of heat under varying conditions was more intimately known, and overheating was more easily guarded against. The improvements in grinding machinery had enabled many hard materials to be satisfactorily ground to required fineness without undue proportion of dust or contamination and consequently with a better chemical reaction where required in the later stages of the process. The increased use of mechanical screening relieved the mill, increased the output and saved power and time. In past days, only ½-ton per hour was obtained from grinding plant with certain materials per horsepower, whereas to-day five or more times that amount could be turned out per hour with no more power absorbed, and less wear and tear on the plant. The formation of emulsions by high-speed mills had been made easier. The knowledge of filtration had increased the usefulness of the filter press. Continuous filters had proved their utility and the latest developments of the stream-line filter were being carefully followed.

In distillation, owing to the recognition of the importance of increased velocities, greater results per square foot of surface had been obtained, and more delicate materials could be handled with less risk. The action inside the still column was being more clearly grasped; the column could give cleaner cuts in the fractions, with greater purity, and columns could be designed to give continuously two or three fractions.

Mechanical crystallisers were again being brought forward, and it was claimed that they yielded better and purer crystals.

The problems of mixing dry and wet materials could yet be studied with advantage, and a great deal of useful power saved by studying the rapidity of the absorption of chemical reaction that is required to take place. Where the time factor entered, large mixers with slow motion and less relative power might be advantageous, and with rapid solution small mixers and quick motion was advisable. There were cases where a very large amount of power was saved when several dry ingredients had to be mixed, simply by studying the order in which the materials were put into the mixer.

Furnaces had received far more attention, and the importance of scientific furnace setting was now recognised, and whilst oil burners, gas firing, mechanical stokers, and mechanical draught all increased efficiency, they resulted in more severe furnace conditions, and contributed to frequent breakdowns unless careful thought was given both to the design and to the refractory materials and cements used.

Electricity was continually becoming more widely used in chemical industry in the electrolysis of alkali chlorides, water and organic compounds, and also as a means of separating either solid matter or vapour in the form of mist or fog. Much research work has been carried on to make improvements to the diaphragm and anodes: the improvements, though slow, were continuous. The electrolysis of salt had reached a very high state of commercial efficiency. Electrolysis of water appeared to have gone as far as possible. The electrolysis of inorganic compounds awaited development, but the plant could be properly designed. The highly complicated reactions that took place, however, did need investigation. Electro-reduction was more promising, and in Italy one firm used an ordinary cell for making mercury amalgam, used to reduce organic compounds.

The separation of ashes from coke and unburnt coal by means of electromagnetic separators was now being carried out commercially.

Lower working costs had been attained mainly through the more detailed study of the power factor in connexion with the movement of bulk material, or in the saving of heat by studying the thermal efficiency of fuel or interchange of heat from one material to another, and the greater freedom from breakdown of machinery and plant, causing dislocation of work. The automatic control of temperatures, automatic electric appliances for moving bulk material, automatic filling, weighing and packing, were other factors in the lowering of cost of production of chemicals.

Cheaper apparatus was now obtained, owing principally to the large amount of research work on rates of flow, whether in calories or liquids, and which had enabled the engineer the better to calculate the strains and stresses and outputs under which his machinery had to perform. In other words, he was able to reduce the incalculable quantity. Many other improvements in various types of machinery were the outcome of practice and experience, which, although not fundamental departures, were improvements in detail or alterations to main branches of the general principle.

The sum of all these improvements had made it possible to surmount many difficulties, and to lay plans with greater confidence.

The Report, which showed that the Association had a very useful year, was adopted and the following officers and committee for the ensuing year were elected :—Chairman, Mr. F. R. Blizzard (T. & C. Clark & Co., Ltd.); Vice-Chairman, Mr. J. Robinson (Mather & Platt, Ltd.); Treasurer, Mr. E. A. Alliott (Manlove, Alliott & Co., Ltd.); Committee, Mr. H. Bush (Huntingdon, Heberlein & Co., Ltd.); Mr. L. M. G. Fraser (W. J. Fraser & Co., Ltd.); Mr. J. A. Revell (Kestner Evaporator and Engineering Co., Ltd.): Dr. R. Seligman (Aluminium Plant and Vessel Co., Ltd.), Mr. E. C. Watkins (W. Neill & Son. Ltd.), Mr. J. W. Wright (Cannon Iron Foundries, Ltd.).

ANNOUNCEMENT OF CHEMICAL EXPOSITION DATE

Owing to some confusion which is believed to exist in a few quarters regarding the holding of the next chemical exposition, an announcement has been sent out by the International Exposition Company, under whose management the Exposition of Chemical Industries has been held since 1915. Numerous inquiries have been received by the management which lead it to believe that many interested parties are of the opinion that there will be a chemical exposition this year. This is not the case. There will be no chemical exposition in 1924, the next Exposition of Chemical Industries will be held September 28 to October 3, 1925, at the Grand Central Palace, New York.

"This Exposition will not be held in the United States prior to September, 1925," states the announcement of the management. "Numerous inquiries which we have received, lead us to believe that there is some uncertainty regarding the date of the next Exposition of Chemical Industries. As a result of a vote of exhibitors, taken last year, the decision was definitely reached at that time not to hold the Exposition in 1924, but to skip a year and hold the next one in 1925. Owing to the fact that the Chemical Exposition has been held without interruption since 1915, the many inquiries regarding the omission of the Exposition this year are only natural.

"At the same meeting in 1923, where time and place for the next Chemical Exposition were discussed and decided upon, the exhibitors decided by a large majority to hold all future Expositions in New York, and selected the Grand Central Palace for 1925. New York was decided upon as the logical place to hold the Expositions in the future, because it was believed to offer the best location and conditions to attract the greatest number of people interested in the Chemical Industries from all parts of the world. So that the matter may be definitely understood, the next Exposition of Chemical Industries will be held at the Grand Central Palace one year from this September, during the week of September 28 to October 3, 1925."

CORRESPONDENCE

VERSE RELATING TO SCIENCE

Sir,—The letter of Mr. C. G. Ruby in your issue of June 13 asking for verses of any kind relating to science awoke an idea long dormant in my mind. I have always been of opinions that poems on purely chemical subjects could be written, but, however much belaboured, my own muse steadily declines to work, and I never get beyond the first line.

Failing a poem, I have ventured to submit a sort of chemical drama, or rather it should be called a scenario. It is I believe quite up to the usual cinema standard, and it may attract the eye of some budding epic poet or film producer. To such I give it freely. If you, Mr. Editor, cannot grant the necessary space, my hopes of seeing a masterpiece rise from my humble foundations must perish.

"Ben Zeen, an old organic Radical, possesses a large collection of jewellery, including a magic ring and quite a number of chains. He is anxious to unite himself by double or even triple bonds to pretty Annie Line; the young lady, however, pooh-poohs the idea of any union, whether direct or co-ordinated, with the old fellow. She is in fact much attracted to Ben's nephew, Benzy Dean, who also is the possessor of a magic ring.

"Someone has stolen the nucleus from Ben's ring, and has substituted a very inferior ionic micelle in the para position. Suspicion falls on Benzy, who is forthwith thrown into prison and loaded with ions. Annie Line, activated by her pure B.P. love, engages the services of the two famous detectives Proton and Niton. Using the Perkin reaction, they find distinct traces of the emanation from the nucleus at the house of an old Auntie body, said to be equal to anything. Auntie is diazotised to the n'th degree, and, being thoroughly decomposed, confesses that the nucleus is concealed at the back of her house under a heap of hormones and other rubbish. It was given to her by an amphoteric girl, called Silly Kate, who had once been united to Ben Zeen by a side-chain, but had been reduced. In revenge she had dextrosely abstracted the precious nucleus." Here follow the usual dénouements and happy ending

This, I believe, is a pioneer attempt, and is no doubt capable of great improvement. For instance, a lot of comic business could be made out of the rivalry of Polly Morphous and Sally Cylic, two housemaids, for the hand of Nick L. Oxhide, a catalytic insurance agent. One can easily imagine how Sally and Polly hide behind X-ray screens, crawl under filter-beds, and make barricades of periodic tables and chairs of chemistry, while Nick climbs up fractionating columns and scrambles through diffraction gratings.

For him who would write chemical poetry there is no lack of heroines—they are everywhere. As it is I have to apologise to Miss Molly B. Denum and to quite a number of ladies named Ethyl, for not being able to find a place for them among by *dramatis personæ*.—I am, etc.,

E. G. Bryant

Box 11, Prieska S. Africa
August 5, 1924

PERSONAL AND OTHER ITEMS

The Southern Gas Association of America has completed the financial arrangements necessary to establish a chair of gas engineering at the Johns Hopkins University, Baltimore. The Association intends to make a continuous effort to influence the right sort of students to take the course so that the gas industry may be gradually rendered still more efficient.

A New Source of Hydrogen

During the recent Congress of Industrial Chemistry at Bordeaux, Prof Matignon described his work on the distillation of bituminous schists, and pointed out that these might become an important source of hydrogen. In fact, autun schists distilled in a closed vessel yielded per ton 63 cb. metres of gas containing carbon dioxide, 14 cb. m, carbon monoxide, 3 cb. m., hydrocarbons, 25 cb. m., hydrogen, 21 cb. m. The same schists distilled in Scotch retorts under certain conditions produced 670 cb. m. of gas of fairly low calorific power. To utilise the residual carbon formed during the distillation in the upper region of the vertical retort, steam is injected at the base, producing water gas which, mixed with the distillation gas yields, carbon dioxide. 139 cb m., ethylene, 5 cb. m.: oxygen, 24 cb. m.; carbon monoxide, 29 cb. m.: methane, 45 cb. m.; hydrogen, 171 cb. m.; nitrogen, 255 cb. m. After eliminating the carbon dioxide and nitrogen, the gas constitutes a useful source of hydrogen. In a gas-tight plant each ton of schist would yield 345 cb. m. of gas containing 173 cb. m. of hydrogen, and a works treating 100,000 tons of schist yearly would produce 17,000,000 cb. m. of hydrogen from which 8500 t. of ammonia could be produced. The unsaturated hydrocarbons could be recovered at the same time, and calculating from ethylene it would be possible to produce 5000 hectolitres of alcohol at the same time

GERMANY

Beryllium

In addition to the better-known light metals, which are now of great importance in Germany, beryllium has also been receiving some attention. Like aluminium, it is silver-white, hard, and fairly durable. In alloys it behaves similarly to silicon, but on account of its cost finds little application. Alloyed with copper to the extent of 5–10 per cent. it gives a product which does not oxidise in the air, can be hammered cold, and is easily worked. The colour is influenced by as little as 0·5 per cent. of beryllium; the alloy with 1·3 per cent. has a fine golden colour, whilst that containing 10 per cent. has only a faint yellow tinge. Alloys with aluminium, which may contain 1 to 99 per cent. beryllium are resistant to moisture; those containing a small amount of beryllium are stronger than similar alloys with magnesium and their specific gravity is considerably reduced; these alloys are thus very suitable for aircraft construction

Fuel Consumption of the Badische Anilin und Soda-Fabrik

In its factories at Ludwigshafen, Oppau, and Kerseberg, this company uses daily 2100 tons of hard coal, 1900 t. of coke, 600 t. of lignite briquettes, and 9000 t. of raw lignite. Pumps, compressors, etc., use 26,000 h.p., provided by 25 boiler houses containing 270 boilers with 1,260,000 sq. ft. of heating surface.

The Cracking of Heavy Oils

A new method for the cracking of heavy oils due to Dr. Blumner is described in *Brennstoffchemie*. In the present cracking processes light oils are produced, together with tar and coke, but in Blumner's process it is claimed that no coke is formed. The oil to be cracked is mixed with the residue from a previous run and sprayed into an autoclave at 450–500° C., which contains melted lead. The oil is kept in intimate contact with the lead, but is not allowed to touch the walls of the autoclave. The gases and oil are removed at the top and the tar and high-boiling point oils removed at the side. The remainder is passed through a fractionating column maintained at 210 220° C., the condensate in this column being the portion mixed with fresh oil as mentioned above. The benzine is condensed and the residual gases used to heat the autoclaves. About 70 per cent. of the crude oil is thus obtained as benzine.

FRANCE

Industrial Steaming Practice in France

During a recent lecture given by Monsieur Roszak before the Ecole de Perfectionnement Industriel, particular attention was paid to the three characteristics of a boiler plant, the size of the units, the working pressure, and the degree of super-heat. The increase in the size of the units beyond those actually carried out were not considered advantageous, as the actual advantages such as yield, economy of construction and gain of space were less important than was once thought, being far from compensating the increased risk of shutting down the plant. The probability of shutting down a unit owing to a leak in one of the tubes was proportionate to the number of tubes, and the fragility of the furnace refractories increased greatly with larger furnaces, thus again increasing the risk of breakdowns. The possibility of progress lay in the progressive increase of the pressure far beyond values now accepted. Recent researches had confirmed the clear trend towards the maximum of the curve of total heat of vaporisation as a function of the temperature. The same total heat could be furnished by one kg. of water either at the temperature of the ascending part of the curve, or at the temperature still higher on the descending side of the curve, thus admitting of a higher thermal yield. In addition the proportion of total heat furnished to the water was greater, thus making it possible to develop the relative influence of the recuperators and increasing the coefficient of utilisation of the heat produced by the fuel. To illustrate the nature of the changes that increased pressure brings about in the utilisation of boilers, it was of interest to consider the curious phenomena that are manifest when the critical point is approached. The expansion of the water became great and its density at the critical point was one-third of its normal density. The diminution of the latent heat in evaporation greatly reduced the size of the boiler

to the profit of the pre-heaters acting as recuperators. In addition the small difference of density between water and steam completely changed the conditions of evolution of bubbles and required the water to be circulated mechanically in the boiler. The increase in the density of the steam and the pressure also greatly facilitated the exchange of heat in the superheaters.

GENERAL

Italian Chemical Industry

Progress is being made in establishing the country as independent of foreign supplies of fixed nitrogen, while the colour and artificial silk industries have also advanced greatly. The chemical industry is capitalised to the extent of 422 million lire; annual production is valued at one milliard lire, one third of this being exported.

COMPANY NEWS

CHLORIDE ELECTRICAL STORAGE

The profit for the year to March 31, less provision for depreciation and taxation, was £115,542; available with £33,016 brought forward £44,557. The final dividend is 5 per cent. and bonus 10 per cent., making 20 per cent., tax free; £50,000 is placed to reserve, and £44,888 carried foward.

UNITED ALKALI CO., LTD.

An interim dividend of 5 per cent. is announced, compared with 4 per cent. at this time last year, the final dividend of 6 per cent. again making 10 per cent. for the year. In April, 1923, a capitalised bonus of 50 per cent. was distributed, raising the issued ordinary capital to £900,000.

UNITED TURKEY RED CO., LTD.

An interim dividend is announced of $2\frac{1}{2}$ per cent. actual, tax free. No dividend was distributed on the ordinary shares for 1921 and 1922, but $2\frac{1}{2}$ per cent., tax free. was paid for 1923, together with twelves months' arrears of dividend on the second preference shares.

AUTOMATIC AND ELECTRIC FURNACES, LTD.

In order to meet the increasing demand for large size Wild-Barfield Patent Electric Furnaces, with Internal Heaters, arrangements have been made whereby all such furnaces above 25 K.W. will in future be designed by Automatic and Electric Furnaces, Ltd., in conjunction with Electric Furnace Co., Ltd., of 17 Victoria Street, S.W. 1, and supplied by them. Arrangements have also been made with G. J. Hagan Co., of Pittsburg, U.S.A., who have constructed a large number of electric resistance furnaces up to 350 K.W. capacity, for the use of their drawings and information, so that the best British and American practice will be incorporated in the designs. The manufacture of Wild-Barfield Automatic Hardening Furnaces with magnetic detector, and internally heated type of Furnaces up to 25 K.W. will be continued by Automatic and Electric Furnaces, Ltd.

REVIEWS

Allen's Commercial Organic Analysis. Part I. By S. S. Sadtler, S.B., E. C. Lathrop, A.B., Ph.D., and C. Ainsworth Mitchell, M.A. Pp. viii.+796. London: J. and A. Churchill. 1924. Price 30s.

This new edition of Allen continues the practice begun in the last edition, and rendered more than ever necessary by the advance of science and the increasing bulk of specialised knowledge, of entrusting the revision of each section to an expert in its subject. If, as the result, there is some lack of uniformity in treatment, looking at the book as a whole, this is more than outweighed by the authoritative and "first hand" character of most of the information.

The subjects treated are practically the same as those in the corresponding volume of the fourth edition; and the increase in the bulk of the volume by 40 per cent. gives some indication of the amount of work which has been done during the fifteen years' interval between the editions, the results of which are here embodied.

It may be said at once that, as a whole, the book keeps up its high character, and that the changes, both of addition and of excision, seem to reflect faithfully the progress that has been made: the book remains a trustworthy guide. Additional matter is especially conspicuous in the sections on methyl alcohol and acetone, wines, chloroform and carbon tetrachloride, chemical methods for sugar determinations, pentoses, starch, mechanical tests for paper, vinegar, and tartaric acid. An excellent feature of the book is that in so many places typical analyses of the substances under discussion are given. This should be more frequent in analytical treatises.

It seems a pity that more revision was not effected in the first section. The application of physical methods to chemical work has been so greatly developed of late that it is disappointing to find in this section merely a reprint. The excision of the descriptions and figures of purely general and elementary apparatus like specific gravity bottles, separating funnels, and drying ovens, and the insertion of paragraphs on hydrogen ion determination, for example, would certainly be a change for the better. Parenthetically, the writer can never understand why the Sprengel tube is so constantly figured in English chemical literature, whilst the enormous improvement on it devised by our own Perkin (Chem. Soc. Trans., 1884, **45**, 443; 1896, **69**, 1043) is scarcely ever mentioned.

Allen is nowadays a book both for American and for English chemists, and is edited more or less for the requirements of both. In some respects this is an advantage to the English reader many excellent analytical methods of the A.O.A.C., for example, are made available to English workers who otherwise might not have come across them—but in other respects it is far from being so. Thus, new tables of specific gravity of alcohol and water mixtures have been inserted, from which the percentage of proof spirit by volume corresponding with any specific gravity has disappeared; surely an alteration which, in view of the legal position of proof

spirit in this country, should not have been made. And when, in an edition of a book published in London for British workers, we find an official American method for determining moisture in wood pulp fully described, whilst the official British method, entirely different, is ignored, can we be blamed for feeling that things are not altogether as they should be?

Naturally, there are here and there American expressions—"an aliquot," "a high-grade absolute," "are apt to be *quite* coloured," the use of "per cent." for "percentage," and of the misleading and untruthful "water-white" for "colourless." These are few in number, and for the most part not very objectionable; but the writer hopes that all right-minded persons, American as well as British, will agree that such sentences as "Hydrometers are graduated to read in direct or according to an arbitrary scale," or "The point to which the spindle sank in a 15 per cent. salt solution was marked 15 and in pure water as O and extending the scale," are inexcusable. There are very few misprints. Curiously, the two which the writer noticed, *is* for *in*, on page 46, and *corbonyl* chloride on page 84, are both brought over from the last edition.

Its virtues far outweighing its faults, the new Allen will worthily displace the old; it will doubtless enter many laboratories on the reputation of its ancestors, but it will remain, as an honoured inmate, on its own. J. T. DUNN

DIE FERMENTE UND IHRE WIRKUNGEN. By PROF. CARL OPPENHEIMER. With an appendix on "PHYSIKALISCHE CHEMIE UND KINETIK," by DR. RICHARD KUHN. Fifth edition, revised. Part I. pp. vii+160. Leipzig: G. Thieme, 1924. Price $1·90.

The original edition of this work was published in 1900 as a book of 350 pages, whilst the present edition will be completed in the course of about a year in 10—12 parts each of some 10 sheets (160 pages). The entire work will comprise two volumes, but the publishers announce that single parts cannot be supplied.

The subject of fermentation is treated in its broadest sense, all changes which occur in the living organism being dealt with under that head. From a synopsis published with this part it would appear that the text will be entirely academic, the application of fermentation to the arts and manufactures being excluded. Some idea is afforded of the enormous additions to our knowledge of fermentation phenomena in a quarter of a century by the extension of this work during that period from a small handbook to a voluminous treatise. We do not propose to comment on Prof. Oppenheimer's book until it has been completed further than to say that, judging from the part before us it will give by far the most exhaustive account of the subject of any work yet published. We hope to prepare a review when the entire work is before us. Meanwhile we are quite safe in recommending those of our readers who are interested in fermentation to add the book to their libraries.

ARTHUR R. LING

SPECTROSCOPY. By E. C. C. BALY, C.B.E., M.Sc., F.R.S. Pp. xi+298. Third Edition. Vol. I. London: Longmans, Green and Co. 1924. Price 14s.

The previous edition of this book appeared in 1912. Since that time probably no branch of physics has made such tremendous advances as has spectroscopy. To-day it occupies one of the foremost places—if not the foremost place—in those departments of scientific work which have for their object the determination of the fundamental laws of the structure of matter. This has come about, of course, largely through the Bohr theory of spectral emission and its developments, but it is due in no small measure also to the extension of experimental investigation into the previously unexplored regions of the far ultra-violet spectrum. On both the practical and the theoretical side spectroscopy has taken on a new aspect, and it is now so complex and specialised that the need of a reliable comprehensive text-book has become urgent.

The twofold aspect of the subject is doubtless one of the reasons which led the author very wisely to produce the new edition of this important work in two volumes, of which only the first has now appeared. It is, however, clearly not the only reason. The subject-matter is that of the first chapters of the previous edition (with the exception of Chapter IX. on "Interference Methods in Spectroscopy"), and the second volume will therefore contain a very large amount of matter also dealing with the experimental side of spectroscopy. This is as it should be, although those who have become bewildered by the intricacy of the theoretical developments of the last few years might pine for a smaller disproportion between theory and practice. It must be remembered, however, that the book is a text-book, and as such, must confine itself to results which are more or less firmly established. It is inevitable that, with such limitations, experiment must overbalance theory.

The first volume is, in the main, a reprint of the corresponding portions of the edition of 1912, although considerable additions and modifications of detail have been made to bring the work up-to-date. These are concerned mainly with new methods of investigation in the infra-red and ultra-violet regions, improved methods of mounting grating, and tables of standard international wave-lengths and connexions from wave-lengths in air to those in vacuum. Some misprints in the previous edition have been corrected, although on page 30 a property of the grating itself is still attributed to a particular method of mounting the grating, and on page 169 (fifth line from bottom), although some of the symbols have been changed, an error is retained which now consists in the printing of *m* instead of *p*. The only plate in the book—representing the spectra of copper and iron—is scarcely representative of the best results obtainable with even a moderate instrument. These, however, are minor points. The book as a whole is admirably planned and executed and will be found invaluable to anyone who has occasion to use the spectroscope for any purpose whatever.

H. DINGLE

Kolloidchemie und Biologie. By H. Freundlich. Pp. 47. Theodor Steinkopff. Dresden und Leipzig. 1924. Price $0·50.

This little book originated in a recent lecture, by the author, on the relation between colloidal chemistry and biology; it is at the same time a third edition of the author's "Kapillarchemie und Physcologie," of which two editions appeared more than ten years ago. The great development of colloidal chemistry, to which the author has largely contributed, falls almost wholly in the present century and although the subject cannot compare in fundamental importance with contemporary developments in the theories of atomic structure or of relativity, it yet has an interest of its own, for colloidal chemistry is and will remain a basis for an understanding of vital phenomena.

In this little book Prof. Freundlich deals with some elementary and fundamental notions, perhaps not always so fully as to make them really intelligible to those unacquainted with the subject. His object is apparently rather to remind his biological readers of the achievements of colloidal chemistry and then to discuss its recent applications, such as, for instance, Warburg's conclusion that carbon assimilation, respiration and fermentation are all processes which, like adsorption, take place on a surface. A trace of iron on the surface of charcoal catalyses the oxidation of amino-acids. Cyanides stop this oxidation, just as they "poison" ferments. The applications of colloidal chemistry to the agglutination of bacteria, to phosphorescent organisms, and to many other biological phenomena are dealt with

In a book of this size we cannot, of course, expect the detailed or comprehensive treatment of text-books like "Bechold's Die Kolloide in Biologie und Medizin," or Höber's "Physikalische Chemie der Zelle und Gewlbe," but what Prof Freundlich has selected is all the more up to date and all the more suggestive. We are a little surprised at the inclusion of a discussion of electrokinetic and Nernst potentials in a book of this scope.

G. Barger

Theoretical Metallurgy. By R. Scott Dean. Pp. vii+246. London: Chapman and Hall, Ltd., 1924. Price 15s.

Schenck's work on "The Physical Chemistry of Metals," which has been found valuable by many teachers and students of metallurgy on account of its novel and interesting discussion of technical problems in a scientific manner, was translated into English by Mr. R. S. Dean a few years ago. The subject had then advanced considerably, and the English translation lagged behind the knowledge of the day. The translator has now prepared a work on the same general plan and incorporating much of the earlier book, but with many additions, so that it is no longer a mere translation. Modern scientific metallurgy calls for some acquaintance with such departments of pure science as the structure of crystals as revealed by X-rays, and even with the modern theory of the constitution of the atom. These subjects are therefore dealt with, together with recent work on the growth and recrystallisation in metals, and the nature of surface phenomena. Some further notes on technical processes, such as wire drawing and extrusion, have been introduced, and the chapters on equilibria in smeltering processes have been considerably expanded. These chapters are perhaps the most interesting to the metallurgical student, who has otherwise to resort to German works for information on these subjects. The sections on metallic alloys are naturally only brief abstracts of what is to be found in text-books on metallography, and are perhaps too scanty to furnish more than suggestions. The principal defect of the book is, indeed, its scrappiness. Interesting subjects are dealt with in the course of a page or two with references to a few, but only a few, of the important papers on each subject. The effect on a keen student will be stimulating, since he will discover from an examination of the book that many familiar facts in metallurgy may be better understood by taking into account the results of modern physics and physical chemistry. The other defect is more serious. Inaccuracies are unfortunately very common. The author has become confused in regard to the allotropic modifications of iron, and the reader would fail to obtain an indication of the now well-established facts of allotropy. So on page 30 the account of explosive antimony overlooks the fact that this substance is not an allotropic modification, but contains chlorine as one of its constituents. The author is unlucky in dealing with steels. The account of the alloys of iron and nickel overlooks the important work of Benedicks and Hanson, and might well have included a discussion of the relation to meteorites. The succeeding paragraph on permanent magnets completely fails to represent present practice, and the account of the hardening of steel on page 152 is inaccurate. It is also incorrect to say that the iron-chromium alloys used for resistance to corrosion contain more than 15 per cent. of chromium. It must be added that misprints are very frequent, proper names are often spelt wrongly, and figures in the references are incorrect. On page 68 both the algebraic formulæ, of considerable interest to the reader, are printed wrongly, and the errors in some instances are such as to make it very difficult to discover the true reference or the true formula. In spite of these faults the book is an interesting one, and it is a matter for regret that so excellent an idea has not been carried out with more care.

C. H. Desch

The Quebec Government is spending an additional $500,000 on the St. Maurice River. This will make a total of $3,000,000 in all, expended for storage dams on the river. The Government is expending $950,000 at Lake Kenogami, which makes total expenditure for daming this lake of $2,750,000. A number of smaller sized dams are being placed in rivers throughout the province. These works are all revenue producers, as the fees for the supply of water return a substantial amount.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Copper Sulphate	£25 per ton.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d
Nickel Sulphate	£38 per ton d/d. Normal business.
Nickel Ammon. Sulphate	
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrite refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d.—4s. per lb., according to quantity.
Carbon Bisulphide	£30—£33 per ton according to quantity. Again dearer.
Carbon Black	7d.—7½d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	£60—£65 per ton according to quantity, drums extra. Again dearer.
Chromium Oxide green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	5d.—9½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	£48 per ton, barrels free. Advanced.
Lead **Hyposulphite**	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£16 5s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Precip. B.P.	£56—£57 per ton, according to quantity.
Sulphur Chloride	4d. per lb., carboys extra. Dearer.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	5s. 1d. per lb. dearer.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

"Summer conditions" prevail in this as in most industries.

Acetate of Lime—	
Brown	£12—£12 5s. per ton d/d. Market easier.
Grey	£17—£18 per ton. Market easier.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 10s.—£9 per ton, according to grade and locality. Demand fairly good.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. ,, ,, 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	4s. 10d.—5s. per gall. 60% O.P. Market dull.
Solvent	5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar	£4 per ton. Cheaper.
Brown Sugar of Lead	£44 per ton. Cheaper.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6¼d. per lb. Quiet.
Crude 60's	1s. 9d.—1s. 11d. per gall., according to district. Still quiet.
Acid Cresylic, 97/99	2s.—2s. 1d. per gall. Demand fair.
Pale 95%	1s. 10d.—2s. per gall. Fair demand.
Dark	1s. 9d.—2s. per gall. Quiet.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	7½d.—9d. per gall. Quiet.
Unstrained	7d.—7½d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.

Benzole—	
Standard Motor	.. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	.. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% ..	.. 1s. 5d.—1s. 5½d. per gall. Small demand.
Pure ..	.. 1s. 8d.—2s. per gall. Small demand.
Xylol coml. ..	.. 2s. 3d. per gall.
Pure ..	.. 3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	.. 8½d. per gall. Not much business.
Middle Oil ..	.. 5d.—6½d. per gall., according to quality and district. Small export inquiry. Market quiet but fairly steady.
Heavy Oil ..	..
Standard Specification	
Naphtha—	
Solvent 90/160	.. 11½d.—1s. 3d. per gall., according to district. Fair demand.
Solvent 90/190	.. 11½d.—1s. 1½d. per gall. Fair demand.

Naphthalene Crude—
Market dull. Not much export inquiry. Cheaper in Yorkshire than Lancashire.
Drained Creosote Salts £4—£6. Quiet.
Whizzed or hot pressed £7—£9 per ton.

Naphthalene—	
Crystals and Flaked	.. £13—£16 per ton in Yorkshire and London respectively.
Pitch, medium soft	.. 55s.—60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160	.. 19s. per gall. Again dearer. Market firm.
Heavy	.. 12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

Business in dyestuffs has not been good lately, but an improvement is expected after the holidays. Prices remain firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	.. 1s. 7d. per lb.
Acid H.	.. 4s. per lb. 100% basis d/d.
Acid Naphthionic	.. 2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	.. 1s. 1d. per lb. Improved demand.
Acid Sulphanilic	.. 9½d. per lb. 100% basis d/d.
AluminiumChloride,anhyd.	1s. per lb. d/d.
Aniline Oil ..	.. 7¾d.—8½d. per lb. naked at works.
Aniline Salts	.. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base ..	.. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	.. 1s. 1d. per lb.
p-Chlorphenol ..	.. 4s. 3d. per lb. d/d.
p-Chloraniline ..	.. 3s. per lb. 100% basis.
o-Cresol 19/31° C.	.. 4½d. per lb. Demand steady.
m-Cresol 98/100%	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline ..	.. 2s. 3d.—2s. 11d. per lb.
Dichloraniline S. Acid	.. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol ..	.. £85 per ton.
Diethylaniline ..	.. 4s. 6d. per lb. d/d., packages extra, returnable.
Dimethylaniline ..	.. 2s. 3d. per lb. d/d. Drums extra.
Dinitrobenzene ..	.. 9d. per lb. naked at works.
Dinitrochlorbenzol	.. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine ..	.. 2s. 10d. per lb. d/d.
Monochlorbenzol	.. £63 per ton.
β Naphthol ..	.. 1s. 1d. per lb. d/d.
α-Naphthylamine	.. 1s. 4d. per lb. d/d.
β-Naphthylamine	.. 4s. per lb. d/d.
m-Nitraniline ..	.. 4s. 9d. per lb. d/d.
p-Nitraniline ..	.. 2s. 3½d. per lb. d/d.
Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. per lb. 100% basis d/d.
Nitronaphthalene	.. 10½d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis
m-Phenylene Diamine	.. 4s. per lb. d/d.
p-Phenylene Diamine	.. 10s. 3d. per lb. 100% basis d/d.
R. Salt	.. 2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 3d. per lb. 100% basis d/d.
o-Toluidine ..	.. 8½d. per lb.
p-Toluidine ..	.. 3s. 3d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. 3d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P	.. £45 per ton.
Acid, Acetyl Salicylic	.. 3s. 2d.—3s. 4d. per lb., according to quantity. Good demand. Price firm.
Acid, Benzoic B.P.	.. 3s. per lb.
Acid Boric B.P. ..	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric ..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 4½d.—1s. 5d. per lb., less 5% for ton lots. Market very weak.
Acid, Gallic ..	.. 3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst	.. 6s. 9d. lb. Resublimed quality 8s. per lb. Market firm, increasing demand.
Acid, Salicylic ..	.. 1s. 6d.—1s. 9d. per lb. Market unsettled and difficult.
Acid, Tannic B.P.	.. 3s. per lb. Market quiet.
Acid, Tartaric ..	.. 1s. 1½d. per lb. less 5%.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 2s. 1d. 2s. 3d. per lb. for quantity. Demand slow.
Amidopyrin ..	.. 13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone	.. 15s.—15s. 6d. per lb. Quiet market.
Benzonaphthol ..	.. 5s. 3d. per lb. Small inquiry.
Bismuth Salts ..	.. Prices reduced by about 1s. 3d.—2s. 3d. per lb. on account of the fall in the price of the metal.
Bismuth Carbonate	.. 10s. 6d.—12s. 6d. per lb.
„ Citrate ..	.. 10s. 3d.—12s. 3d. „
„ Salicylate	.. 9s.—11s. „
„ Subnitrate	.. 8s. 8d.—10s. 8d. „
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Unsettled. Spot supplies short. Raw materials dearer. Market very firm and advancing.
Ammonium ..	.. 1s. 3d.—1s. 5d. per lb.
Potassium ..	.. 1s. 1d.—1s. 3d. per lb.
Sodium ..	.. 1s. 2d.—1s. 4d. per lb.
Calcium Lactate ..	.. Market fairly firm and higher prices talked of. Good English make can be had from 1s. 6d. upwards.
Chloral Hydrate ..	.. 4s.—4s. 3d. per lb. Very firm and scarce.
Chloroform ..	.. 2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Formaldehyde ..	.. £52 per ton, ex works. English make in casks.

Glycerophosphates—	Fair business passing
Calcium, soluble and citrate free ..	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. ,,
Guaiacol Carbonate	.. 10s. 6d.—11s. 3d. per lb.
Hexamine ..	.. 3s. 6d. per lb. for English make Market steady.
Homatropine Hydrobr'ide	30s. per oz.
Hydrastine hydrochlor ..	English make offered, 120s. per oz.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £25 per ton, less 2½%. Price reduced.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 62s. 6d. per lb. Market rising rapidly.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Strong demand.
Mercurials ..	.. Market flat.
Red oxide ..	.. 5s. 3d.—5s 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. ,,
White precip. ..	.. 4s. 7d.—4s. 8d. ,,
Calomel ..	.. 3s. 11d.—4s. ,,
Methyl Salicylate	.. 1s. 10d.—2s. 1d. per lb. Keen competition.
Methyl Sulphonal	.. 26s. per lb.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 2s. 10½d.—3s. per lb. Not very active.
Paraldehyde ..	.. 1s. 5d.—1s. 6d. per lb. in free bottles and cases.
Phenacetin ..	.. 6s. per lb. Price and demand steady.
Phenazone ..	.. 7s. 6d. per lb. A shade firmer. Forward prices higher.
Phenolphthalein ..	.. 6s. 6d. per lb. Ample supplies.
Potass. Bitartrate—	
99/100% (Cream of Tartar) ..	.. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues heavy.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate	.. 7½d. per lb.
Quinine Sulphate	.. 2s. 3d. per oz., in 100 oz. tins. Very heavy demand.
Resorcin	.. 5s. 2d. per lb.
Saccharin.. ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. 6d. per lb.
Silver proteinate..	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb. Ample supplies. B.P. quality available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity.
Sod. Hyposulphite—	
Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	.. 75s.—82s. 6d. per cwt., accordin to quantity. Steady marke good demand.
Sod. Salicylate ..	.. Market more active. Powde 2s. 3d.—2s. 5d. per lb. Cryst at 2s. 5d.—2s. 7d. per lb. Flak 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal.. ..	.. 15s. 6d. per lb. Easier.
Thymol	.. 19s. 6d. per lb. nominal. Very scarce indeed. Still rising.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.
Aubepine	.. 15s. 3d. ,,
Amyl Acetate ..	.. 2s. 9d. per lb.
Amyl Butyrate ..	.. 6s. 9d. ,,
Amyl Salicylate ..	.. 3s. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 10½d. ,,
Benzyl Alcohol free from Chlorine ..	.. 2s. 10½d. ,,
Benzaldehyde free from Chlorine ..	.. 3s. 6d. ,,
Benzyl Benzoate	.. 3s. 6d. ,,
Cinnamic Aldehyde Natural.. ..	.. 16s. ,,
Coumarin ..	.. 19s. 6d. ,,
Citronellol ..	.. 17s. ,,
Citral	.. 9s. ,,
Ethyl Cinnamate	.. 13s. 6d. ,,
Ethyl Phthalate ..	.. 3s. 3d. ,,
Eugenol	.. 10s. 6d. ,,
Geraniol (Palmarosa)	.. 35s. ,,
Geraniol	.. 11s.—18s. 6d. per lb.
Heliotropine ..	.. 7s. 9d. ,,
Iso Eugenol ..	.. 15s. 9d. ,,
Linalol ex Bois de Rose..	26s. ,,
Linalyl Acetate ..	.. 26s. ,,
Methyl Anthranilate	.. 9s. 6d. ,,
Methyl Benzoate	.. 6s. ,,
Musk Ambrette ..	.. 45s. ,,
Musk Xylol ..	.. 14s. ,,
Nerolin	.. 4s. 9d. ,,
Phenyl Ethyl Acetate	.. 15s. ,,
Phenyl Ethyl Alcohol	.. 16s. ,,
Rhodinol	.. 57s. 6d. ,,
Safrol	.. 1s. 10d. ,,
Terpineol	.. 2s. 4d. ,,
Vanillin	.. 26s. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 15s. 6d. per lb.
Anise Oil	.. 2s. 6d. per lb.
Bergamot Oil ..	.. 17s. 6d. per lb.
Bourbon Geranium Oil	.. 36s. 6d. ,,
Camphor Oil ..	.. 75s. per cwt.
Cananga Oil Java	.. 10s. 6d. per lb.
Cinnamon Oil, Leaf	.. 6½d. per oz.
Cassia Oil, 80/85%	.. 9s. 6d. per lb. Advanced.
Citronella Oil—	
Java 85/90% ..	.. 5s. 8d. per lb.
Ceylon ..	.. 3s. 7d. per lb.

Clove Oil	..	8s. per lb. Firmer.
Eucalyptus Oil 70/75%		2s. 4½d. per lb.
Lavender Oil—		
French 38/40% Esters		30s. per lb. Very firm. Higher price expected owing to bad crops.
Lemon Oil	..	3s. per lb.
Lemongrass Oil	..	3d. per oz.
Orange Oil, Sweet	..	13s. per lb.
Otto of Rose Oil—		
Bulgarian	..	37s. 6d. per oz. Production below average.
Anatolian	..	18s. per oz.
Palma Rosa Oil	..	18s. per lb.
Peppermint Oil—		
Wayne County	..	21s. 6d. per lb.
Japanese	..	17s. 3d. per lb. nominal. Market rising rapidly.
Petitgrain Oil	..	9s. 3d. per lb.
Sandal Wood Oil—		
Mysore	..	26s. 6d. per lb.
Australian	..	21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than October 20th, they are on sale at 1s. each at the Patent Office Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on September 4th.

I.—Applications

Fraser, Rissik, Fraser & Co., Ltd. Colloidal mills etc. 19481. Aug. 16.

Hogan and Marshall. Apparatus for accumulating and discharging latent heat. 19,206. Aug. 13.

Joseph. Filters for air etc. 19,417. Aug. 15.

Lowe, Manchester Furnaces, Ltd. Muffle furnaces. 19,238. Aug. 13.

Synthetic Ammonia and Nitrates, Ltd. Catalyst. 19,445. Aug. 16. (U.S., 16.8.23.)

Te Aroha Dairy Co., Ltd. Deodorizing, cooling, and dehydrating fluid substances. 19,061. Aug. 11. (New Zealand, 14.8.23.)

I.—Complete Specifications Accepted

6599 (1923). Soderlund, Boger, Testrup, and Techno-Chemical Laboratories, Ltd. Separating solids from liquids. (220,015.)

19,656 (1923). Keene. Filtering-apparatus. (220,157).

21,584 (1923). Coward. Crushers and pulverizers. (220,176.)

27,039 (1923). Haddan (American Blower Co.). Method and apparatus for treating vapours. (220,201.)

1677 (1924). Rousseau. Ore pulverizers. (220,229.)

7082 (1924). Field. Method and apparatus for recovering solids from liquids by heat interchange. (220,253.)

II.—Applications

Denham and Jones. Producer-gas generators. 19,283. Aug. 14.

Escorihuela. Combustible product. 19,201. Aug. 13. (Spain, 13.8.23.)

Kohlenscheidungs Ges. Distillation of bituminous substances. 19,145. Aug. 12. (Ger., 28.11.23.)

Miniken. Apparatus for dewatering coal slimes. 19,108. Aug. 12.

Pintsch Akt.-Ges., J. Porous charges for containers for storage of acetylene etc. dissolved in liquids. 19,408. Aug. 15. (Ger., 16.8.23.)

Rosencrants and Vickers International Combustion Engineering, Ltd. Drying coal, etc. 19,023. Aug. 11.

Sankey. Manufacture of activated carbon. 19,128. Aug. 12.

Sauer. Manufacture of active carbons. 19,179. Aug. 13.

Synthetic Ammonia and Nitrates, Ltd. Gas purification. 19,447. Aug. 16. (U.S., 16.8.23.)

Ward. Apparatus for washing and separating coke etc. from clinker. 19,006. Aug. 11.

Winser. Retorts for distillation of oils etc. 19,214. Aug. 13.

II.—Complete Specifications Accepted

6165 (1923). Becker. Coking retort oven batteries with regenerators. (209,380.)

11,797 (1923). Firth, Blakeley, Sons and Co., Ltd., and Wright. Washers or purifiers for use in the manufacture of gas. (220,039.)

11,901 (1923). British Thomson-Houston Co., Ltd. (General Electric Co.). Electric incandescent lamps and filaments therefor. (220,045.)

15,948 (1923). McAlpine. *See* XXIII.

19,587 (1923). General Electric Co., Ltd. Manufacture of electrodes for tungsten arc lamps. (209,028.)

10,794 (1924). Farbwerke vorm. Meister, Lucius and Bruning. *See* XX.

IV.—Applications

Colloidal Colour Co., Ltd., Goedecke. Production of colour lakes. 19,496. Aug. 16.

Harris, Jones, Morton, Morton, Sundour Fabrics, Ltd., Wylam. Dyes and dyeing. 19,066. Aug. 11.

IV.—Complete Specifications Accepted

19,495 (1923). Farbenfabriken vorm. F. Bayer and Co. Production of dye-stuffs of the anthraquinone series. (201,575.)

30,390 (1923). Johnson (Badische Anilin and Soda Fabrik). Manufacture and production of green vat dye-stuffs. (220,212.)

30,721 (1923). Johnson (Badische Anilin and Soda Fabrik). Manufacture and production of vat dye-stuffs of the anthraquinone series. (220,216.)

31,989 (1923). Compagnie Nationale de Matieres Colorantes et de Produits Chimiques. Manufacture of a dye-stuff from naphthidine. (208,720.)

V.—Applications

British Celanese, Ltd., Ellis and Goldthorpe. Treatment of acetyl cellulose etc. 19,292. Aug. 14.

Kempter. Process of making viscose. 19,443. Aug. 16. (Ger., 15.5.24.)

Zdanowich. Manufacture of cellulose derivatives. 19,405. Aug. 15.

V.—Complete Specifications Accepted

17,883 (1923). Souchon. Method of and apparatus for bleaching cellulose pulp for the manufacture of paper. (220,137.)

18,226 (1923). Thomassen. Process for freeing paper pulp from impurities. (220,139.)

VI.—Applications

Harris, Jones, Morton, Morton, Sundour Fabrics, Ltd., Wylam. 19,066. *See* IV.

Mohr. Bleaching of textiles. 19,385. Aug. 15.

VII.—Applications

Casale. Catalytic synthesis of ammonia. 19,063. Aug. 11. (Italy, 29.3.24.)

Farbenfabriken vorm. F. Bayer and Co. Manufacture of highly-active silica gels. 19,416. Aug. 15. (Ger., 3.9.23.)

Liebreich. Production of solutions containing oxides of chromium etc. 19,226. Aug. 13.

Scott. 19,208. *See* IX.

VII.—Complete Specification Accepted

5699 (1923). Amber Size and Chemical Co., Ltd. (Muth). Manufacture of aluminium hydroxide. (220,011.)

VIII.—Applications

Bell. Production of refractory bodies for electrical purposes. 19,257. Aug. 13.

Colloidal Colour Co., Ltd., Goedecke. 19,496. *See* IV.

IX—Applications

Burney. Manufacture of artificial wood and of building elements therefrom. 19,332. Aug. 14.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

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EDITORIAL

THE first World Power Conference was opened in the conference halls of the British Empire Exhibition on Monday last by the Prince of Wales, and the serious business on the programme began on Tuesday. Representatives of no less than thirty different countries, including the British Dominions, will be busy for nearly a fortnight, discussing problems that are of vital importance. It is fitting that the Conference should be international rather than national, for its purpose is to discuss the various ways in which power can be utilised and how the sources of power can be adjusted both nationally and internationally. The programme is enormous and covers every aspect of the subject, over 300 papers having been prepared for the Conference. The discussion first centres on the potential resources of hydroelectric power, oil and minerals in each country, and the generation and utilisation of power; it then branches out to consider the necessary research in its widest sense, and there will be conferences on the development of scientific agriculture, on technical education and its improvement, on the economic and financial aspects, both national and international, of industry, and many other subjects. As the Prince of Wales said, in his opening speech, "the study of power is still in a comparatively elementary stage, and no effort has hitherto been made to find out on what foundations our present industrial structure is built, and what part power plays in it." And one speaker pointed out, very truly, that ancient civilisations failed to advance because they failed to discover new sources of power. The characteristics and utilisation of the different sources of power have been the object of a vast amount of investigation during recent years, and the technical journals are filled with accounts of devices for economising coal, for the utilisation of waste materials or the better use of ordinary fuels, for the conservation of heat, for the economical application of power, such as the wave-impulse process, the mercury boiler, the high-pressure boiler recently described in *Chemistry and Industry*, fuel economisers, pulverised-fuel installations, heat exchangers—the list is unending. But the fundamental problems remain untouched, although the effective use of power for industrial purposes is at the very base of the social structure. Yet our resources of coal and oil are to be considered as wasting assets if we are to believe one branch of opinion, although optimists are not lacking to proclaim that only a fraction of the world's power resources has been tapped. However that may be, we in England will be forced to consider the problem very seriously in a few hundred years. Pictures have been drawn of the migration of industry from the coal fields to districts with water power, of the abandonment and consequent impoverishment of the countries that lack "white coal," as our Gallic friends call hydraulic energy. But it is not easy to foresee economic conditions even a few months ahead, and we cannot pretend to the century-striding imagination of Mr. Wells. Whatever may be the result of the Conference, it cannot but stimulate efforts "amongst the nations in the endeavour to harness the forces of Nature for the common good."

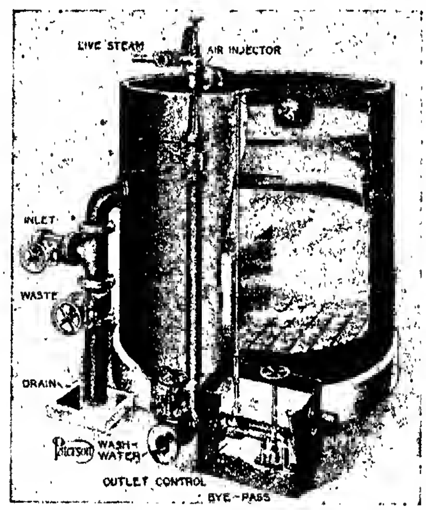
Chemists have a particularly deep interest in the problems of power, whether as motion or heat, apart from the fact that power and labour are two economic factors that have an important influence on the application of chemical processes. The particular aspect of the problem that concerns chemistry is the utilisation of low-potential energy, energy that is developed irresistibly in every hedgerow, in every mossy cranny of the wall, in every flower-decked field. An esteemed clerical contributor has written in these columns about Prof. Baly's work on the synthesis of sugars in the plant, and it is to be hoped that the work is making good progress, for we know so little about the chemical operations performed by living matter. Despite the perfection of modern chemical methods, despite the vast accumulation of chemical data, operations are performed at low temperatures by the vegetable world that are difficult of imitation in the laboratory, and then only at a considerable expenditure of energy and with the aid of elaborate apparatus. Last week Prof. Drummond pleaded for a broader basis in the training of chemists, and remarked how often chemists were faced with the problems of the cell. How beautiful are the processes of the living cell! Who could fail to be impressed when the microscope reveals the amazing process of cell division, when the chromosomes are seen to divide equally, arrange themselves symmetrically, one-half at each end of the cell, when the formation of the dividing wall becomes apparent, to be followed by the separation of two cells where there was but one before. We have no explanation of this mysterious activity, we cannot imitate it, but we can be confident that an explanation will be found. Prof. Irvine and his co-workers are unravelling many twisted threads in the chemistry of the carbohydrates, Prof. McBain has inspired an active school of research in colloid chemistry, and at Liverpool, those members who attend the Society's Annual Meeting, will be able to see Prof. Baly in the flesh and to acquire fresh knowledge about the syntheses in the plant cell. Pessimism leads nowhere, optimism is too often blind, but we are confident that the future holds a vast treasure of knowledge that will be won and distributed. Sir William Pope has thought much about these matters, and it is of interest to quote from his recent Cantor Lecture: "Fears are often expressed that humanity is being impoverished, and that posterity will be embarrassed by the rapidity with which our coal and petroleum resources are being consumed; but it is reasonable to presume that long before these potential supplies of energy have disappeared, their applications will have become obsolete. Whilst every motive exists for employing our present sources of energy with the maximum efficiency, we may safely leave posterity to look after itself with the aid of its scientific heritage." How fortunate will be the chemist who arrives at an understanding of the mechanism of chemical changes, particularly of catalytic reactions such as occur in living matter; he will have his fingers on the very pulse of life. We cannot tell whither we are going, but chemistry is preparing the road to the future.

INDUSTRIAL FILTRATION PART II

By S. G. URE, M.A., B.Sc.

Sand Filters

Sometimes the water supplies to factories contai impurities which can be removed either directl by filtration or precipitated by treatment wit suitable materials and then filtered. The type c filter usually employed in this class of work is th sand filter. One plant of this type made by th Paterson Engineering Co. consists of a cylindrica steel vessel having dished ends placed with it axis vertical in the smaller sizes, and horizonta in the larger units. A layer of pea gravel is spreac on the bottom of this vessel and over this is placec the filtering medium consisting of a thick bed o quartz sand. To prevent disturbance of the uppe surface of the sand and to ensure an even feed

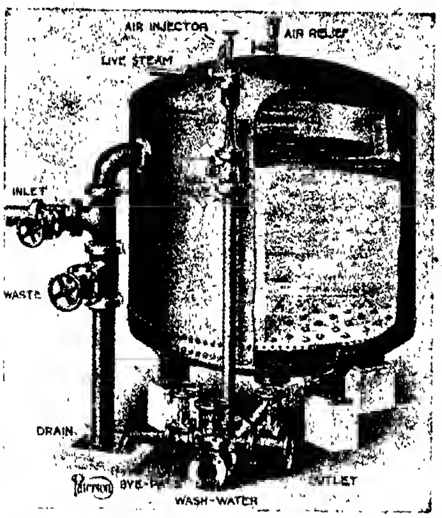


Paterson Gravity Filter

Fig. 1

the water enters through a trough situated near the top, and riveted to the inside of the cylinder The water, after flowing down through the sand, is collected by a manifold strainer system and leaves the filter through an inspection box. These filters may be of the gravity or pressure types illustrated in Figs. 1 and 2. As the rate of filtration with this system is fifty times that obtained with the slow sand filter, it is evident that for successful working efficient means of cleaning the filtering medium must be installed. In the smallest types this is done by passing a current of water in the reverse direction through the sand which meanwhile is agitated by stirrers operated by a hand wheel on the top of the filter, whilst in the larger sizes the agitation of the sand bed is effected by compressed air. When cleansing the filter the water level is lowered to the level of the inlet trough.

he main inlet and outlet valves closed, and com-ressed air admitted at the bottom of the filter, which thoroughly agitates the sand and loosens the ntercepted impurities. The impurities are washed ipwards by a current of water, also admitted at he bottom of the filter and are collected and emoved through the annular trough. The cleansing nd aeration of the bed can be accomplished in a ew minutes, and on the filter being again put into ommission an automatic outlet control causes his to take place gradually, thus ensuring a filtered lischarge. When very large units are desired, iorizontal cylinders are employed, as it is found hat in the vertical type, dished ends greater than ft. in diameter cannot withstand the pressures.



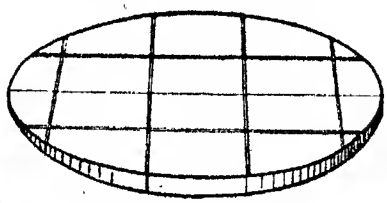
Paterson Pressure Filter

FIG. 2

The coagulation of very finely divided particles is effected by the addition of small quantities of sulphate of alumina which, reacting with the calcium carbonate, either present in or added to the water, forms aluminium hydrate, which brings down the suspended matter. The firm provides an automatic coagulant-supply gear, which adds the correct amount of coagulant to the varying volumes of water passing through the filter.

Porous Plate Filters

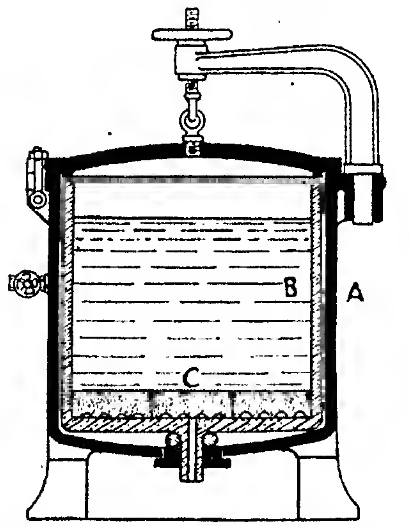
In filters of this class made by S. Bornett and Co., Ltd., and illustrated in Figs. 3, 4 and 5, the filtering medium consists of porous plates, made of carbon, silica, fireclay and siliceous clay. Such filters are capable of handling acid, alkaline, corrosive, hot and volatile liquors. In its simplest form the filter is made by placing a number of these bricks suitably shaped in the bottom of an earthenware cylinder, as shown in plan in Fig. 3. At the lower corners of these plates are projections, which keep the plates clear of the bottom of the cylinder and so provide a collecting space for the filtered liquor. The upper edges of the plates are bevelled, so that when two plates are in contact, a V-shaped groove is formed, which can be filled with a suitable jointing material, such as portland cement, lead, or a mixture of sulphur and graphite. The unfiltered liquor is admitted above the porous plates, and is filtered



Arrangement of Porous Filter Plates for Bornett Circular Vacuum Filter

FIG. 3

by its passage through them. Porous plate filters work either under vacuum, but usually under pressures greater than atmospheric. The smaller sizes, illustrated in Fig. 4, consist of a vertical cast iron cylinder, provided with a hole in the bottom, and fitted with a swing cover on the top. Into this cylinder is placed a stoneware cylinder open at the top, and having a central outlet pipe at the bottom which passes through the hole in the bottom of the outer



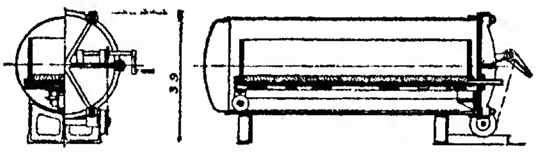
A—Filter. B—Funnel. C—Plates.

Bornett Pressure Filter, 20-gallon Pot Type

FIG. 4

cylinder, the joint between the outer and inner cylinder being formed by a rubber ring, which fits tightly over the outer surface of the outlet pipe. The porous plate is fixed near the bottom of the stoneware cylinder, which is then filled with the liquid to be filtered. The cover of the outer cylinder having been put into position, and screwed down, com-

pressed air is admitted to the cylinder, and forces the liquid through the porous plate, and at the same time compresses the rubber ring between the bottom of the cast iron and the bottom of the porcelain cylinders, thus forming an airtight joint. In the larger sizes (Fig. 5) the cast iron cylinder is horizontal, and a number of rectangular troughs, suitably dimensioned to fit the cylinder, are attached to the cover. This cover is mounted on a trolley, to facilitate the insertion or withdrawal of the troughs from the cylinder, and the inner ends of the troughs are fitted with wheels, which, running on rails attached to the wall of the cylinder, prevent tilting. The troughs are provided with a double bottom made of porous plates cemented together. Outlet pipes communicating with the space between



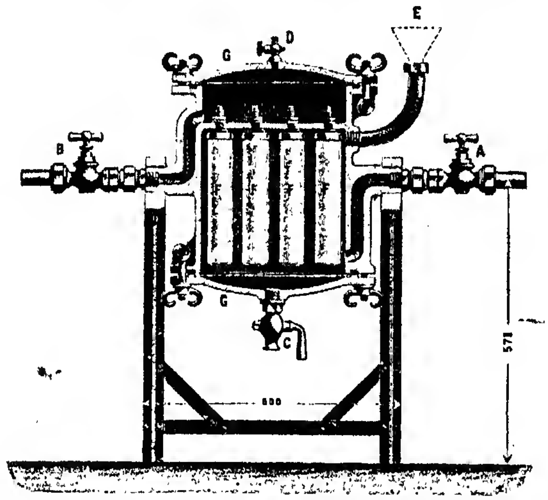
Bornett Pressure Filter
Capacity 50 Gallons an Hour

Fig. 5

the porous plates and the bottom of the trough pass through the movable cover, and are then connected to the tank for reception of the filtered liquor. The leakage of air round those pipes is prevented by suitable stuffing boxes and glands. In operating the machine, the troughs are withdrawn from the casing and filled with the liquid to be filtered. They are then run into the cylinder, and after the cover has been screwed up, compressed air is admitted to the cylinder, the filtered liquid being removed by the outlet pipes, which can if desired deliver the liquid into a receiver placed on a higher level than the filter. After filtration, if washing of the precipitate is necessary, the troughs may be withdrawn, filled with water, and again returned to the cylinder. Compressed air is again applied, to force the wash water through the precipitate on the plates. After washing, the air is released and the troughs withdrawn to enable the precipitate to be removed. Filtration can be made continuous instead of intermittent by running in the liquid from overhead receivers under pressure and washing or extraction can be carried out in a similar manner without withdrawing the troughs in the manner described. The following figures give an indication of the rates of flow obtained with filters of this type :—

Material	Thickness of cake in.	Working pressure in lb. per sq. in.	Flow in litres per sq. metre per hour
Calcium chloride	3	30 lb.	200 to 250
Magnesium carbonate ..	3	Vacuum	200
Photographic chemical ..	1½	60 lb.	150
Silicic acid..	1½	Vacuum	145

In the Berkefeld filter, illustrated in Fig. 6, the filtering medium consists of carbon or kieselguhr candles cemented into metallic caps having central outlet pipes. These candles are suspended by their outlet pipes from a plate placed at right angles to the axis of the cylindrical containing vessel. This plate divides the cylinder into two compartments the lower one of these containing the filter candles The liquid to be filtered is pumped into this compartment, and in its passage to the upper compartment must flow through the filtering medium The outlet for the filtered liquid is attached to the upper compartment. In using the filter a fine coating of kieselguhr is first deposited on the outside of the candles, by mixing kieselguhr with the



Section of Berkefeld Filter, Large Size, Pattern T

Fig. 6

incoming water. After a suitable layer of kieselguhr has been formed, the liquid only is admitted to the lower compartment, and filtration is continued until the rate of flow falls off owing to the accumulation of impurities on the filtering surface When this occurs, the filter is cleaned by passing water in the reverse direction through the filtering medium. This water washes off the kieselguhr deposit and the impurities collected thereon, and these can be removed through a cock at the bottom of the filter.

Bag Filters

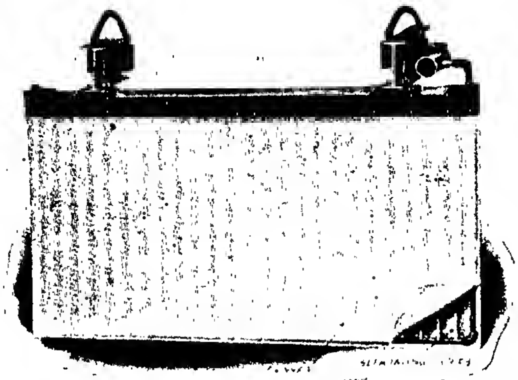
An early form of filter consisted of a number of bags made of muslin or cotton wool. The open end of each bag is attached by means of a metal fitting to short pipes projecting downwards from a trough or launder. The liquor to be filtered is fed into the launder, and entering the bags suspended underneath, flows outwards through the filtering medium whilst the precipitate is retained in the bag. Filters of this type can be made having a very large filtering surface but can only be worked at low pressures. When filtering hot liquors, in order to retain the heat, the bags are enclosed in a steam-heated cast iron chamber. This type of filter was largely used in sugar refineries and is still employed in the filtration of gases obtained from furnaces smelting lead and zinc ores. In this

case bags 18 in. in diameter and 30 ft. long are used. These are usually made of wool, as this material resists the heat and acid fumes better than cotton.

Leaf Filters

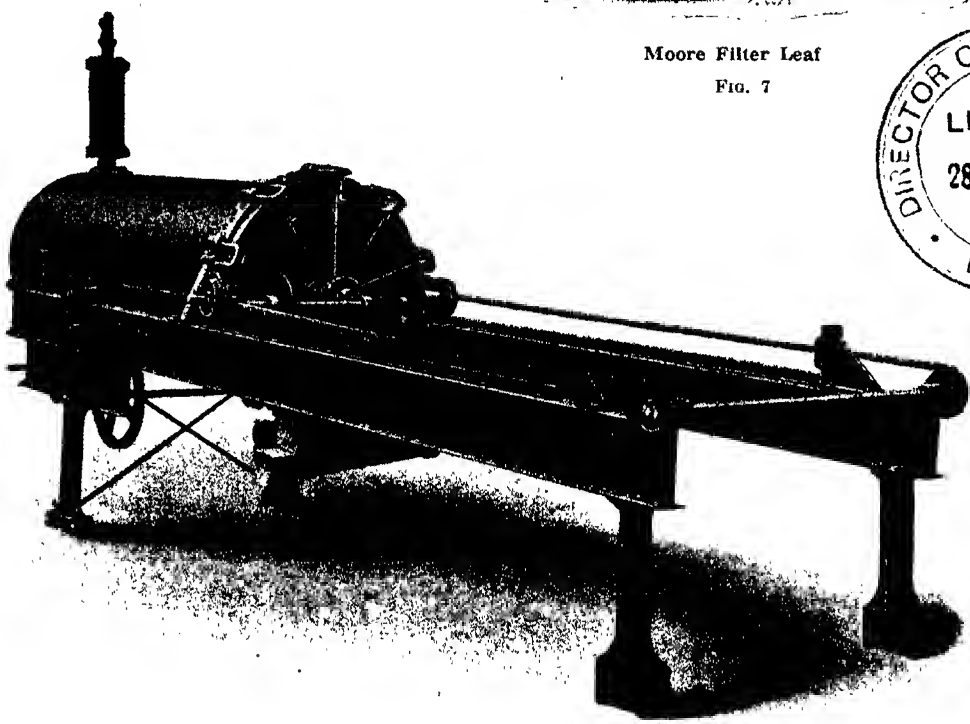
Filters of this type may be divided into two classes, namely, suction and pressure leaf filters. Suction leaf filters were originally introduced to filter the slimes obtained by treating fines with cyanide to extract gold. The filter (Fig. 7) is built up of a number of leaves, each leaf consisting of a filtering medium in the form of a bag, which envelopes a rectangular frame usually made of perforated pipes. Inside this frame and rigidly attached to it is a stiff corrugated surface made of coconut matting, wood or iron. This prevents the collapse of the walls of the bag when suction is applied internally, and at the same time allows the liquor which passes through the filtering medium to reach the outlet placed at the top of the leaf. A filtering unit is formed of a number of parallel leaves rigidly suspended from a series of cross girders. The distance between the leaves depends upon the economical thickness of cake required, but is usually not less than four inches.

The outlet pipes from the leaves are coupled to a collecting pipe, which is connected with a receiving tank, by a piece of flexible tubing, of such a length that it will permit of the unit being immersed in the furthest tank. In working this filter, the unit or battery of leaves is lowered into a tank, containing the liquor to be filtered, and then suction is applied by means of a vacuum pump connected with the receiver from which the filtrate can be removed by a suitable pump or barometric leg. When sufficient



Moore Filter Leaf

Fig. 7



Hand-operated Kelly Filter, ready for Filtering

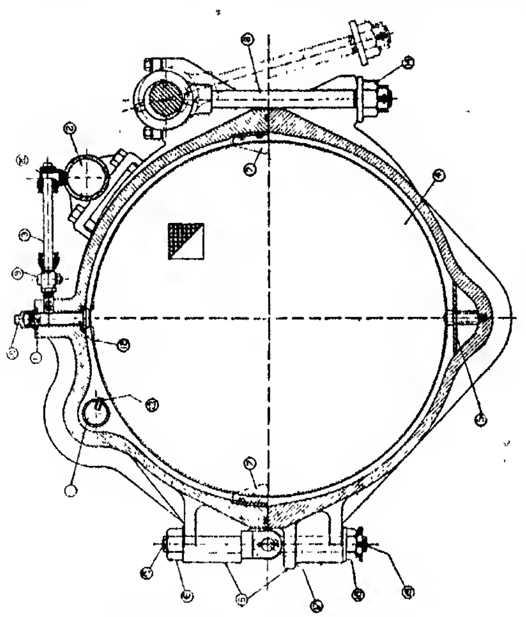
Fig. 8

thickness of cake has been built up, it can be washed by immersing the battery of leaves in a second tank, containing water, and again applying suction to the leaves. If the cake has to be dried, the battery of leaves is removed from the wash tank, and a current of air is drawn through the cake. To remove the cake, compressed air or steam with or without the aid of an externally applied jet can be used, or the leaves may be immersed in a tank of water and a reverse current of water employed. A travelling crane carried on a suitable track above the tanks is used to transport the batteries of leaves from one tank to another. Smooth running must be an essential feature of this crane, as jerky motion is liable to dislodge the cake, and so nullify subsequent washing or drying operations. Special attention should be given to the method of attaching the battery of leaves to the crane, to ensure that the pull exerted by the crane is directly over the centre of gravity of the battery of leaves. During transportation, suction should be applied to the leaves to prevent displacement of the cake. For efficient working, the filtering surface must be kept continually immersed in the liquid, or wash water, and this is accomplished by admitting the liquor or wash water to the tank at a faster rate than can be dealt with by the filter, and removing the excess through a weir at the top of the tank above the filtering surface. Filters of this type are made having a filtering surface of 10,000 square feet, and with this size of filter, the crane may be required to handle loads of about 20 tons. As, however, this is a low pressure filter, the maximum filtering pressure being always less than atmospheric, thus necessitating very large filtering surfaces, pressure leaf filters have been introduced. Belonging to this class are the Kelly and Sweetland filters made by the United Filters Corporation, and the Vallez Filter, manufactured by the Vallez Rotary Filters. The Kelly filter (Fig. 8) consists of a number of rectangular leaves of analogous construction to those used in suction filters, placed parallel to one another, and to the axis of a surrounding cylinder. To obviate the necessity of a crane, involving considerable head room, for the removal of the leaves, the axis of the cylinder is only slightly inclined to the horizontal; the withdrawal of the leaves through the lower end of the cylinder being thus assisted by gravity. In the twin unit type, however, the axes of the cylinders are horizontal, the movement of the leaves being effected by a motor driven mechanism. The leaves are attached to the cylinder cover, the outlet pipes passing through the cover, and then being coupled to the discharge pipe. The other ends of the leaves are attached to a horizontal bar carrying two small wheels, which run on rails fixed one on each side of the inner surface of the cylinder. The cylinder cover is also carried by a frame mounted on wheels, which travel on rails extending from the cylinder. In this way the cover and leaves can be easily withdrawn from the cylinder, to permit of the removal of the cake. The tightening of the joint between the cylinder and cover is effected by a series of radial arms carried on the cover. These engage in a series of U bolts fixed to the cylinder in such a way that by binding on an inclined surface they press the cover against the flange of the cylinder. These radial arms are connected at their inner ends to the actuating mechanism which operates them all simultaneously.

Mounted on the outside of the cylinder are the valves for controlling the admission of the liquor to be filtered, and the wash water, an automatic compressed-air regulator, an air release valve and a drain cock. In operating the filter the relief valve is opened until the filter chamber is filled with the liquid being filtered. On closing this valve the pressure rises inside the filter and filtration begins, the pressure being maintained constant by the incoming liquid. When the desired thickness of cake has been formed the unfiltered liquor in the cylinder is returned, through the drain cock to the storage tank. Whilst this is being done, the cake is held in position by compressed air admitted through the automatic air regulating valve. If, after draining, washing is required, the wash water is pumped into the cylinder, and as its level rises in the chamber, air is released in such a manner that a positive pressure is maintained on the cake. When the cylinder is full of water, the condition will be similar to that existing at the end of filtration and washing can begin. Unfortunately, this operation requires considerable skill and care, as a fall in pressure is liable to crack or break the cake and so cause uneven washing. To overcome this, water containing unwashed cake from previous runs or inert clays is sometimes used to fill up any cracks or holes which may be formed during the transition stage. When it is necessary to dry the cake, the liquid in the cylinder is again drained off through the drain cock, the cake being again held in position by a positive pressure produced by compressed air. After all the liquid has been removed from the cylinder, the air is allowed to flow through the cake and escape through the outlets of the leaves. Here, again, care must be taken to prevent the cake from cracking or breaking. To discharge the filter, the air pressure is released, the cover unlocked, and then drawn as smoothly as possible out of the cylinder. The outlets of the leaves are then closed, and air at about 10 lb. per square inch pressure is admitted into the interior of the leaves. Higher pressures are not used, as they are liable to injure the filter cloths. The efficiency of this process is again lessened by the presence of cracks or holes in the cake. For efficient working of the filter the cakes on two adjacent leaves should not touch each other. Where economy of floor space is essential the twin unit type can be adopted. This consists of two cylinders with their axes in line, and having a space between them equal to the length of the cover and leaves, when fully drawn out from the cylinder. Into this space the leaves are drawn, alternately from each cylinder, in order to remove the cake.

The Sweetland filter (Fig. 9) as at present designed consists of a cast-iron cylinder permanently closed at either end and divided longitudinally so as to form two equal portions. The axis of the cylinder is horizontal, and the upper half is rigidly attached to columns supporting the machine, whilst the lower half is hinged to the upper, in such a way that it can

swing through an angle of at least 90°. Counterbalance weights attached to this portion facilitate its rotation into the shut position. The closing of the joint between the upper and lower halves of the casing is effected as follows. Rigidly attached to the upper half and having its axis parallel to the axis of the casing, is a shaft carrying a number of eccentric sheaves. The straps of these sheaves are each connected to a rod terminating at its lower end in a bolt head. These rods swing into slots formed in the outer flange of the two portions of the casing, the heads being in contact with the lower flange. A hand wheel operat... ...rain of toothed wheels rotates this shaft, and t... raises or lowers the rods,



Cross-section of Sweetland Filter

Fig. 9

thereby applying or releasing the pressure on the joint. A passage is cast in each portion of one of the ends of the filter, in such a manner that when the casing is closed one complete passage is formed, having its inlet on the outer surface of the upper half and its outlet at the lowest point on the inner surface of the lower half. The inlet pipe is bolted to the inlet to this passage, the outlet of which discharges into a duct cast in the lower half of the casing. This duct is covered by a distribution plate through which the liquid is discharged evenly between the leaves throughout the length of the filter. Drain cocks are fitted at the lowest points of the lower half of the casing. The leaves of this press are circular and of such a diameter that they fit closely against the inner surface of the casing. They are attached to the upper half of the casing by the outlet pipes, which, starting from the highest point of each leaf, pass through the highest points of the upper casing and discharge through sight glasses into a common collecting pipe. Lugs cast at the lowest points of the upper half of the casing space out the leaves and prevent them from rotating. A channel cast near the highest point of the upper half of the casing carries a steel pipe parallel to the axis of the filter. This pipe is capable of slight longitudinal as well as rotational motion, and carries a number of nozzles, through which flows the water required for sluicing the cake off the filtering medium. The method of operation of this filter is analogous to that employed on the Kelly machine.

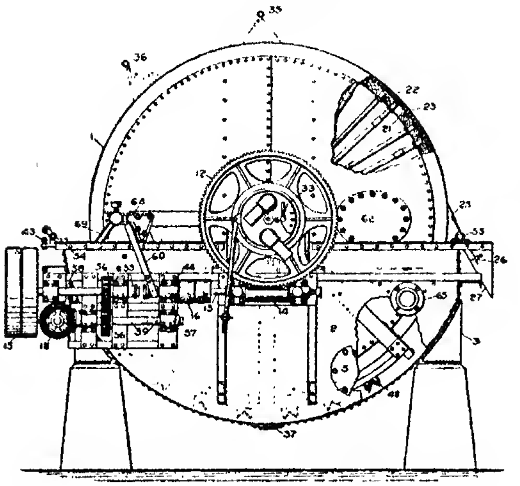
When extra agitation of the liquor being filtered is necessary, some of it is allowed to escape from the filter through the sluicing pipe mentioned above.

The housing of the Vallez filter is also cylindrical, and cast in two portions, which are bolted together, giving a longitudinal joint. The axis of this casing is horizontal, and as it does not require to be opened for the removal of the cake a permanent joint can be made after the filtering surface has been put into position. The filtering surface is formed of a series of cloth-covered discs which are keyed to a stout hollow shaft. The discs are provided with hollow hubs which regulate the spaces between the discs. The hollow portion of the hub communicates with the drainage area behind the cloth, and by means of radial holes in the shaft, with the hollow portion of the shaft. Four angle irons attached to the peripheries of the discs maintain their alignment, and at the same time remove any solid material from the wall of the casing. The shaft is carried by bearings in the end plates of the casing, leakage past these bearings being prevented by suitable stuffing boxes and glands. One end of the hollow shaft is plugged and fitted with a worm wheel which engages with a worm, through which rotational motion is given to the shaft and leaves. The other end of the hollow shaft is fitted with a stuffing box and gland through which passes the outlet pipe for the removal of the filtered liquid. At the lowest point of the casing is a trough which contains a screw conveyor, by which the cake is carried to the discharge boxes. At the highest point of the casing is a second channel containing a pipe having a series of nozzles so arranged that they can direct streams of water or air over the filtering surfaces of the discs, and so remove the cake, which is then carried by the above mentioned angle irons into the lower trough. Suitable openings at the bottom of the filter-casing admit the solution to be filtered, the water for washing the cake, and steam if required, and permit of the removal of the surplus liquor and wash water. A small cock at the top of the filter provides a suitable vent for the air displaced by the incoming liquid. When the air has been displaced, the pressure inside the cylinder rises, and forces the liquid through the filtering medium. The rotation of the discs keeps the liquor thoroughly agitated, and ensures a uniform deposit of cake. This machine is also provided with an ingenious device by which the thickness of cake can be directly measured. After formation of the cake, the liquor is drained off, the cake being meanwhile held in position by a positive pressure created by the admission of compressed air to the filter. If washing is necessary, this air is gradually displaced by wash

water, care being taken to prevent fluctuation in the pressure on the cake. After washing, the surplus wash water can be again drained off, and if necessary, the cake can be dried by compressed air before it is blown off the leaves by the compressed air admitted through the top manifold pipe. These pressure filters require skilled attention, to prevent the cracking and breaking of the cake during the removal of the surplus liquor and wash water.

Continuous Filters

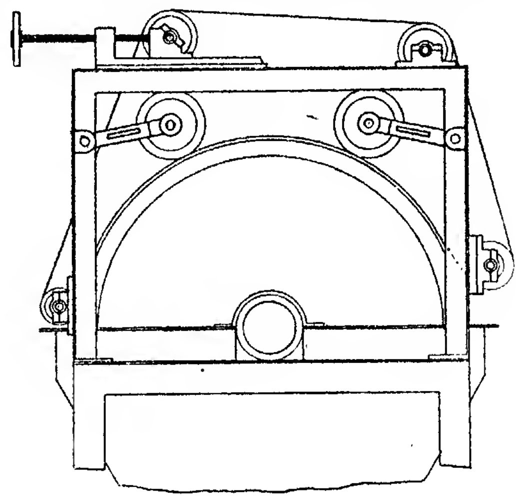
This type of filter is suitable for handling free filtering materials at such temperatures that the vapour pressure does not greatly reduce the vacuum employed. Filters of this class may be divided into



Oliver Filter with Oscillating Agitator and Enclosed Heads

Fig. 10

two types, namely, the drum and the disc type, and although the former has been in use for a considerable time, its modern development only dates from 1908, when the Oliver filter (Fig. 10) was invented. This filter consists of a hollow drum, which rotates on a horizontal axis. The outer surface of this cylinder is divided into a number of independent and separate compartments by partitions placed parallel to the axis of rotation. Supported by the outer edges of these partitions is a screen, upon which rests the filtering medium, in the form of a continuous sheet. Each compartment has two outlets, to facilitate drainage, one on the leading, and the other on the lagging side of the compartment. These two outlets are coupled to one pipe, which, passing through one of the trunnions supporting the drum, terminates in its own port on the end of the shaft. The valve consists of a hollow cylindrical casting, on the inner face of which is an annulus which coincides with the ports on the end of the shaft. A number of radial walls divide the cylinder into a number of compartments, the outlets of which are formed by holes drilled in the outer end of the valve. Adjustable bridge pieces are fitted into the annulus, so as t isolate the group of ports in communication with or chamber of the valves, from the groups of ports i communication with the chambers on either sid The shaft of the drum rests on bearings mounte on the upper edge of a tank which is provided with suitable agitating device, and contains the liquid t be filtered, which thus covers the lower portion of th drum. The lowest chamber of the valve, whic remains stationary, is connected to a vacuum pump and in this way a suction is applied to those com partments of the drum immersed in the liquid. Th filtered liquor drawn into this chamber can be caugh in a receiver, placed in the pipe line leading from th chamber to the vacuum pump, and can be withdraw from this chamber, by another pump, or barometri leg. As the drum rotates, those compartments after passing the first bridge, come one by one int communication with the second valve chamber i which a low vacuum is maintained. During th time that the compartments are in communication with this chamber of the valve, the cake is washed by water applied in the form of a fine spray. The compartments of the drum during this period are ascend-



Sketch of end view of FEinc Filter

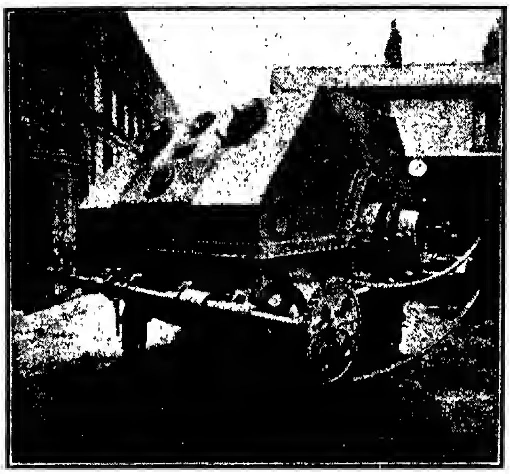
Fig. 11

ing from the upper edge of the tank to their highest position. During the descent of these compartments from their highest position their ports pass the second bridge and come into contact with a third chamber of the valve in which also a low vacuum is maintained By this means air is drawn through the cake to dry it Just before the compartments of the drum reach the level of the upper edge of the tank, their ports pass a third bridge piece, and bring them one at a time into contact with a fourth valve chamber containing compressed air, which loosens the cake, and causes it to be easily removed by a knife or scraper, placed parallel to the axis of the drum and a little above the upper edge of the tank. Further rotation of the

drum causes the ports, to pass the fourth bridge piece, and to come again into communication with the first chamber of the valve, just as the corresponding compartment is again submerged in the liquid in the tank. The compartments of the drum then repeat the cycle described above.

To obviate the use of an atomised spray for washing purposes, and at the same time to compress the cake and provide a new method of removal from the drum, the Filter Engineers Incorporated have developed the FEinc filter shown in Figure 11.

This consists of a drum filter similar in action to the one described above. Over the upper surface of the drum from the liquor level to the point of removal of the cake passes an endless belt made of a porous material such as wool or cotton. This belt extends over the full length of the drum and is carried by four pulleys mounted on a frame work



Kestner Continuous Filter
Fig. 12

attached to the top of the tank. Sometimes idle rollers resting on the top of the belt whilst in contact with the cake, are used to compress the cake on the drum. When the cake has to be washed, the wash water is applied as a stream on the upper surface of that portion of the belt in contact with the cake. The objects of this device are to prevent cracks developing in the cake, and so reduce the capacity of the vacuum pumps required, to deliver drier cakes, to cause the cake to be discharged as a sheet on the application of compressed air and to eliminate nozzle troubles and pumping plant required for atomising the wash water.

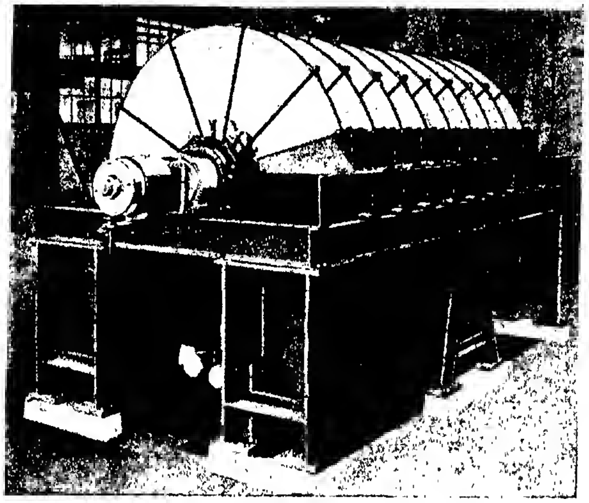
The Kestner Evaporator and Engineering Co., also manufacture a continuous filter of the drum type illustrated in Figure 12, which can be used for filtering volatile liquids. In this plant the drum is totally enclosed in a vapour-tight chamber by means of a metal cover fitted to the top of the liquor tank. The precipitate is scraped off the drum in the usual way and falls into a trough in which is a conveyor which carries the precipitate to suitable discharging boxes. In the bottom of the liquor tank is an agitating gear driven from a crank shaft mounted inside the cover of the machine

Bevel gearing and chain drives are used to transmit motion from the drum shaft to the conveyor and mixing shafts. The discharge of the vacuum pump is connected to the top of the cover of the filter. In this way any vapour which passes through the filtering medium is returned to the filter, thus maintaining the pressure within the casing at or about atmospheric, and at the same time preventing the loss of valuable vapour. Filters of this type are being used for filtrations of volatile oils, in which case the filtering medium is made of cotton cloth. Messrs Kestner also make an open-type filter for non-volatile liquids which is of similar design, except that the air-tight covers on the drums and conveyors are dispensed with.

Another type of continuous filter, manufactured by the United Filters Corporation and known as the American Continuous Filter, is illustrated in Figure 13. In this machine the filtering surface is made up of a number of equidistant parallel discs mounted on a horizontal shaft. Each of these discs is made up of a number of sectors formed of wood or cast iron and suitably grooved to give efficient drainage, and covered with the filtering medium. The shaft carrying these discs contains a series of equidistant holes, termed filter channels drilled parallel to its axis. The number of these holes corresponds with the number of sectors constituting a disc. An outlet pipe at the inner end of each sector connects the drainage area with one of these filter channels. Radial bolts are also used to fix the sectors in position. The filter channels are connected at their outer ends to a corresponding number of radial ports formed in a conical bush. Inside this conical bush fits a conical plug divided up by bridges into a series of compartments within which are maintained the vacuum required for filtration, washing and drying, and the compressed air required for removal of the cake from the disc. The outlets of these compartments are formed in the outer end of the plug.

This plug and its conical bush constitute an arrangement similar to the standard plug cock, but in this case the plug remains stationary whilst the bush or seat revolves. Tightness between the rubbing surfaces is maintained by the action of a spring on the plug. The disc shaft is carried on bearings mounted on the liquor tank in such a manner that the lower portions of the discs will be immersed in the liquor contained in the tank. The tank itself has on the discharge side of the machine a number of troughs each a little wider than the thickness of a disc, and so arranged that each trough encloses one lower quarter of a disc, the other lower quarter of the disc extending into the open portion of the tank, which does not restrict the thickness of cake formed and permits of good circulation of the liquor being filtered. The cake is removed by radial scrapers and falls through the spaces between the troughs into a hopper. Wash water can only be applied to the cake in the form of a fine spray and great care

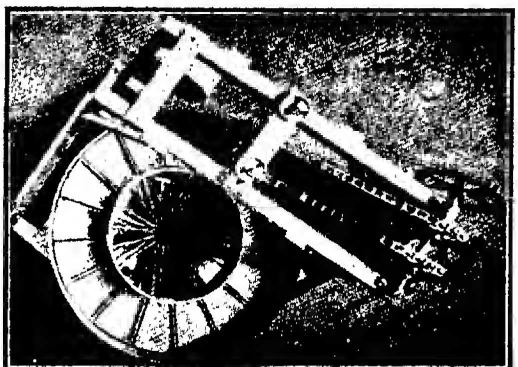
has to be taken to ensure its uniform distribution over the filtered material. This type of machine has a greater filtering surface than that obtainable with the drum type of plant occupying the same floor space.



American Continuous Vacuum Filter

Fig. 13

For handling coarse and granular products it is found that filters of the above types are unsuitable and this has lead to the development of the Oliver Continuous Plane Filter, illustrated in Figure 14. This plant consists of a horizontal annular trough divided by a number of radial partitions into a series of compartments. Each of these compartments



Aeroplane View of Oliver Sand Table Filter

Fig. 14

is covered over the top with the filtering medium which is carried on a suitable supporting surface. The lowest point of each compartment is connected to its own port on an Oliver automatic valve, whose axis coincides with the axis of rotation of the annulus. A rail fixed to the bottom of the annulus and resting on rollers maintains the trough in a horizontal position during rotation. A scraper which works in conjunction with an elevator collects and removes the cake from the filtering surface. After the filtering surface has passed this scraper a fresh lot of liquor to be filtered is uniformly distributed over the surface. During this operation suction is applied to those chambers over which the liquor is being distributed thus removing the liquid and leaving the precipitate on the filtering medium. As the wheel rotates this precipitate passes under the wash water sprays, the compartments underneath being again under suction to draw the wash water through the cake. After passing the washing zone, suction is still applied to these chambers to draw air through the cake to dry it. Before reaching the scraper, compressed air is admitted to the chamber thus loosening the cake from the filtering surface and facilitating its removal by the scraper.

(*To be continued*)

MAGNESIUM SULPHATE IN CANADA

A comparatively new industry has contributed to Canada's mineral production within the past few years as the deposits of magnesium sulphate (Epsom Salts) have been proved and production started on a commercial scale. The alkali deposits which occur in numerous localities in the prairie provinces contain appreciable percentages of magnesium sulphate and it is possible that from these occurrences commercial magnesium sulphate will soon be recovered as a by-product in the production of sodium sulphate. In addition to these deposits there are three known deposits in British Columbia, one of which is being operated at the present time.

The Mines Branch of the Department of Mines is investigating these deposits, in connexion with the examination of the sodium sulphate areas in the prairie provinces.

A deposit of magnesium sulphate occurs in Spotted Lake, B.C., a slight depression in which is a partially dried up lake containing considerable quantities of hydrous magnesium sulphate crystals and saturated brine. Approximately 1600 tons of crude magnesium sulphate have been recovered so far.

The Basque Chemical Company is operating a series of five lakes situated 15 miles west of Ashcroft British Columbia. From these lakes they are excavating crude magnesium sulphate (Epsom Salts) which is shipped to Vancouver where it is refined and sold as medicinal salts, and for tanning purposes. Plans are now under way for greatly extending the development of this deposit.

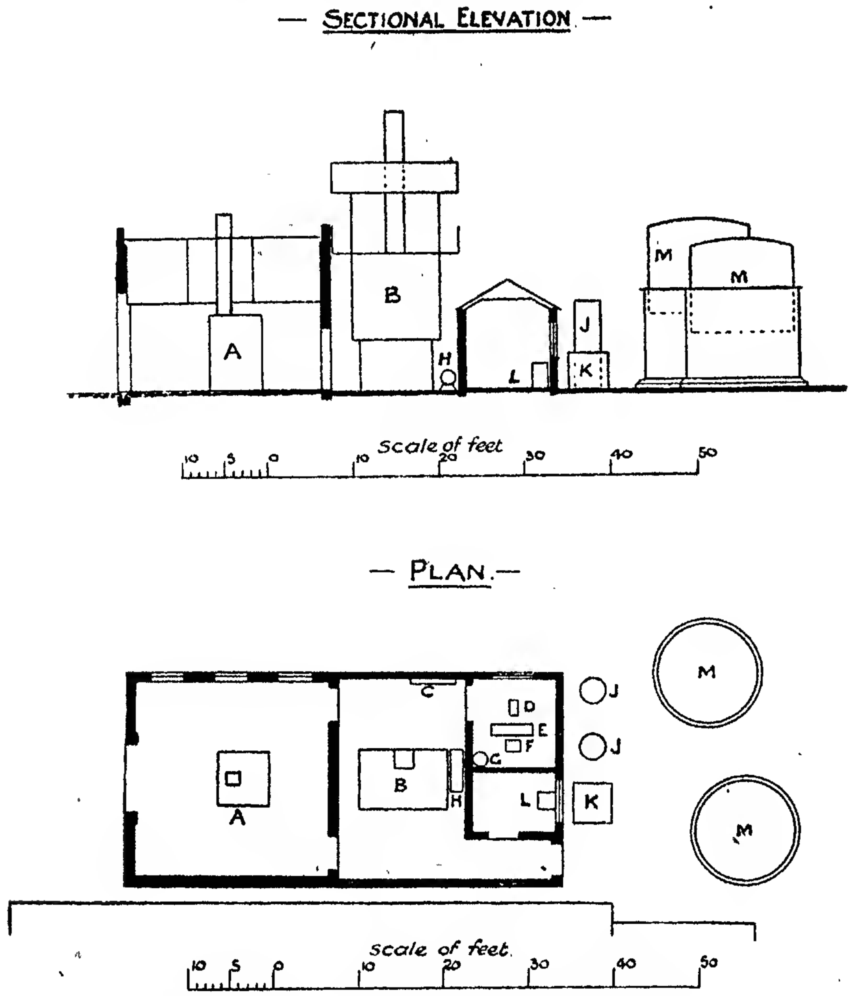
There is a small lake one mile south of Clinton, British Columbia, from which a small tonnage of magnesium sulphate was obtained; and, as the market increases, it may be possible to develop an export trade from Vancouver.

EXPERIMENTAL GAS PLANT IN THE UNIVERSITY OF LEEDS

SIR CORBET WOODALL MEMORIAL

In September, 1917, Mr. Henry Woodall, Junior, made the generous offer to erect and hand over to the University of Leeds an experimental coal gas plant in memory of his father, the late Sir Corbet Woodall, D.Sc. This offer was gratefully accepted by the Council of the University in November, 1917, but the conditions prevailing at that time prevented the carrying out of the project. When circumstances became more favourable, Mr. Henry Woodall commenced operations, and the plant is now complete and ready for use, the scale of the scheme for plant and fund connected therewith having been meanwhile extended by other donors who desired to be identified with Mr. Woodall in this work.

It stands on a site provided by the University adjoining the Department of Coal Gas and Fuel Industries. Mr. J. F. Scott, A.M.I.C.E., has been the engineer in charge of the layout and construction of the plant, which is housed in buildings erected by Messrs. Banks Mawson, contractors, Leeds. Whilst the plant is arranged for the carbonisation of coal, with recovery and measurement of the usual products, it is not merely a coal-gas plant of normal type on a small scale. It is designed to carbonise coal on a scale greater than is possible in laboratory apparatus, which is apt to yield some products in quantities too small to permit of measurement and examination. At the same time the scale of operation is moderate, so that it will still be possible to



The University of Leeds. Experimental Coal Gas Plant

THE FOURTH CONGRESS OF INDUSTRIAL CHEMISTRY

(From our Special Correspondent.)

The Fourth Congress of Industrial Chemistry organised by the Société de Chimie Industrielle was held from June 15 to 21 at Bordeaux. As in previous years numerous foreign delegates were present, and addresses were delivered at the Congress dealing with two subjects of vital importance to the prosperity of South-West France, namely, Oenology, and the Pine and its Related Industries. All the papers read illustrated the essentially collective work of science, pursued by a multitude of workers of all ages and nationalities, following each other and associated by virtue of a tacit understanding to seek the truth and to apply that truth to the continuous transformation of the conditions of all men (Berthelot).

The Congress opened on June 15 by a gala evening at the Grand Theatre of Bordeaux after which the foreign delegates and members were received in the "foyers," remarkable for their delicate architecture in the purest 18th century style. On June 16, the Congress was formally opened under the presidency of Monsieur Tassel representing the Ministry of the Colonies, supported by MM. H. Gall, vice-president, Jean Gérard, Jean Voisin, Maurice Deschiens and members of the local organising committee. After a welcome by Monsieur Philippart, mayor of Bordeaux, Monsieur Gall outlined the many reasons which decided the Council to select Bordeaux for the meeting.

Monsieur G. Dupont, director of the Institut du Pin then gave an address on *Pinus maritima* and industries dependent on it. After describing the resin-producing districts of France, and the methods of producing resin and turpentine, the lecturer discussed the various industries which could use the products of the pine, and instanced paper-making, varnish, synthetic perfumes, pharmaceutical products, industries making plastic materials and synthetic camphor, lamp black and printing ink, and smaller industries such as soap-making, the making of polishes, dyes, and tanning. In addition pine wood might be used as pit-props and railway sleepers. Monsieur Dupont concluded by stating that France was the second largest producer of turpentine and resin in the world.

In the afternoon of June 16, and on the following days the work of the sixteen different groups of the Société continued regularly. Amongst the many papers presented special note may be taken of those on the Estimation of Manganese in Steel; Considerations on the Electrical Precipitation of Dust; Problems of Solid and Liquid Fuels; The Question of Absolute Alcohol; The Industrial Manufacture of Hydrogen; Sensitometry and the Infra-red in Photography; Turpentine and Wood Pulp from *Pinus maritima*; The Theory and Practice of Wine-making; and Economic Problems. All these articles will appear at a later date in the Journal of the Société.

The visits to works and the excursions provided particularly happy illustrations of applied chemistry. Visits to the shipyards of Bordeaux showed how up to date was French industry, and the inspections of factories making liqueurs, preserving food, and making chocolate were particularly instructive. A visit to the Port of Bassens built on the banks of the Garonne by the United States during the war showed the possibilities of developing the port of Bordeaux.

The closing meeting of the Congress on June 18 was devoted to a paper by Monsieur Lafforgne on "The Production of Wine in the Gironde District." The audience listened enthralled to the account of the cultivation of the vine, its protection against disease and the production of the wine itself, terminating with valuable hints on testing, explaining the merits of the various "grands crus" of the district. The same evening the qualities of the Giroudian wines were tested with appreciation at the banquet, but the day after those present had the fortune to visit the district where are produced the famous Barsac, Sauterne and Graves.

A visit to Arcachon on June [illegible]ated the pine and resin industry, which was seen in its pri[illegible] stages. At Arcachon the visitors saw a new sulphurous spring found during recent borings in search of petroleum. On the way back a visit was paid to the broadcasting station at Croix d'Hins.

The whole congress passed off most successfully, and again showed the vigour and activity of the Société de Chimie Industrielle. The Fifth Congress will be held in Paris in 1925, when the chief addresses will be devoted more particularly to metallurgy.

On May 27, the Fuel Group heard a paper by M. A. Kling on the Bergius process. Monsieur Kling, who has studied the process at Manheim, where the process is being worked, stated that the operation by which Bergius transformed solid fuels of high molecular weight into hydrocarbons of low molecular weight, depended on dissociation, and that the laws controlling the operation should be similar to those simple dissociations, though complicated by polymerisation of the dissociated products. Comparing cracking with the Bergius process, the lecturer said the dissociation of the cracked materials yielded hydrogen and unsaturated molecules which then polymerised, then the polymerised products underwent the same transformation and so on. Cracking thus yielded products of low molecular weight, hydrogen, unsaturated hydrocarbons, and large amounts of carbonised material, which decreased the yields and choked the plant. In the Bergius process on the contrary, cracking under a high initial pressure of hydrogen (200 atmospheres) displaced the equilibrium, the long chains breaking into shorter ones but without yielding unsaturated products, so that there was no carbonaceous residue. The speaker then discussed the validity of the various Bergius patents from the point of view of priority, and after considering laboratory and large-scale results, stated that the process seemed to be sufficiently developed to be applied to liquid or pasty natural products, whereas it was not possible to say whether its application to coal would be advisable.

The Inorganic Group met on June 11, Mr. H. Gall in the chair. A paper was read on "Leucite as a source of alumina, potash and silica," by Baron

G. H. Blanc, who described his process for the treatment of leucite by the acid method, utilised by the Società Italiana Potassa. Leucite thus becomes a most important raw material for the production of alumina and potash. In addition the very pure silica obtained as a by-product has physico-chemical properties which render it of much interest as an industrial material. Another process using an alkaline treatment has been elaborated by M. Gordon, a collaborator of Baron Blanc. (For a full description of the process see the article by Prof. J. W. Hinchley entitled "The Manufacture of Potash and other Salts from Leucite,"—*Chem. & Ind.*, 1924, pp. 158-168).

THE BIOCHEMICAL SOCIETY

A meeting was held at St. Thomas's Hospital on June 16, when the following papers were read:—(i) W. H. Hurtley, "Millon's Reagent." (ii) J. L. Rosedale, "The Amino-Acids of Flesh." (iii) R. H. A. Plimmer and J. Lowndes, "The Transformation in the Calcium Content of the Hen's Egg During Development."

The fourth paper was by A. Hunter and James A. Morrell, on "Some Conditions Affecting the Action of the Enzyme Arginase." The activity of arginase commences at p_H 4·8, rises to a maximum at or near p_H 9·8, and falls then so abruptly that at p_H 11·5 it is practically zero. At a p_H of 7·3 the enzyme has a temperature coefficient of 2·69 for 0°—10° C., 2·32 for 10°—20° C., and 2·13 for 20°—30° C.; the corresponding values for the constant of Arrhenius are 15,300, 14,000 and 13,400. Variations in the concentration of enzyme (E) and substrate (S), if confined within certain limits, have an effect expressed by the formula $ET/S=k$, where T is the time taken to decompose a given fraction of the total arginine. The hydrolysis of arginine by arginase does not obey the law of a unimolecular reaction. Under certain conditions and for limited periods of time the velocity curve has been found to fit the square-root law or the more general formula of Arrhenius.

SOCIETY OF GLASS TECHNOLOGY

The last meeting of the Society of Glass Technology for the session 1923-24 was held in Sheffield, on June 18, the President, Col. S. C. Halse, C.M.G., in the chair. Two papers were presented.

(1) "Some Remarks on the Erection and Operation of Modern Pot Furnaces," by Percival Marson. In the absence of the author this paper was read by Prof. W. E. S. Turner, D.Sc. The author pointed out that the glass manufacturer, before constructing a pot furnace, which represented so heavy a capital expenditure, should have adequate plans prepared. A furnace builder who knew his business should be able to guarantee his furnace, but in any case it was desirable to have a technologist as intermediary in order that suitable specifications might be laid down and adhered to. Amongst other things the builder should study the nature of the ground upon which the furnace was to be erected and he should construct an adequate foundation, providing also any necessary drainage and protection of the flues from ingress of water. The provision of suitable flue dampers with some form of indicator allowed of a more accurate regulation of the furnace during working. A small hole in the furnace above one of the pots served to give an indication, by observation of the issuing flame, of the state of combustion, so that correct conditions could thereby be attained. For a "full crystal" glass a furnace temperature of 1300° was sufficient, and nothing was gained by exceeding this, but for soda-lime glass a temperature of 1400° could be maintained with advantage. It was claimed that for the crystal glass a circular pot was better than an oval or egg-shaped one, since it was less likely to cause cords in the glass.

(2) A "Note on an Unusual Type of Recuperative Tank Furnace," by F. W. Hodkin, B.Sc., and Prof. W. E. S. Turner, D.Sc., was presented by Mr. Hodkin, who gave an account of observations made upon a recuperative tank furnace in operation at the Belindar Works of Messrs. Lax and Shaw, Ltd., Leeds. The observations were made as the result of an invitation extended by Mr. J. S. Shaw to Prof. Turner to inspect the furnace. The main feature of interest was the method of recuperating the secondary air. This air entered by arched passages situated beneath the bottom of the tank and above similar passages conveying the exit gases to the chimney flue. It then passed by means of vertical channels in the working end of the furnace to a space between an upper and a lower crown. After traversing the space between the crowns the air entered the furnace through a series of ports placed so as to have the gas ports between them. Producer gas was admitted, without preheating, through a gas-chamber connected with ports or burners opening into the melting end of the furnace. The flames traversed the whole length of the furnace, the products of combustion escaping through vertical downtakes in the working end to the flues beneath the tank. The batch was charged through an opening at the side of the furnace, and one big advantage claimed for the method of construction was that it permitted of working operations being conducted along the walls, not only of the working end, but also of the melting end, by the use in the latter of syphons. The tank had a double bridge. In other words the bridge had three walls separated by cavities through which steam was blown for cooling purposes. With gas at 700° C., and air at 720° C., the temperature of the glass in the melting end was 1460° C. The production of glass from the tank, which was not being worked at full capacity, averaged 80 tons per week for a consumption of about 60 tons of coal on the producers. This glass was worked by three machines with feeders situated in the working end of the furnace, and by hands from four boots in the melting end. The designers anticipated a production of more than 120 tons of glass per week when working fully.

The President announced that a party of members of the Society was visiting Belgium from July 7 to 12.

CORRESPONDENCE

THE LAW OF SOLUBILITY PRODUCT

Sir,—In reference to Mr. Butler's interesting proof of the law of solubility product (*Chemistry and Industry*. 43, 25, p. 634), I think the usual proof is of more value than Mr. Butler is disposed to admit of.

The usual deduction of this law from the law of mass action is unsatisfactory only in this, that we cannot submit it also to experimental proof, because we do not know the degree of ionisation of strong electrolytes except in very dilute solution, when they are completely dissociated. We, therefore, cannot prove that the law of mass action applies to them.

It is usually made clear to students that calculations on the ionisation phenomena of electrolytes are only valid in the case of very dilute solutions, in which the ions approximate in their behaviour to perfect solutes. To such solutions the law of mass action *must* be applicable whether we are in a position to prove this experimentally or not.

From an educational point of view the fact that the law of solubility product is a necessary corollary of the law of mass action as applied to dilute solutions of electrolytes is of prime importance. Mr. Butler's proof is instructive but should not, I think, replace the usual proof.—I am, Sir, etc.,

J. E. Wynfield Rhodes

Technical College
Blackburn

ASCARITE

Sir,—The article on "Ascarite," by Mr. Stetzer, which appeared in *Chemistry and Industry* of June 20, was very interesting, as this material seems to possess similar advantages to those we claim for Sofnol Soda-lime G., particulars of which appeared in one of our recent advertisements in the *Journal*.

The introduction of both materials also seems to have been brought about by similar difficulties encountered in the first instance in the laboratory, but, whereas Ascarite was introduced in connexion with steel analyses, Sofnol Soda-lime G. was prepared by us owing to the want of a more satisfactory absorbent in connexion with fuel analysis.

Sofnol Soda-lime G. has a very low moisture content, which eliminates the error due to the presence of water in ordinary soda-lime, and as it contains a certain percentage of manganese, this accelerates absorption and, at the same time, acts as an indicator.

The progress of the absorption can be actually watched by means of the change of colour, you know when the reaction is complete, and can see how much "life" there is still left in the Soda-lime. Hence analyses can be carried out in a minimum of time.

Sofnol Soda-lime G. possesses all the advantages claimed for Ascarite; in addition it is a product of British manufacture and considerably lower in price

—I am, Sir, etc., Sofnol, Limited

L. O. Newton, Managing Director

Greenwich, S.E. 10
June 24, 1924

WHAT IS A CHEMIST?

Sir,—It is high time that chemists studied a little grammar and were reminded that the word "chemical" is strictly an adjective and not a noun. Thus a "chemical" substance is one and individual, and possesses valuable and characteristic properties which are not destroyed by mechanical subdivision. Take a carboy of sulphuric acid. A single tap with a hammer destroys the glass vessel, but the characteristic properties of the contents now become evident.

A chemist is one who maintains himself by his ability to recognise and appreciate the properties of substances coming under the above heading. To revert to our broken carboy, the chemist alone can advise properly in solving the vexatious problem of a quantity of acid spilled on the floor and he only can ascertain the index figure which will lead to estimating the monetary value of the lost acid.

Every man to his profession. The solicitor with his deeds and conveyances, the doctor with his prescription (in the widest sense) for the restoration of health, the dentist with his forceps and drills, the pharmacist with his right to dispense powerful medicines, the auctioneer with his hammer, and so on. But where is the chemist amongst all these? Let him claim his right to be the sole user of a box of standardised weights in ascertaining the properties of "chemical" substances and in directing their movements.—I am, Sir, etc.,

Flint F. Shedden
June 28, 1924

[According to the "New English Dictionary" the word "chemical," though used principally as an adjective, is also used as a substantive, the definition being "A substance obtained or used in chemical operations."—Ed]

OBITUARY

SIR J. J. DOBBIE, F.R.S.

The death of Sir James Johnston Dobbie, M.A., D.Sc., LL.D., F.R.S., lately Government Chemist, occurred at Fairlie, Ayrshire, on the 19th of this month.

Sir James Dobbie succeeded Sir Edward Thorpe in 1909 as Principal of the Government Laboratory, and was the first to hold the position of Government Chemist after that institution had been consolidated in 1911 as a separate Crown Department dealing with chemical matters arising from all Departments of State.

He was born in Glasgow in the year 1852 and educated at the High School and the University there, graduating in Arts with First Class Honours in Natural Science, thereafter, pursuing his duties at Leipzig and in Edinburgh, where he took the degree of D.Sc. He was appointed lecturer in Mineralogy at Glasgow University, and in 1881 was appointed assistant to the Professor of Chemistry there, proceeding in 1884 as Professor of Chemistry to the University College of North Wales at Bangor There he devoted himself to teaching, research and to agricultural education.

As a teacher he commanded the respect of all his students in virtue of his personality, and afforded

encouragement to the senior ones to take up research, for the most part in subjects in which he was interested.

Research on the relation between the chemical constitution and the absorption spectra of chemical compounds, and on the chemical constitution of alkaloids was pursued at Bangor in conjunction with a school of assistants. A large number of papers appeared on these subjects, and in recognition of their value he was elected a Fellow of the Royal Society in 1904.

He was greatly interested in agricultural education into which he introduced new methods, including deductions from field experiments, his services in this direction being cordially acknowledged by the Board of Agriculture.

For six years, from 1903 onwards, he occupied the post of Director of the Royal Scottish Museum, Edinburgh, which under his care and well-known methodical supervision was considerably increased and rendered more effective. During this period also he found time to pursue his researches on absorption spectra and the constitution of alkaloids. He continued his work on absorption at the Government Laboratory, both from the point of view of the constitution of the alkaloids and also to gain information on this property in the case of the vapour of elements heated throughout a range of temperature. In addition, he investigated the constitution of diphenylene and communicated papers on subjects which came before the Laboratory.

His well-known sound judgment and experience led to his appointment as a member of important Commissions and Committees, such as the Royal Commission on Awards to Inventors, and the University Grants Committee. In 1915 his services to science both as an investigator and administrator were recognised by the King, who conferred a knighthood on him, and in 1908 he received the degree of LL.D. from Glasgow University. In 1915 he was President of the Institute of Chemistry and in 1919 of the Chemical Society. His period as Government Chemist covered the difficult years of the War when greatly increased duties were thrown upon him.

The charm of his personality and the unvarying courtesy with which he met everyone are features which come to the mind of all who were acquainted with Sir James Dobbie. The present writer has had occasion frequently to observe the influence of his work in the Government Laboratory, and to note the great affection that all members of his staff had for him.

He was buried on Monday at Largs Cemetery on a hillside overlooking the Firth of Clyde and commanding a view of the low-lying Cumbraes with the mountains of Arran in the distance, a prospect of which he was never tired, as it was that which faced the home where he spent his holidays and his retirement from office.

Sir James Dobbie is survived by his wife, a son and two daughters, of whom one is the wife of Prof. Haworth, of Armstrong College, Newcastle-on-Tyne. The loss during the War of a promising son, who was an officer in the Black Watch, affected him very deeply at a time when his energies were concentrated on the work of his Department. R. ROBERTSON

PERSONAL AND OTHER ITEMS

The degree of D.Sc. of Trinity College, Dublin, has been conferred, *honoris causa*, upon Prof. R. A. Millikan.

Dr. A. L. Stern, of Burton-on-Trent, is retiring after thirty-four years' service with Messrs. Bass and Co., seventeen of which have been spent as head brewer. A native of Birmingham, Dr. Stern was educated at Mason's College, now Birmingham University, and took the degree of D.Sc. of the University of London. He is the author of several papers read before the Chemical Society, the Institute of Brewing and the Society of Chemical Industry.

The annual meeting of the French Association for the Advancement of Science will be held at Liège from July 28 to August 2.

The Commissioners for the Exhibition of 1851 have awarded senior studentships for 1924 to, *inter alia*, Mr. M. Dixon, M.A., for research in biochemistry, on the recommendation of the University of Cambridge, to Mr. R. D. Haworth, M.Sc., Ph.D., for research in organic chemistry, on the recommendation of the University of Oxford, and to Mr. R. W. Lunt, M.Sc., Ph.D., for research in physical chemistry, on the recommendation of the University of London, University College.

At a recent meeting of the Senate of London University, the title of professor of physics in the University was conferred on Prof. O. W. Richardson, D.Sc., F.R.S., in respect of his part-time appointment as director of research in the Department of Physics at King's College. The degree of D.Sc. in chemistry was also conferred upon Miss M. L. V. Gayler.

The Senate of London University has instituted a degree of M.Sc. in the principles, history and method of science for both internal and external students.

Mr. S. G. Blaylock, general manager of the Consolidated Mining and Smelting Co., Traill, Canada, has been awarded the McCharles prize by the University of Toronto in recognition of his work on the production of electrolytic zinc and on the treatment of complex lead, silver and zinc ores.

Messrs. F. W. Dootson, H. McCombie, W. G. Palmer and A. J. Berry have been appointed demonstrators of chemistry in the University of Cambridge. Dr. J. Chadwick has been appointed assistant director of radioactive research in the Cavendish Laboratory, Cambridge.

Mr. H. W. Cremer, M.Sc., A.M.I.Chem.E., has been appointed senior lecturer and chemistry, and Mr. E. W. McClelland, B.Sc., Ph.D., has been appointed demonstrator in chemistry in King's College, London.

The Degree of Doctor of Science has been conferred by the University of Glasgow on Mr. William M. Cumming, lecturer on Organic Chemistry in the Royal Technical College, Glasgow.

The late Mr. A. E. Tucker, analytical chemist, of Sutton Coldfield, left £12,851, net personalty £9765.

The late Mr. W. E. Gilmour left personal property valued at £238,421, the sum of £214,584 representing

his holding in the United Turkey Red Company, of which he was a director.

Meeting of the British Association in Canada

Many distinguished scientists will be included in the 500 members of the British Association for the Advancement of Science who are travelling to Canada, at the end of this month, to attend the annual meeting of the Association which is being held in Toronto. Amongst those who will be there are Profs. E. C. C. Baly, V. H. Blackman, W. A. Bone, Lord Bledisloe, Sir Wm. Bragg, Dr. H. H. Dale, Profs. C. H. Desch and F. G. Donnan, Sir Henry Fowler, Prof. G. W. O. Howe, Sir Wm. Herdman, Principal J. C. Irvine, Profs. J. W. McBain, W. McDougall and J. C. McLennan, Sir Charles Parsons, Sir Robert Robertson, Sir E. Rutherford, Dr. N. V. Sidgwick and Prof. W. W. Watts. On August 6 the President, Major-General Sir David Bruce, Chairman of the Governing Body of the Lister Institute, will deliver his presidential address, the subject of which will be "The Prevention of Disease," specially dealing with experience acquired during the war. The meetings of the sections will commence on August 7 and continue until August 13, and the sectional presidential addresses will include discourses on "Chemistry and the State," by Sir Robert Robertson; "Inter-Racial Problems and White Colonisation in the Tropics," by Prof. J. W. Gregory; "Academic Freedom in Universities," by Principal Ernest Barker; and "Combination in Attacking Farmers' Problems," by Sir John Russell. The members from Great Britain will sail from Liverpool or Glasgow on July 25 and 26. Excursions to various places of interest are being planned, and during the visit to Saskatchewan a session of the Association will be held in connexion with the opening of a new chemical laboratory in the University of that city.

Empire Mining Council

As a result of the Empire Mining and Metallurgical Congress at the British Empire Exhibition, it has been decided to form an Empire council of mining and metallurgical institutions, with the following main functions:—To promote intercommunication between the various interests, to create and maintain a higher standard of technical efficiency and professional status than now exists, to compile, if deemed necessary, a register of British mining and metallurgical engineers, and to convene future congresses.

Winter Oil Seeds in British India, 1923-24

The memorandum received from provinces which contain 98·7 per cent. of the total area under rape and mustard, and 99·1 per cent. of the total linseed area of British India, states that the total estimated yield of rape and mustard is 1,154,000 tons, as against 1,209,000 t. in last year, there being a decrease of 4 per cent. The total area under rape and mustard amounts to 6,134,000 acres, which is 2 per cent. below the finally revised area of last year. The total area under linseed is 3,730,000 acres, whilst the yield is estimated at 462,000 t., as against 533,000 t. last year, or a decrease of 13 per cent. The condition of the crops, on the whole, is reported to be fair.—(*Ind. Tr. J.*, 1924, May 29.)

FRANCE

Reserves of Energy

In a lecture recently delivered in Paris, Monsieur A. Kling, the director of the Municipal Laboratory of Paris, stated that the world reserves of coal amounted to 7400 milliard metric tons, compared with reserves of petroleum exceeding 82 million hectolitres. The speaker did not discuss production of hydroelectric power, as he considered from present conditions that the cost of the electric calorie was still too high for industry in general. France possessed 17 milliard t. of coal, and French water-power could develop 9 to 10 million h.p., but sources of petroleum are scanty. In 1923, however, France consumed 62,000,000 t. of coal, of which 30,000,000 t. was imported, and 29,000,000 litres of fuels of which 27,700,000 was imported. France obviously must investigate every means of economising fuel, and it was with this idea that experiments are being carried out on the development of methods of utilising tidal power, which might yield another 4 or 5 million hydroelectric h.p., equivalent to the saving of 14,000,000 t. of coal. In the consumption of coal at least 50 per cent. was lost in one way or another, and it was desirable that methods of industrial and domestic heating should be closely scrutinised to prevent waste.

The Synthetic Resin Industry in France

During a recent meeting of the Société d'Encouragement, Monsieur G. Kimpflin described the initiation of the resin industry in France in 1896 by Trillat, who laid down the fundamental principles. During the war the bakelite industry developed greatly. After discussing doubts as to the exact constitution of the product, the speaker showed that the importance of the market justified the rapid development of the industry in recent years in France. The present production was estimated at 12,000 t., corresponding to one-fifth of the American output. Such figures offered an interesting comment on possible development of the industry, development due largely to the increasing demand for phenol-formaldehyde condensation products for use in the electrical industry.

The Coal Industry in the Nord and Pas de Calais

Reports from these districts show that whilst the production in the Nord in January, 1924, was 91 per cent. of that of 1913, the output of briquettes and coke was greater than in pre-war years. At Lens, two batteries of 70 Koppée coke ovens are working; two batteries of 42 ovens utilising washed coke, have been re-lit at Dourges, and 100 metallurgical coke ovens are being rebuilt. The coke ovens at Courrières are also to be reconstructed.

Synthetic Ammonia in France

Recently a note was published in this journal (May, 1924, p. 507), on the new French law of April 11, 1924, authorising the establishment of a State factory at the national powder factory of Toulouse, for the manufacture of synthetic ammonia by the Haber process. A consulting commission has just been set up to examine the plans connected with the new factory at Toulouse. Apart from representatives of the Ministries interested, the commission includes Profs. Schloesing and Guichard, Monsieur Pascalis, and Monsieur Fèvre.

UNITED STATES

Research on Colloids

Plans are being considered by the American Chemical Society, the National Academy of Science, and the U.S. National Research Council for the establishment of a National Institute of Research in Colloid Chemistry. A tentative scheme has been worked out for the Institute, and it is hoped to raise a fund of one million dollars as an endowment.

Gelatin and Glue in 1923

The output of glues and gelatin in 1923, as reported to the Census Bureau by 66 establishments, compares as follows with the production in 1922:—

	Pounds 1923	Pounds 1922
Glues of animal origin	109,061,762	94,640,981
Hide glue	64,757,479	57,891,041
Extracted bone glue	24,428,758	8,532,893
Other bone glue	19,875,525	28,217,047
Other glues	39,164,680	41,254,432
Flexible glue	832,784	604,838
Vegetable glue	32,704,321	40,649,594
Fish glue / all other, incl. casein	5,627,575	
Gelatin of animal origin	15,617,060	15,223,669
Edible	13,321,618	13,242,615
Other than edible	2,295,442	1,981,054

Mineral Output in 1923

Preliminary figures showing the output of minerals in the United States in 1923 are as follows:—

			1923	Inc. (+) or Decr. (—) against 1922
Coal	tons	Bituminous	545,000,000	+123,000,000
		Anthracite	95,000,000	+ 40,000,000
Copper	lb.		1,477,000,000	+530,000,000
Gold	oz.		2,485,000	+ 120,000
Iron	tons		40,060,000	+ 13,200,000
Lead	tons		534,000	+ 57,000
Petroleum	barrels		745,000,000	+187,000,000
Platinum	oz.		900	— 100
Silver	oz.		72,610,000	+ 16,370,000
Zinc	tons		623,000	+ 150,000

Potash Output in 1923

In 1923 the United States produced 39,029 short tons of crude potash salts (20,215 t. of K_2O). Of this output 32,254 t. of crude potash (17,982 t. K_2O) was produced from mineral sources and 6775 t. of crude potash (2233 t. K_2O) was produced from organic sources. This output was made by eight companies operating 12 plants. The quantity sold was 35,164 t. of crude potash (19,281 t. K_2O), valued at $784,671. Imports of crude potash into the United States in 1923 totalled 748,101 t. (209,581 t. K_2O), valued at $15,354,755. Of this amount, 712,441 t. of crude potash (194,079 t. K_2O), valued at $10,624,475, was used mainly in the fertiliser industry.

Artificial Silk Industry

From 1,566,000 lb. in 1913, and 8,000,000 lb. in 1919, the output of artificial silk in the United States has risen to 35,380,000 lb. in 1923. Despite this great increase, imports of artificial silk rose from 2,987,775 lb. in 1922 to 3,906,037 lb. in 1923. Imports of raw (true) silk in 1923 were 49,505,581 lb., a decline of over 1 million lb. compared with the previous year.

CANADA

The Carbon Black Industry

The production of carbon black, a material of considerable importance to the printing ink and rubber industries, is practically confined to the North American continent, where large supplies of natural gas are found. At present British requirements, which amount annually to about 10 million lb., are supplied from the United States. Canadian imports from the same source are about 3 million lb. The American carbon black industry is located mainly in West Virginia and Louisiana, but, as many of the gas fields in these States begin to show signs of decline, and conservation becomes more stringent, the industry is seeking new fields. Interest has also been manifested in Canada as a possible source of supply. Ontario and Alberta are the only provinces in Canada possessing large resources of natural gas. According to the Dominion Department of Mines (Ottawa) there are four or five natural gas fields in Alberta where the prospects for the establishment of a carbon black industry might be considered. These fields are the Many Islands field, near Medicine Hat, the Wainwright field, 100 miles east of Edmonton, and the Peace River and Pelican Rapid fields, in Northern Alberta.—(*Ch. Comm. J., May* 16, 1924.)

Pulp and Paper Industry

The St. Regis Pulp and Paper Co., which possesses 37,000 acres of freehold land west of the Godbout River on the North Shore of the St. Lawrence, and 14,000 acres on the Canadian National Railway, near Escolona, Quebec, proposes to erect, this year, a pulp and paper mill at Cap Rouge, near Quebec at a cost of $5,000,000.

The Gulf Pulp and Paper Co., which recently secured a lease of timber limits from the Quebec Government, at Manicougan, on the north shore of the St. Lawrence, will erect a large mill in proximity to the same city. Lord Rothermere, who was in Quebec about the middle of April, is asserted to be the chief holder in this company.

The A.P.W. Paper Co. of Albany, N.Y., are erecting a large sulphite plant at Sheet Harbour, N.S. The woodlands department of this company will be in charge of Frederick A. Gaylor, a graduate of Yale School of Forestry, and recently in the U.S. forest service, and several forestry engineers.

The St. Maurice Paper Co., Three Rivers, Quebec, is installing, in its mill, two new large machines, estimated to cost $2,250,000.

GENERAL

Potash and Superphosphates in Poland

According to a report of the U.S. Commercial Attaché at Warsaw, the Polish production of potash salts in 1923 was 61,494 tons (46,082 t. in 1922), including 22,119 t. of kainit (2520 t. in 1922). The output of salt rose from 295,000 t. in 1922 to 363,307 t. in 1923. There are 16 superphosphate factories, and two more are being built, but only 12, employing 3000 workers, are producing. The output from 6 of these factories is said to be about 67,000 t.

REVIEWS

1. The Manufacture of Sulphuric Acid (Chamber Process), (Lunge-Cumming Series). By W. Wyld. Pp. xii+424. London: Gurney and Jackson, 1924. 31s. 6d. nett.
2. The Concentration of Sulphuric Acid (Lunge-Cumming Series). By John Wilfrid Parkes, M.Sc., A.I.C. Pp. xii+394. London: Gurney and Jackson, 1924. 31s. 6d. nett.

These two important processes constitute the subject matter of Vols. II and III of the Lunge-Cumming series, which have just been published. The two volumes afford evidence of the wisdom of sectionising the subjects, as the rearrangement has rendered it possible for scattered information to be collected, and for new matter to be introduced.

1. At one period towards the close of the European war the supersession of the chamber process was vaguely foreshadowed. To-day, owing to economic considerations, it would appear that for the production of sulphuric acid up to 80 per cent. strength, the chamber system is more firmly established than ever. It will be generally appreciated that the chamber process embraces the Glover tower, sulphuric-acid chambers, and Gay Lussac towers. This combination of plant in turn involves the circulation and distribution of acid, the supply of steam or atomised water and oxides of nitrogen to the chambers. Moreover, the theory of the production of sulphuric acid in the chamber system rightly deserves a place. Generally speaking, the whole gamut, as briefly outlined above, has been suitably treated, and a due sense of proportion has been observed. Many interesting points emerge from a perusal of the first four chapters.

It is remarked on page 3 that "the pillars upon which the chamber is erected must, of course, go down to the rock, as in any ordinary building of considerable height." Whether the foundations should extend to the ballast or not depends essentially (*a*) on the nature of the subsoil; (*b*) on the weight thrown on the foundations, and (*c*) on the provision made so far as the foundations are concerned for the distribution of the weight. Few sulphuric acid plants in this country exert a greater distributed weight per square foot than 10-cwt., when basing on 18-inches depth of acid in the chambers. The weight, however, is not uniformly distributed on each of the columns. Certain columns carry a greater weight than 10-cwt.; others (indeed, the larger number) carry less than 10-cwt.

From foundations we are led to the construction of sulphuric acid chambers, and the methods of supporting the lead. A variety of methods have been proposed from time to time. What needs to be aimed at is such a construction as will afford the greatest unrestricted area for the distribution of heat. The value of the first chapter would have been enhanced had photographs been furnished showing the actual construction of acid chambers, the methods of rearing the side sheets, and the framework used for fixing the top sheets. There will be general agreement with Mr. Wyld when he says that "the *sine qua non* for lower chamber space is ample Gay Lussac capacity." In this connexion it is important that "intensive working" should be defined. On thi subject divergent views are cited. In the 57tl Alkali Report (1920), it is stated that "intensiv working has much to be said for it." On the othe hand, Nemes's statement is referred to, in which h says, "whether it is really more economical to worl at 18 or 9 or 6 cub. ft. per ton of sulphur per 24 hour is a question not finally decided."

About eighteen pages are devoted to a descriptior of plant intended to replace lead chambers, but nc very definite views are expressed as to the developments which are likely to be expected.

There is much interesting matter concerning the construction of Glover and Gay Lussac towers, but no definite attempt is made to place the design on a really scientific basis. It is true that past and existing practice are dealt with in a lucid way. But beyond this Mr. Wyld does not go.

On page 213 there is an obvious error. The lead lining of the first portion of the Glover tower is referred to as "36-lb."; obviously, "16-lb." is intended.

Mr. Wyld is on familiar ground in dealing with the starting of chambers, and the general questions surrounding the operation and control of the chamber process, as also when he discusses the loss of nitre and the purification of sulphuric acid.

The remaining chapters—Nos. 5, 6 and 7—have been compressed into a few pages. They deal respectively with the arrangement of a sulphuric acid works, chamber system, other processes for the manufacture of sulphuric acid, and the applications of sulphuric acid—a chapter affording valuable statistical data.

One or two mistakes appear in the text. On page 183 "cubit" feet should read "cubic" feet, and on page 382 "cuprous" should be "cupreous," Some of the diagrams appear to be below the standard of those of previous volumes.

Apart from these slight defects, the book is a creditable one, and without doubt it will be regarded as the standard work on the subject.

2. This volume is divided into ten chapters, the first two of which deal respectively with an outline of the processes used in concentration, and the properties of ordinary concentrated sulphuric acid. The latter chapter is an admirable one, and contains a wealth of information of a reliable character. In the third chapter, concentration in heated pans and retorts is very suitably treated. No mention, however, is made of the defects encountered in the concentration of arsenical chamber acid in lead pans.

The question of loss of sulphuric acid in the cascade concentration system is largely affected by the question of adequate draught and the tightness of the tiles and insets on which the basins are seated. The concentration of sulphuric acid in a current of hot gases constitutes the subject-matter of chapter four, and here again plenty of useful information has been amassed. The Trepex, Skoglund, Kessler, Perrin, Duron, Gaillard, Gilchrist, and Kalbperry plants are dealt with in turn.

Chapters six and seven have reference respectively to the condensation of sulphuric acid vapours, and the recovery of sulphuric acid from waste acids.

Both chapters are suitably treated, and much valuable information is afforded.

Chapters eight, nine and ten deal with costs and efficiencies, transport of sulphuric acid, and its application. Under "Costs and efficiencies," reference is made to the graphical system of representation instituted by Quinan. One can cull very valuable data from this chapter concerning the relative merits of the various concentration plants. For example, the approximate average efficiency of concentration plants during the war period (1914-1918) is stated as follows :—

Cascade plant, 85/90 per cent.
Kessler plant, 91/93 per cent.
Gaillard plant, 96/97 per cent.

Again, evidence can be found that the Gaillard plant is more economical to work in all respects except fuel consumption than the Kessler plant.

Finally, it may be said that Vol. III, which is well-written and well-illustrated, will certainly constitute a standard work on the subject of acid concentration for some years to come, and Mr. Parkes is to be congratulated on maintaining unimpaired the Lunge tradition.

P. Parrish

Ore Dressing. Principles and Practice. By T. Simons. First Edition. Pp. xvii+292. London: McGraw Hill Publishing Co., Ltd., 1924. Price 17s. 6d.

Quite a number of books on the Dressing of Minerals have been issued within comparatively recent years, and it must, unfortunately, be admitted that the work now under review, the latest addition to the series, must rank in many respects as amongst the least satisfactory. The author has, of course, the advantage of being the latest writer on the subject; in a highly progressive industry like ore dressing new methods and appliances are continually being introduced, and it is hardly too much to say that a book upon the subject is getting out of date whilst it is passing through the press. On the other hand this rapidity of development enables the author of the latest book on the subject to describe appliances which were non-existent when previous writers produced their works. Thus we find in the present work that modern vibratory screens, such as the Hum-mer Screen, are fully described, though unfortunately the author seems to have little personal knowledge of their working and is forced to fall back upon the statements of the various makers for information as to their screening capacity.

The book is divided into three parts, the first devoted to the principles of ore dressing and containing chapters on the principles of what the author terms gravity processes of concentration, on breaking, crushing, grinding and pulverising, on volumetric sizing, on classifying, on concentration and separation, fine sand concentration, flotation and magnetic and electrostatic separation. The second part is devoted to stamp-milling and plate amalgamation, and the third part to mill accessories.

The great defect of the whole work is that the author's ideas on the subject do not yet appear to have properly clarified; as above noted, he devotes one part of his book to the stamp-milling and amalgamation of gold ores; now, it is a moot point whether this subject should be included under the head of ore dressing or not, though undoubtedly arguments can be brought forward to justify its inclusion; what is, however, not justifiable is that a writer should include it among ore-dressing processes when he commences by stating that "The actual extraction of the metals from the ore is not attempted by these processes." It is quite obvious that this definition would exclude the extraction of gold from its ores by the above methods. Again the author places log washers, thickeners and mechanically-worked classifiers among mill accessories. It never seems to have occurred to him that these are examples of what he terms gravity processes of concentration. The objection to the above phrase is that it includes two different methods of working which the author of this work has chosen to place under one head, without appearing to see the essential differences underlying them. These gravity processes of separation really include hydraulic and pneumatic separation, which ought to receive separate consideration. The author of this book has, however, practically excluded pneumatic separation except for a casual reference under jigs to the effect that "Where water is scarce, and for certain purposes, such as the removal of dust from finely ground material, the use of air under pressure in place of water is quite effective," and he illustrates this casual remark by a brief description of a pneumatic jig. The important differences between hydraulic and pneumatic separation are never touched upon, and no reference whatever is made to a number of pneumatic appliances, some of which, like the Sutton-Steele table, have attained a certain measure of importance.

It will be gathered that none of the chapters of the book can be considered as really satisfying a modern standard, but easily the worst of them all is that dealing with magnetic separation. The author appears to have no knowledge of the principles upon which this is based, and the only appliance which he mentions is an old-fashioned machine for the dry treatment of minerals of high magnetic permeability. In modern practice minerals of high permeability are practically always treated wet, and there are a number of efficient wet separators on the market; these are not even mentioned. An even worse fault is his omission to mention in any way appliances for the treatment of minerals of low magnetic permeability, of which the Wetherill magnetic separator has been the prototype. The author's ignorance of modern European practice might perhaps be excusable, but magnetic separation has made great strides and has been employed on a large scale in recent years in the United States, so that an American author ought really to know something about this portion of the subject.

The book is liberally illustrated, but many of the illustrations are too small for clearness; scales are conspicuous by their absence.

Henry Louis

LOW TEMPERATURE CARBONISATION. By C. H. LANDER and R. F. MACKAY. Pp. 277. London: E. Benn, Ltd., 1924. Price 35s. net.

Low-temperature carbonisation seems to possess a never failing interest for many, not only in scientific circles, but also of the general public. The evils of smoke from the use of raw coal are so apparent. The same coal partially carbonised would yield a smokeless fuel which would readily ignite and burn in the fireplaces now installed in British homes. Added to that there would be by-products of carbonisation which, on the analogy of the existing carbonisation industries, might be expected to yield a considerable revenue and, incidentally, contribute to the supply of liquid fuel which modern transport on sea and on land demands in ever increasing quantities. As has been truly said, the advantages are too obvious. There are, of course, snags, many of them, which hinder the development of low-temperature processes, as many of the investing public know, who have put up the necessary capital. Unfortunately, in the past, insufficient well-authenticated results have been publicly available to enable the claims put forward from time to time by interested parties to be tested, a want which this book will certainly fill. The authors have been intimately associated with the work on low-temperature carbonisation which the Fuel Research Board has made one of its principal objects. The writer is inclined to think that the production of this book is not the least valuable result of the Fuel Research staff's work. It is also a recommendation that the book under review is written round the results of the work at the Fuel Research Station—for books which are the records of first-hand experience cannot be too warmly welcomed. The fact that these results are among the few available and emanating from independent sources renders them peculiarly important.

There is a considerable space devoted to supply of fuel in general, and particularly as it affects British conditions. It is interesting to notice here that whilst low-temperature carbonisation appeals to us primarily as a source of smokeless household fuel, elsewhere it is mainly the liquid products which are sought. Free-burning domestic fuel is relatively unimportant in countries where closed stoves are almost universal.

There follow important chapters on the fundamentals of the subject—the classification of coal, the chemistry of the processes and products of coal carbonisation. To the trained chemist it may seem that unnecessary space is allotted to the formulæ and characteristics of compounds which are to be found in any standard textbook of organic chemistry. The profound difference between the effects of carbonisation at high and at low temperature has been repeatedly disclosed by the studies made from time to time in the laboratory, and these are traversed in the text.

The important subject of technical problems is treated in Chapter X, which will enable the enquiring reader to understand why low-temperature processes have made such modest headway in spite of the existence of the present gas and coke industries. These are not troubled to the same degree by the swelling of coal during the carbonisation or by the production of a coke which is too friable to stand the handling which must be incurred in distribution. Both have proved most serious problems to the early inventors of low-temperature processes, but the intensive work of recent years shows that neither can now be regarded as insurmountable. The merits of low-temperature coke as fuel are surveyed with a temperance which is commendable. In countries where winter temperatures are so low; or where fuel is so costly as to rule out the open fire as a means of domestic heating, low-temperature coke makes no special appeal. Burned in a closed stove, it has no marked advantages over gas coke or anthracite. For this reason the writer thinks that some claims for low-temperature coke, as for domestic water heating in an independent boiler, are rather overstated (p. 151).

Chapter XIII on the tar produced is largely a record of the results of the Fuel Research Station tests. These show that early expectations and claims as to the quantity and value of the tar products are without justification. Many of the constituents which give to high-temperature tar its commercial value are absent from the low temperature products, whilst other important fractions have no value to-day greater than that of crude fuel oil. It is here that the lessons of the coal-tar industry are useful. Gasworks tar was once similarly placed, and its many applications were only gradually discovered and its value was correspondingly realised. The same path will have to be followed by the newer industry. The production of ammonia as a by-product cannot be expected to help low-temperature carbonisation greatly, but the question is dealt with, and recent work bearing on the problem has been discussed.

Chapter XIX examines the no less formidable economic difficulties which will face a low-temperature industry when it has to be established on a national scale—*i.e.*, when markets have to be found for the products from millions of tons of coal. It is clear that all the products will have to find a stable market if the industry is to have a chance, and here the sale of the gas assumes a key position. The town gas industry seems to be the only one which can utilise properly the kind and quantity of gas contemplated. It is shown that the fabulous profits often imagined are not likely to be realised.

The book itself is a handsome and presentable example of the publisher's art which one is accustomed to look for from the firm which has issued it. It can be recommended to all who wish to find solid ground for opinions on so controversial a subject.

H. J. HODSMAN

The large concentrator of the Consolidated Mining and Milling Co., at Anyox, British Columbia, has begun to work on low grade copper ore. Its capacity is 1500 t. of ore a day, and it is estimated there exists, for concentration, about 8—10 million t. of ore.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

German Reparation (Dyestuffs)

In a written answer to Mr. Baker, Mr. Lunn stated that the deliveries of dyestuffs as reparation to Allied Powers from the commencement up to December 31, 1923, are as follows :—British Empire, 7,664,993 kg. ; Italy, 6,274,601 kg. ; France, 4,276,533 kg. ; Belgium, 1,219,214 kg. ; United States, 2,391,589 kg. ; Japan, 679,313 kg. ; Greece, 67,006 kg. ; and Serbia, 10,140 kg., making a total of 25,583,389 kg.—*June* 23.)

Dyestuffs

Replying to Mr. Black, Mr. Webb said that the total importation of synthetic indigo during 1923 amounted to 413 tons. No reparation dyestuffs were normally sold to the British Dyestuffs Corporation, but in 1922, with the approval of the users, a special transaction was entered into to sell to the Corporation a quantity of 333 tons of synthetic indigo dye which was requisitioned from Germany. In the absence of complete returns from the Reparation Commission the Board was unable to furnish the value in sterling. This special parcel of indigo was sold to the British Dyestuffs Corporation at cost plus freight and charges plus 5 per cent. on the gross cost. The difference between cost and selling price would be brought to account by the Board in the Reparation Dyestuffs Trading Account. With the approval of indigo users in this country the Corporation agreed to re-sell these dyes in combination with a quantity of their own products at prices not to exceed 1s. 3d. per lb. in the ease of sales to large consumers. The transaction had not been repeated.—(*June* 24.)

Vinegar

Mr. Hannon moved: "That leave be given to bring in a Bill to prevent the sale of liquids or products made in imitation of and purporting to be vinegar," as it was one of the defects of the Food and Drugs Act in this country that no provision had been made for fixing the standard of vinegar. The Bill proposed to define malt vinegar and imitation vinegar. Malt vinegar was a brewed product prepared by the alcoholic and subsequent acetous fermentation of barley or some other cereal, the starch of which had been converted by malt. Imitation vinegar was prepared from commercial acetic acid. The Bill followed principles which have been already adopted under similar legislation in the United States, New Zealand, South Africa, Australia and Canada, namely, provisions for defining what vinegar really is, provisions for labelling of vinegar so that the public will not be deceived, the fixation of penalties for the violation of the law, and arranging procedure in relation to offences under the Act. The object of the Bill was to fix a standard compelling the vendor, whether wholesale or retail, to sell to the public, as pure vinegar or malt vinegar, vinegar brewed in accordance with the principles for the making of malt vinegar. The motion was accepted. — (*June* 25.)

Drug Trade In India

Answering Mr. C. Wilson, Mr. Richards stated that the drug trade in India is regulated by the Opium Act of 1857 and 1878, the Excise Act, 1896, a number of Provincial Acts, and Rules under these Acts. The provisions of these Acts and Rules were not identical with those of the Dangerous Drugs Act, but they enabled the Government of India to fulfil her obligations under the Hague Convention. The consumption in the Punjab in 1922–23, though greater than in the previous year, was only 25,494 grains, or about one grain per thousand of the population, which is very greatly below the consumption in European countries. The consumption of opium per head was 8·5 grains in 1902—1903, and 5·25 grains in 1922—23. During the year 1912—1913 the consumption per head was 10·75 grains, but there had been a steady decline since that year. The gross revenue from licence fees and duty was 17 lakhs, 79,917 rupees in 1902—1903, and 35 lakhs, 86,027 rupees in 1922–1923.—(June 30.)

COMPANY NEWS

BLEACHERS' ASSOCIATION, LTD.

The report for the year ended March 31, 1924, shows a trading profit of £1,091,628, after deducting central charges and interest, and charging £379,328 for repairs and maintenance, estimated amounts for income tax, corporation tax and special repairs. From this sum £180,000 has been deducted for depreciation fund, £15,000 for leasehold and sundry property accounts, and £101,250 for debenture interest, leaving a net profit of £795,378, to which is added £361,712 brought forward. The final dividend proposed is 15 per cent. actual, making 20 per cent. for the year. The sum of £371,885 remains to be brought forward, after allowing for payment of the preference dividends.

COURTAULDS, LIMITED

A meeting of the shareholders will be held on July 17 to pass a resolution made by the directors in favour of a new bonus to shareholders. It has been decided to place a value of £16,013,629, instead of £7,804,021 as shown by the balance sheet on December 31 last, upon the shares held by the company in the American Viscose Corporation, and to carry the additional amount of £8,209,608 to the credit of capital reserve account. The directors have also decided to increase the capital from 12 to 20 millions by creating 8 million of 5 per cent. cumulative preference shares of £1 each, and to distribute these shares as fully paid among the shareholders at the rate of two preference shares for every three existing shares, the first dividend on the new preference shares being payable on January 1 next for the six months ended December 31. The dividends are to be paid half-yearly, less tax. This handsome gift to the shareholders indicates the great prosperity of this artificial silk manufacturing company, whose capital, since 1914, has been multiplied ten times, its profits about six times, and the

amounts appropriated to reserves seven times. The directors have also declared an interim distribution on the ordinary shares of 1s. 3d., the same amount as last year. The present ordinary dividend absorbs about £1,800,000 net and the new preference shares will take £400,000, less tax, annually. Assuming that the profits maintain the 1923 level—about £3,000,000—it would be possible to meet the interest on the new preference capital without reducing the ordinary dividend, and still leave a substantial margin for reserves.—(*The Times*, June 30.)

REPORTS

Report on the Industrial, Commercial, and Economic Situation in Poland, February, 1924. By R. E. Kimeus, Commercial Secretary, Warsaw. Department of Overseas Trade. Pp. 40. H.M. Stationery Office, 1924. Price 1s. 6d.

The country has continued to experience great financial difficulty, and in the year under review the whole life of the country was affected by the depreciation in the currency. The advent to power of M. Grabski was generally welcomed in business circles, but it is recognised that his stringent taxation programme must inevitably cause at first a general increase in prices, reduced production, and more unemployment. The conditions in industry, however, mitigated to some extent the effects of the financial collapse. The first year of Polish administration in Upper Silesia showed a considerable improvement, the collapse of the mark and the Ruhr occupation helping to produce this result.

The favourable position declined towards the end of the year, increased costs of production being largely responsible as exports necessarily fell. The textile industry felt this decline markedly in the middle of the year, but the chemical industry made satisfactory progress, and production increased. The chief raw materials imported for this industry are pyrites, phosphates, sodium nitrate, dyestuff intermediates, and fats, the last-named being the only one principally obtained from Great Britain; nearly all the necessary machinery is imported from adjacent countries. The metallurgical industry is steadily recovering from the effects of the German occupation; many imports are absorbed by this industry, steel being obtained largely from Great Britain. The output of sugar, improved, the estimated production being 320,000 t.

The favourable trade balance of recent years was maintained in 1923, exports being about 11 per cent. greater than imports. Owing to competition from Germany not being so keen imports from Great Britain were maintained throughout the year at about £278,000 per month, but for this trade to increase prices must fall. The information given in the last report (*cf. Chem. and Ind.*, 1923, 776) on the system of trading and payment that should be used by intending traders is repeated in detail. Colonial goods, chemicals, and machinery are among articles in demand from this country.

Development of the mining industry was satisfactory in 1923. The output of iron ore (Jan., to Oct.) was 366,600 t., of zinc ore, 200,600 t., of lead ore, 14,000 t., of salt, 300,327 t., and of potassium salts, 54,154 t. Coal production amounted to 30,300,374 t. in the same period. The petroleum industry showed some expansion, the output in 1923 being 632,044 t., about 114,000 t. more than in 1922.

Report on the Commerce and Industry in Bulgaria, dated February, 1924. By C. B. Peake. Department of Overseas Trade. Pp. 20. H.M. Stationery Office, 1924. Price 9d.

The favourable conditions obtaining in Bulgaria at the end of 1922 have not led to any marked improvement in the state of the country. Fluctuation in the value of the lev between 860 in February and 350 in June had an unsettling effect, and for a time exportation was impossible. The question of reparations and other obligations has affected the budget, which for the current year will show a deficit, another disturbing factor. The present year can hardly be satisfactory for trade on account of the embargo on importation, which has been placed on 150 classes of goods, and which will affect British traders seriously, though textiles may still be imported. The country is in as good a position as most Balkan States, however, and progress may be noticeable again soon. The natural resources, which are capable of development, may prove of interest to British investors in the near future.

The latest trade figures are for 1922. As foreshadowed in the last report (*cf. Chem. and Ind.*, 1923, 662) exports exceeded imports, the former being valued at 4,330 million levas, and the latter at 4038 million levas. Germany supplied 21 per cent. of the imports, Great Britain 15 per cent., and Italy 12 per cent. Of the exports Turkey took 25 per cent., Germany 17 per cent., and Italy, 13 per cent. The embargo mentioned above makes the opening up of trade difficult, but attention might usefully be given to the demand for motors and agricultural machinery, though here good credit terms must be allowed.

The country is largely agricultural, and the good cereal harvest in 1923 was of great value. The beet production was also good, and the 38,000 t. of sugar which should be obtained will suffice for home needs. Coal was mined in 1922 to the extent of 1,021,327 t. whilst salt and copper were also obtained to a small extent.

STEEL PRODUCTION IN FRANCE IN APRIL, 1924

On May 1, 136 blast furnaces were working in France, being the same number as on April 1. At the same time 39 were ready for firing, and 45 were being built or repaired. The total output of cast iron in April was 651,323 tons, an increase of 16,759 t. over March, and the production of steel rose to 567,485 t.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 6d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.: Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	6¼d.—6¾d. per lb. Market firmer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	45s per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	4s. 10d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton. Fair demand.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall. 60% O.P. Market dull.
Solvent	5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£46 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d.—6¾d. per lb. Better inquiry.
Crude 60's	1s. 9d.—1s. 10d. per gall. Market flat. Only odd lots being offered.
Acid Cresylic, 97/99	2s 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—1s. 11d. per gall. Steady demand.
Dark	1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	9½d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d. per gall.
Pure	1s. 10d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.

Creosote—	
Cresylic 20/24% ..	9d.—9½d. per gall. Few inquiries.
Middle Oil ..	6½d.—9d. per gall. according to grade and district. Market very quiet.
Heavy	
Standard Specification	
Naphtha—	
Solvent 90/160 ..	1s. 4d.—1s. 5d. Market steady.
Solvent 90/190 ..	1s. 1d.—1s. 4d. Fair business passing.
Naphthalene Crude—	
Drained Creosote Salts	£6—£6 10s. Demand falling off.
Whizzed or hot pressed	£9—£12 per ton. Little business.
Naphthalene—	
Crystals and Flaked ..	£16—£17 per ton.
Pitch, medium soft ..	52s. 6d.—57s. 6d. per ton. No export business at present. Plenty of inquiries for next season.
Pyridine—90/160 ..	21s.—22s. per gall. Market less firm.
Heavy ..	12s.—12s. 6d. Market steady.

INTERMEDIATES AND DYES

Business in dyestuffs has been fairly good, but very little improvement is shown. Prices remain constant.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 6d. per lb.
Acid H	4s. 3d. per lb 100% basis d/d.
Acid Naphthionic ..	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. ..	1s. 1½d. per lb. Steady demand.
Acid Sulphanilic ..	9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% ..	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C. ..	4½d. per lb. Demand steady.
m-Cresol 98/100% ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid ..	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	4s 9d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol ..	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. per lb. d/d
Monochlorbenzol ..	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine ..	1s. 4½d. per lb. d/d.
β-Naphthylamine ..	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol ..	2s. per lb. 100% basis d/d.
Nitronaphthalene ..	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine ..	4s. 2d. per lb. d/d.
p-Phenylene Diamine ..	10s. 3d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate ..	2s. 5d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 6d. per lb. naked at works.
m-Toluylene Diamine ..	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P ..	£47 per ton.
Acid, Acetyl Salicylic ..	3s. 3d. per lb. Value and demand maintained.
Acid, Benzoic B.P. ..	3s. 6d. per lb. Larger supplies available. Market easier.
Acid, Boric B.P. ..	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain. Prices reduced by £3 per ton.
Acid, Camphoric.. ..	19s.—21s. per lb.
Acid, Citric	1s. 6½d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst. ..	7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic	Prices quoted from 2s. per lb. down to 1s. 7d. for ton lots. Market still weak. Keen competition and smaller demand.
Acid, Tannic B.P. ..	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d.—1s. 2d. per lb. less 5%. Better tone but not yet very active. Cheap offers of second hand parcels of foreign acid. Higher prices expected in view of firmness of raw materials.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 3d. per lb. for quantity. Demand slow. Prices shaded to secure large orders.
Amidopyrin	13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate ..	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate ..	12s. 6d. per oz. for English make.
Barbitone..	15s. per lb. Quiet market.
Benzonaphthol	6s. per lb. Small inquiry.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate ..	12s. 9d.—14s. 9d. per lb.
„ Citrate.. ..	11s. 4d.—13s. 4d. „
„ Salicylate ..	10s. 2d.—12s. 2d. „
„ Subnitrate ..	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Fluctuating market. Continental prices decidedly firmer.
Potassium	11d. per lb.
Sodium..	1s. „
Ammonium	1s. 1d. per lb.
Calcium Lactate.. ..	Demand active. Good English make can be had from 1s. 7d to 2s. 6d. per lb.
Chloral Hydrate ..	3s 7d.—3s. 9d. per lb, duty paid
Chloroform	2s. per lb. for cwt. lots. Very steady
Creosote Carbonate ..	6s. 0d. per lb. Little demand.
Formaldehyde	£55 per ton, *ex* works. English make.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free	7s. per lb.
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50% ..	3s. 6d. per lb.
Sodium, 50%	2s. 6d. „

Guaiacol Carbonate	11s. per lb. for cwt. lots. Slightly cheaper.
Hexamine	3s. 6d. per lb. for English make. Market quiet and steady.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	English make offered at 120s. per oz.
Hydroquinone	4s. 3d. per lb. in cwt. lots. Foreign make.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 2d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	52s. 6d. per lb. Weaker.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Market firm.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	2s.—2s. 3d. per lb. for carboys. Not much demand.
Methyl Sulphonal	20s. per lb.
Metol	11s. per lb. British make.
Paraformaldehyde	3s. per lb. More inquiry.
Paraldehyde	1s. 4d.—1s. 6d. per lb. in free bottles and cases, according to holder and quantity.
Phenacetin	6s. per lb. Ample stocks available.
Phenazone	7s. 3d. per lb. for cwt. lots. Quiet.
Phenolphthalein	6s. 6d. per lb. Easier with supplies more plentiful.
Potass. Bitartrate—	
99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 10d.—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 6d. per lb. Sales slow.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d.—3s. 11d per lb. Easier in sympathy with other salicylates.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 9d. per lb. In quantity for British product.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity. Firm in common with other citrates.
Sod. Hyposulphite—	
Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.
Sod. Salicylate	Market more active. Powder 2s. 2d.—2s. 6d. per lb. Crystal at 2s. 5d.—2s. 8d. per lb. Flake 2s. 9d.—2s. 10d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol	15s. 9d.—17s. 6d. per lb. for good white crystal from ajowan seed. Very firm and scarce.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.
Aubepine	14s. 6d. ,,
Amyl Acetate	2s. 9d. ,,
Amyl Butyrate	6s. 9d. ,,
Amyl Salicylate	3s. 3d. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 10½d. ,,
Benzyl Alcohol free from Chlorine	2s. 10½d. ,,
Benzaldehyde free from Chlorine	3s. 6d. ,,
Benzyl Benzoate	3s. 6d. ,,
Cinnamic Aldehyde Natural	15s. 6d. ,,
Coumarin	20s. ,,
Citronellol	16s. ,,
Citral	10s. ,,
Ethyl Cinnamate	15s. ,,
Ethyl Phthalate	3s. 3d. ,,
Eugenol	10s. 6d. ,,
Geraniol (Palmarosa)	35s. ,,
Geraniol	11s.—18s. 6d. per lb.
Heliotropine	7s. per lb.
Iso Eugenol	15s. 9d. ,,
Linalol ex Bois de Rose	26s. ,,
Linalyl Acetate	26s. ,,
Methyl Anthranilate	9s. 6d. ,,
Methyl Benzoate	6s. ,,
Musk Ambrette	45s. ,,
Musk Xylol	16s. 6d. ,,
Nerolin	4s. 9d. ,,
Phenyl Ethyl Acetate	12s. 6d. ,,
Phenyl Ethyl Alcohol	16s. ,,
Rhodinol	57s. 6d. ,,
Safrol	1s. 10d. ,,
Terpineol	2s. 4d. ,,
Vanillin	24s.—24s. 9d. per lb. Price reduced. Demand steady.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 8d. per lb.
Bergamot Oil	19s. 6d. per lb.
Bourbon Geranium Oil	36s. 6d. ,,
Camphor Oil	75s. per cwt.
Cananga Oil Java	10s. 6d. per lb.
Cinnamon Oil, Leaf	6½d. per oz.
Cassia Oil, 80/85%	8s. 9d. per lb.
Citronella Oil—	
Java 85/90%	6s. per lb.
Ceylon	3s. 9d. per lb.
Clove Oil	7s. 3d. per lb.

Eucalyptus Oil 70/75% ..	2s. 2d. per lb.
Lavender Oil—	
French 38/40% Esters	27s. 6d. per lb.
Lemon Oil	3s. 2d. per lb.
Lemongrass Oil ..	3d. per oz.
Orange Oil, Sweet ..	13s. 9d. per lb.
Otto of Rose Oil—	
Bulgarian	27s. 6d. per oz.
Anatolian	23s. 6d. per oz.
Palma Rosa Oil	19s. per lb.
Peppermint Oil—	
Wayne County ..	20s. 9d. per lb.
Japanese	15s. 6d. per lb.
Petitgrain Oil	10s. per lb.
Sandal Wood Oil—	
Mysore	26s. 6d. per lb.
Australian	21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before August 25; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on July 10th.

I.—Applications

Douglas. Apparatus for separating liquids from granulated substances. 14,827. June 19.

Green and Ogden. Separating chemically-inmiscible liquids. 14,894. June 19.

Holloway and North British Diesel Engine Works. Centrifugal separators. 14,693. June 18.

Nyrop. Method of altering properties of fluids. 14,627. June 17.

Ritchie. Drier. 14,561. June 16.

Schindler. Mixing drums. 15,041. June 21. (Switz., 27.6.23.)

Wade (Duff Patents Co.). Furnaces. 14,573. June 16.

Weiss. Drying-cylinders etc. 14,881. June 19.

I.—Complete Specifications Accepted

3116 (1923). Lilleshall Co., Ltd., and Bishop. Centrifugal filter or separator. (217,264.)

16,691 (1923). Heyl. *See* II.

20,299 (1923). Brackett, and Brackett and Co., Ltd. Screening or filtering apparatus. (217,462.)

21,137 (1923). Elmore (Comley). Removal of free moisture from substances by centrifugal means. (217,469.)

22,640 (1923). Duclaux. Manufacture of ultra-filter membranes. (203,714.)

5552 (1924). Grauss. Centrifugal drying-machines. (212,551.)

II.—Applications

Forst. 14,777. *See* VII.

Frey. Fuel compact. 14,753. June 18. (U.S., 25.7.23.)

Glasgow, and Humphreys and Glasgow, Ltd. Water-gas generators. 14,714. June 18.

Hey. 14,540, 14,945. *See* XII.

Heyl. Obtaining volatile products from mineral deposits *in situ*. 14,541. June 16.

Heyl. Treatment of sulphur-containing oils. 14,924. June 20.

Hines. Laying dust in coal mines etc. 14,587. June 17.

Mailhe. Production of petroleum from vegetable etc. oils and glycerides. 14,743. June 18. (Fr., 28.6.23.)

Moore. Manufacture of combustible gases. 14,798. June 19.

Rude. Production of water gas from solid fuel. 14,708. June 18.

II.—Complete Specifications Accepted

9023 (1923). Corthesy and Mills. Combustion of fuel. (217,359.)

10,247 (1923). Thornton and Illingworth. *See* VIII.

16,691 (1923). Heyl. Rotary distillation retorts. (217,428.)

1653 (1924). Koppers Co. Regeneratively-heated vertical retort furnaces. (210,085.)

III.—Complete Specification Accepted

18,691 (1923). Baglin. Regenerative coke ovens. (217,454.)

IV.—Applications

Forcart, and Haco Ges. Production of albumen-dyestuff products etc. 15,031. June 21.

Imray (Soc. of Chemical Industry in Basle). Manufacture of dyestuffs. 14,768. June 18.

IV.—Complete Specification Accepted

2377 (1924). Chemische Fabrik Griesheim-Elektron. *See* VI.

V.—Application

Courtaulds, Ltd., and Gardner. Manufacture of threads or filaments of cellulose esters. 14,943. June 20.

V.—Complete Specifications Accepted

6570 (1923). Dreyfus. Manufacture of threads and filaments from cellulose derivatives. (217,287.)

6986 (1923). Fine Cotton Spinners' and Doublers' Association, Ltd., Balls, and Hutchins. Preparation of fibrous materials for spinning.

20,321 (1923). Fues. Manufacture of paper. (202,314.)

VI.—Applications

Baddiley, Hill, and British Dyestuffs Corporation. Production of greenish-yellow shades on acetyl silk. 14,956. June 20.

Lepine. Dyeing etc. machines. 14,822. June 19.

VI.—Complete Specification Accepted

2377 (1924). Chemische Fabrik Griesheim-Elektron. Process of producing on the fibre azo-dyestuffs from arylamides of 2 : 3-oxynaphthoic acid. (210,462.)

VII.—Applications

Cowles. Process for producing and utilising alkalis and alumina. 14,763. June 18.

Forst. Recovery of ammonia and ammonium compounds from gases. 14,777. June 18.

Norsk Hydro-Elektrisk Kvaelstofaktieselskab. Process for production of catalysts for synthesis of ammonia. 15,045. June 21. (Norway, 14.7.23.)

VII.—Complete Specifications Accepted

5849 (1923). Bone. Production of activated nitrogen (217,277.)

21,072 (1923). Johnson (Badische Anilin und Soda Fabrik). Manufacture of formic acid. (217,467.)

21,089 (1923). Wallace. Recovery of soda from its solutions. (217,468.)

VIII.—Application

General Electric Co., Ltd. Readily fusible glasses and enamels. 14,532. June 16. (Ger., 24.1.24.)

VIII.—Complete Specification Accepted

10,247 (1923). Thornton and Illingworth. Silica or refractory fireclay blocks and bricks for coke oven walls, furnace linings, and the like. (217,377.)

IX.—Applications

Graham and Mackay. Waterproofing concrete etc. 14,838. June 19.

Grieve, and Jameson and Co. Manufacture of emulsions of bitumen etc. 14,510. June 16.

Kaiser-Wilhelm-Institut für Eisenforschung, and Hessel. Production of artificial stone etc. 14,628. June 17. (Ger., 25.6.23.)

IX.—Complete Specifications Accepted

33,343 (1922). Holzveredelung Ges., and Trenkler. Process for hardening wood. (217,095.)

6315 (1923). Lefeburo. Concrete, cements, plasters, and the like. (217,279.)

8019 (1923). Amies. Cementitious composition. (217,343.)

11,801 (1923). Pickstone. Manufacture of mortar, artificial stone, concrete, and the like. (217,388.)

X.—Applications

Compagnie des Forges de Chatillon, Commentry, et Neuves-Maisons. Thermic treatment of steel etc. 14,976. June 20. (Fr., 13.2.23.)

Ferranti, Ltd., and Ferranti. Protection of metals. 14,869. June 19.

Fitzgerald. Means for recovering gold etc. from dilute solutions. 15,042. June 21.

Jordan. Softening aluminium-plated iron articles. 14,969. June 20.

Jordan. Aluminium plating of spooled metal bands etc. 14,970. June 20.

Kelly. After-treatment, finishing, and working of alloys etc. 14,590. June 17.

Kelly. Alloys. 14,594. June 17.

Krupp Akt.-Ges. Friedrich-Alfred-Hutte. Devices for manufacturing steel. 14,937. June 20. (Ger., 8.7.23.)

Poole. Solder. 14,897. June 20.

Soc. d'Electro-Chimie, d'Electro-Métallurgie, et des Aciéries Electriques d'Ugine. Extracting tin from minerals, alloys, etc. 14,562. June 16. (Fr., 21.6.23.)

Summers. Coating metals with other metals. 14,593. June 17.

X.—Complete Specifications Accepted

1140 (1923). Berlin. Reducing metallic oxides. (193,057.)

7408 (1923). Dicker. (N. V. Hollandsche Tungsten-draadfabriek). Treatment of tungsten and other metals having a high melting point. (217,322.)

10,165 (1923). Hooper. Production of aluminium and silicon from bauxite etc. (217,376.)

12,473 (1923). Harris. Refining of metals. (217,391.)

22,570 (1923). Geschwind. Roasting-furnaces. (217,477.)

22,746 (1923). Gelsenkirchener Bergwerks-A.-G., and Opderbeck. Granulating slag (204,318.)

XI.—Applications

Antonoff. Electric batteries. 15,040. June 21.

Bannister. Storage batteries. 14,570. June 16.

Fitzpatrick (Meyer-Keller et Cie.). 14,709. *See* XIX.

Monson Electrical treatment of solids and liquids. 14,509. June 16.

XI.—Complete Specifications Accepted

33,025 (1922). Prior and Riley. Selenium cells. (216,942.)

14,045 (1923). Jackson (Mathieson Alkali Works, Inc.). Electrolytic processes. (217,414.)

20,594 (1923). Katsumori. Electric batteries. (217,465.)

XII.—Applications

Hauschka. Manufacture of synthetic linolin. 14,480. June 16.

Hey Removal of suspended matters from oils etc. 14,510, 14,945. June 16 and 20.

Mailhe. 14,743. *See* II.

Schetelde. Manufacture of soap. 14,669. June 17.

XII.—Complete Specification Accepted

9337 (1923). Pearson and Co., Ltd., and Clark. Removing odour and flavour from cod liver oils etc., or from the unsaponifiable portion thereof in such a manner as to retain vitamin activity. (217,363.)

XIII.—Applications

Terwilliger. Synthetic resins. 14,652, 14,653. June 17. (U.S., 29.6.23 and 5.7.23.)

XIII.—Complete Specification Accepted

7434 (1923). Tyrer. Manufacture of a white pigment. (217,323.)

XIV.—Complete Specifications Accepted

22,910 (1923). Ricard, Allenet, et Cie. Vulcanisation of india-rubber. (204,052.)

3574 (1924). K. D. P., Ltd. Manufacture of caoutchouc. (213,886.)

XV.—Application

Marks (Internationale Galalith-Ges. Hoff und Co.). Manufacture of transparent artificial horn. 14,873. June 19.

XV.—Complete Specification Accepted

7129 (1923). Melamid. Tanning and the manufacture of tanning-substances. (194,723.)

XVI.—Application

Potts (Asahi Glass Co.). Manures. 14,803. June 19.

XVII.—Complete Specification Accepted

8277 (1923). Martin. Manufacture of beer, vinegar glucose, dextrin-maltose, spirits, and the like. (217,348.)

XVIII.—Application

Gaux and Salmon. Manufacture of yeasts. 14,751. June 18. (Fr., 19.6.23.)

XVIII.—Complete Specifications Accepted

8277 (1923). Martin. *See* XVII.

9012 (1923). Pollak. Production of yeast. (195,963.)

XIX.—Applications

Fitzpatrick (Meyer-Keller et Cie.). Rendering vegetable etc. materials durable by electricity. 14,709. June 18.

Hocking. Apparatus for purifying water containing grease or oil. 14,806. June 19.

Nielsen. Sterilising milk etc. 14,617. June 17.

Perky. Food product. 14,548. June 16.

Wallis. Production and use of antiseptics etc. 14,964. June 20.

XIX.—Complete Specifications Accepted

6368 (1923). Imray (Kellogg Co.). Production of food products. (217,282.)

21,916 (1923). Pico. Destructive fermentation of organic residues. (203,336.)

XX.—Applications

Kjaer. Obtaining extracts from animal organs. 14,980. June 20.

Schindelmeiser. Production of thymol and its isomers and homologues. 15,033. June 21.

XX.—Complete Specification Accepted

26,164 (1923). Soc. des Produits Azotés. Isolation of urea. (206,489.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35 Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*Australia*: Leather goods (725); hardware (726); *Canada*: Centrifugal sewage and sludge pumps (tender) (A.X. 1081 and 1082); *Chile*: Raw products (oils etc.) for soap manufacturers (753), photographic materials (B.X. 1017); *France*: Sulphate of copper (734), tinplate, sheet iron and machines for bleaching and dyeing (735); *Italy*, raw materials for paper mills and paper (737), machine tools and technical articles (739), machinery for manufacture of artificial

silk and confectionery (740), chemicals for textile industry (742), paints (B.X./1040); *Netherlands*: Crockery (745); *Rumania*: Coconut fibre yarn (749).

French Company News

In 1923 the Cie. des Mines de Crespin Nord produced 189,406 tons of coke, 2145 t. of ammonium sulphate, 4022 t. of tar, and 16,149,540 cb. m. of gas. In the same year the Cie. des Mines de Vandin les Béthune produced 165,649 t. of coal against 140,723 t. in 1922.

The Société des Phosphates Tunisians produced 424,075 t. of phosphates in 1923, compared with 378,367 t. in 1922. The company's report states that experiments have shown that Tunisian phosphates when finely ground, can be applied directly to acid soils, an observation which confirms experiments carried out by G. Claude in Morocco, and his industrial process for grinding natural phosphates to pass a very fine mesh.

Exports of chemicals in 1924

The United States exports of chemicals and allied products during the first quarter of 1924 had an aggregate value of $32,580,385, which was 4 per cent. below the corresponding period of 1923, but 10 per cent. above the first quarter of 1922. During the three months to March, 1924, sales were the smallest. The exports of essential oils showed the largest expansion of any group of chemicals and allied products exported during the first quarter of 1924 75 per cent. in value—followed by crude drugs, with an advance of 47 per cent.: coal-tar products, 14 per cent.; and pigments, paints and varnishes, 11 per cent. In contrast to these gains, naval stores, gums, and resins decreased 26 per cent.; industrial chemicals, 8 per cent.; and perfumery etc. 4 per cent.; whilst explosives, which dropped 9 per cent. in value, rose 2 per cent. in quantity, and fertilisers and fertiliser materials fell 4 per cent. in value, but rose 11 per cent. in quantity. Coal-tar exports rose to a total valuation of $3,137,383 in the first quarter of the year, and foreign demand increased until $1,421,372 worth of crudes, $95,758 worth of intermediates, and $1,620,253 worth of finished coal-tar products were shipped abroad. A decline of 8 per cent. was registered in the exports of industrial chemicals, their value having reached $6,396,052. Total exports of mineral-earth pigments amounted to 7,455,180 lb. valued at $215,509, and outgoing consignments equalled 6,972,487 lb. worth $600,618, in the first three months of 1924. A 13 per cent. expansion was made in foreign sales of varnishes, the most important improvement for goods of this kind being in carbon and lamp-blacks, which rose from $709,640 to $1,217,922 in 1924. Fertilisers gained in quantity to the extent of 11 per cent., but lost in value by 4 per cent., sales falling from $4,329,862 in the first quarter of 1923 to $4,139,593 in the corresponding period in 1924. Explosives likewise advanced in quantities shipped, but dropped in value, and no great change was reported in dynamite. The heavy shipments of peppermint oil during the first quarter of the current year, when more than double the quantity was exported, accounted fo the big increase in essential oils. Demand fo American crude drugs swelled 47 per cent. durin the period under review, whilst medicinal and pharma ceutical preparations retained the position held i 1923. During the month of March, the shipment of antitoxins, serums and vaccines were unusuall large. After the large amounts of naval stores gums, and resins shipped abroad throughout 1923 it is not surprising that the figures for the first quarte of 1924 should fail to reach the figure for the corre sponding period of 1923. Foreign sales dropped 2 per cent., the exports of rosin decreased 18 pe cent., while spirits of turpentine fell 42 per cent On the other hand, wood turpentine, turpentin substitutes and wood tar and pitch advanced durin the 1924 period to $104,423 (125,017 gallons) $72,461 (225,300 gallons), and $73,823 (13,42 barrels) respectively.—(*U.S. Com. Rep.*, May 5 1924.)

PUBLICATIONS RECEIVED

The Technique of Tissue Culture "in Vitro." By T. S. P. Strangeways. Pp. xii+80. Cambridge: W Heffer and Sons, 1924. Price 7s. 6d.

Tissue Culture in Relation to Growth and Differentiation. By T. S. P. Strangeways. Pp. x+50. Cambridge: W. Heffer and Sons, Ltd., 1924. Price 5s

Standard Methods of Testing Petroleum and its Products. Pp. x+100. Report published by Institution of Petroleum Technologists. London: W. Speaight and Sons, Ltd., 1924. Price 6s.

Simplified Practice Recommendation No. 12. Hollow Building Tile. Bureau of Standards, United States Department of Commerce. Washington Government Printing Office, 1924. Price 5 cents.

Electrode Reaction and Equilibria. A General Discussion held by the Faraday Society, November, 1923 Pp. 666—838. Aberdeen: The University Press, 1924. Price 10s. 6d.

First (Experimental) Report to the Atmospheric Corrosion Research Committee (of the British Non-Ferrous Metals Research Association). By W. H. J Vernon, B.Sc., presented to the Faraday Society December 17, 1923. Reprinted from the *Transactions* of the Faraday Society No. 57, Vol. XIX. Part 3, March, 1924. Pp. 839—934. Aberdeen: The University Press. Price 7s. 6d.

Sodium and Magnesium Salts of Western Canada. By L. Heber Cole. Transactions of the Canadian Institute of Mining and Metallurgy. Part of Vol. xxvii, 1924. Pp. 31.

The Canada Year Book, 1922-23. Official Statistical Annual of the Resources, History, Institutions, and Social and Economic Conditions of the Dominion Published by authority of the Hon. Thomas A. Low M.P., Canada Dominion Bureau of Statistics. Pp xxviii+1038. Ottawa: F. A. Acland, 1924.

Report on the Industrial, Commercial, and Economic Situation in Poland, dated February, 1924. By R. E. Kimens, O.M.G., Department of Overseas Trade. Pp. 40. H.M. Stationery Office, 1924. Price 1s. 6d.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

VOL. 43 NEW SERIES | LONDON, JULY 11, 1924 | NO. 28

EDITORIAL

We do not recollect a Presidential Address which has been more scientific than that which is printed in this week's Transactions. Presidents are apt to have a knowledge so profound that but little of it comes to the surface and their public addresses for this reason deal with generalities, the importance of chemistry to the Nation or some such topic, needing rather a facile pen and a vivid imagination than an exact knowledge of facts. Dr. Armstrong has given us a considerable mass of facts, some familiar, some which require prolonged search to obtain, but in this memoir they are conveniently arranged and their interest and importance are clearly indicated. Fats have often been considered from the point of view of those who regard them as raw materials; the conspicuous feature of this particular address is their consideration as parts of living plants and animals, how chemistry throws light on the processes by which they are built up, how they may be taken to pieces again and what function they have in the growth and life of the organism. Only the acquisitive will learn by heart the table of percentage composition of fatty acids from fats but we suppose that every one, chemist or not, with an average amount of curiosity will find pleasure in reading about the variations in the proportion of saturated and unsaturated acids, the predominance of the acids containing 10, 12, and 14 carbon atoms over all others and the probable relation of the fatty acids to starch and glucose. The chemistry of plant life has been advanced in many ways at Liverpool this address also is an important contribution to the chemistry of life. Slowly we are learning many of the secrets of Nature; it is essential to know the details of the processes before we can imitate them. Dr. Armstrong and his colleague Mr. Allen have opened a window in chemistry illuminating many an obscure point. We wish they would put before the world an equally intelligible statement of the chemistry of plant life in general. Those who are on familiar terms with fats, glucosides, sugars and enzymes have an opportunity which we trust will attract them. It should be no matter of surprise that spectroscopists in Liverpool and soap manufacturers in Warrington should be engaged on the same problem; the problem may be approached from many directions; the X-ray analysts, the stereochemists, the biochemists, all can make their contribution, not all so well as those whose achievement we are now alluding to, but every variety of physical and chemical knowledge will be required before the botanist and the zoologist can understand that life with which they are concerned. Life is mysterious, but how much of the mystery is due to our slender knowledge, we cannot say. Dr. Armstrong has done no small service in opening this window in chemistry, so that he who runs may read.

* * *

There were two papers read at Copenhagen of considerable interest, the first by Professor Biilmann on the use of quinhydrone for the rapid deter-

mination of hydrogen-ion concentration; the author also showed the apparatus, which is simple, and explained the method of using it, which appears to be easy and accurate. The other paper was by Professor Bronsted on the definition of acids and bases. If an acid be defined as a compound capable of yielding a hydrogen ion, then in addition to the easily recognised acids, such compounds as water, the ammonium ion and so on are really acids and the proper definition of a base is the substance left after an acid has lost a hydrogen ion:- hydroxyl ions, ammonia, chlorine and some other substances are thus bases; lime, litharge and caustic soda are not bases. By adopting these definitions and making use of them logically a number of interesting—and even surprising—results are obtained. The pursuit of this branch of chemistry is simple and involves no costly apparatus; whether it will have important industrial applications is not yet apparent. Many branches of human knowledge have passed through a similar logical phase, psychology, jurisprudence, religion, metaphysics and so on. In the majority of cases no permanent ill-effects have been noticed; definitions are very convenient tools but usually they are only rough approximations to the actual facts and, except in mathematics, they require continual adjustment to meet the growth of scientific knowledge.

* * *

Many of our readers must have noticed the drawings which have appeared from time to time in the illustrated papers purporting to depict the manner in which obelisks were quarried and erected in Ancient Egypt. Amazing as the performance may seem when viewed through the mists of time, it was in reality quite simple: a system of levers, a shifting fulcrum and an absence of the eight-hour day, and it was done. Yet one can imagine the chorus of "wonderful" going up in suburban homes, when the illustrations are handed round the breakfast table, though an escape of gas, a short interruption in the supply of electricity, a failure of the morning saline mixture to effervesce are hailed bitterly as signs of the degeneracy of the age. It is a pity that antiquities have so much greater an attraction for the public than evaporators or carbonisation, or that the results of the laborious investigations which led to an explanation of the action of acids on carbonates are accepted without wonder. We have the greatest interest in archaeology and have even dabbled in it ourselves, but we are concerned with chemistry and its appreciation by the non-technical man, and although this appreciation is growing satisfactorily, we shall continue to ask for more. The World Power Conference at Wembley will, from one point of view, carry out useful propaganda, for the mark of the chemist is all over it, as can be gathered on reading the account of the meeting during the first week, which has been contributed to this issue by our special correspondent. Our correspondent feels relieved that we have no commercial sources of volcanic steam in this country. However, Prince Ginori Conti's account of his work since 1904 on the utilisation of the natural steam at Lardarello in Tuscany, reminded us of the article on this subject which we published some time ago, and we were sorry that we could not see the kinematograph demonstration depicting the "soffioni," the turbo-alternators, the concentrating tanks for borax, and all the extensive plant which has grown up under his supervision. Prince Conti is an honorary member of this Society and his pioneer work is well known in this country. Those who met Prince Conti at the Annual Meeting at Cambridge last year will hope that he will be able to be present at Liverpool. Another aspect of the production and utilisation of power is presented in the paper on "Fuel Economy Questions" by Mr. Womersley, who deals more particularly with the boiler plant and makes interesting suggestions that merit the attention of steam users. We cannot avoid the subject of power and it is only owing to the admirable organisation of the chemical industry that labour, although costly, does not provide us with still more difficult problems to solve. And we hope that those who are enjoying the meeting at Liverpool will remember the devoted labour of those who for a long period have worked so tirelessly, so strenuously, to perfect its organisation, and will express their appreciation of the local Committee's arduous work by more than a formal vote of thanks.

* * *

The paper on "Soil Problems and Soil Population," by Mr. Gimingham, is a handy resumé of much recent work. Every amateur gardener knows that the soil population is considerable, but it is only those who pursue their investigations in a scientific manner who can appreciate the vast numbers of microscopic beings which inhabit the soil. We appeal to some of these for advice of a practical kind. A gardener of our acquaintance has a greenhouse infested by wood-lice; according to his account they are as "innumerable as the stars of night, or stars of morning, dewdrops, which the sun impearls on every leaf and every flower." He has read a number of treatises on hydrogen-ion concentration, and watered the ground with many strange devices. Nevertheless, every time the good, easy man thinks his greatness full surely is a ripening, the little brutes come and devour the tenderest rootlets of the most precious specimens, finally killing them. On our advice he watered the soil with an aqueous solution, we think that is the phrase, of creosote. From every cranny and hole there emerged great brown wood-lice, little pink ones, innocent sucklings, fathers, mothers, uncles, cousins, cocking tails and pricking whiskers, families by tens and dozens, brothers, sisters, husbands, wives. For the moment they are running and crawling to a greener, cleaner land, but in a day or two they will return to their old haunts, their old pastures, like a flock of locusts. Is there no soil medicine, no Mothersill, no Yadil, which will make the soil healthy and strong again? Will lime, or litharge, quinhydrone or tartaric acid avail? What Fourneau, what Morgan, what Thorpe or Ingold will come to our friend's assistance? Can he cut of supplies of boron, magnesium or vitamins? We trust we do not appeal in vain.

SOCIETY OF CHEMICAL INDUSTRY

THE ANNUAL GENERAL MEETING, JULY 9, 1924.

The Annual Meeting of the Society of Chemical Industry in Liverpool has been honoured by the patronage of His Majesty the King. This is the second occasion on which His Majesty has thus signified his appreciation of the work of the Society, and the Society will no doubt make strenuous efforts to deserve such encouragement in the future and by deserving it to obtain it.

The meeting has been organised by a General Committee consisting of the Liverpool Section Committee assisted by the Lord Mayor of Liverpool, Mr. Arnold Rushton, Sir Max Muspratt, Bart., Mr. Roscoe Brunner and several others well known in Liverpool and in chemical circles. It may be presumed that the bulk of the work has been done by the Chairman of the Section, Mr. Edwin Thompson and by the Hon. Secretary, Mr. E. Gabriel Jones, and only those who have taken part in the organisation of such a meeting can realise the volume of the work involved, the minute attention to detail required and the many long hours spent by the committee in making the necessary preparations for a successful gathering which includes both social and scientific functions. There will be receptions, dinners, luncheons, visits to the works of Messrs. Joseph Crosfield & Sons, Ltd., and of The United Alkali Co., Ltd., a dance, and an important contribution to our knowledge of fats delivered by our President in conjunction with Mr. John Allan. About four hundred members and guests have signified their intention to be present. Among the distinguished foreigners who are expected are: the President of the Dutch Chemical Society, Dr. C. J. Van Niewenburg, Prince Ginori Conti, an Honorary Member of the Society of Chemical Industry, whilst Dr. A. C. Fieldner represents the American Chemical Society and Dr. Bjarne Johnsen represents the American Section of the Society of Chemical Industry. Monsieur Paul Kestner, the President of the Société de Chimie Industrielle, is prevented by indisposition from attending the meeting. All will regret his absence and hope that he will soon be in much better health. Several years of devotion to the interests of his country, his science and the industry with which he is connected compel him to take a much needed rest.

Dr. Armstrong now retires from the Presidential Chair which he has occupied during the last two years. He signalises his retirement not merely by bowing politely but by providing an interesting account of the chemistry of fats as the result of many years work by himself, Mr John Allan and some other colleagues. This address will be found in the Transactions of the Society, and even those who make no pretence to intellectual eminence or scholarship sublime can enjoy reading it and will find many passages in it which will excite their curiosity and attention. During his Presidency this weekly journal was launched; the Society's Journal has gradually grown in volume, has embraced a greater variety of topics and has been published at more frequent intervals. It has a record more than forty years long and a character and place of its own. It has made no effort to imitate any weekly journal in this or any other country and has no desire or ambition to do so. Its purpose is to make widely known the chemical knowledge which is the basis of so many of our industries, to advocate such plans for the better organisation of the science as the Society approves and to provide a free medium for the expression of opinion by all who have an idea to put forward or a new fact to announce. The Society, when it decided to publish its *Journal* weekly and to enlarge its scope realised that the experiment would be costly. The Council believed that the experiment would cost about five thousand pounds; the members of Council hoped it would not cost very much more and they considered that

The Messel Medal, 1924

such an expenditure was wise and prudent. Their estimate has been found to be very near the truth. During the last few months of 1922 and the twelve months of 1923 a sum of five thousand pounds was spent in excess of the Society's income. This experience enabled the Council to judge the directions in which further expenditure was justified or should be curtailed. It enabled the Council and the staff to become familiar with the routine of a weekly journal and to improve the organisation. It is needless to say that the members of the Council did not fail to make use of the knowledge thus obtained. By the end of 1923 steps had already been taken to effect the necessary adjustments, and throughout this current year the expenses of the Society have not exceeded the revenue. Many a weekly journal has been started by people with long experience in journals and has been not more successful and not less costly than the Society's *Journal*.

Two Annual Meetings have been held during Dr. Armstrong's tenure of the office of President, the one at Cambridge, the other in Liverpool, very different in their atmosphere and surroundings, but both successful and valuable.

If the publication of a weekly journal was the first preliminary step towards a better organisation of British Chemistry, the next step is the establishment of a Chemistry House where a number of those Societies which are most closely alike in aims and objects may have official quarters. Dr. Armstrong has been active in this matter as in many others; the Leonard bequest has made this project practicable and urgent. Of "Chemistry in the Twentieth Century" and our President's share in it, mention has been made in these columns on more than one occasion; the book has been praised in this *Journal* and in several others, and has been well received everywhere, but somehow it has hardly been received with that enthusiasm which it deserves. It was a noble and an inspiring idea to expound the manner in which British chemists of our own time have helped to build the lofty edifice of chemistry. The execution of the task was equally splendid; the work was done by experts in the various branches of chemistry, speedily, almost hurriedly, and con amore; it has a freshness, a vigour and a variety which make the book very agreeable reading. The reader cannot fail to recognise that each contributor has a story to tell, is proud of it and means to tell it in a convincing and interesting manner. Many members of the Society consider that this book will be the most impressive and durable monument of the retiring President's activities during the last two years and will be for a long period a source of pride and pleasure to British chemists in general and Dr. Armstrong in particular.

Mr. W. J. V. Woolcock is the President Elect and he is no stranger to the members of the Society.

Mr Woolcock has the advantage of knowing how a scientific society should be organised; he had considerable experience in the conduct of the Pharmaceutical Society, of which he was Registrar; as a member of Parliament he learned the refinements of dexterity of speech and the tactful handling of mankind so as to obtain his own way, while leaving others of the opinion that he was carrying out their suggestions. He has had considerable experience in business while acting as Parliamentary Private Secretary to the Minister of Munitions and the Postmaster General, as Assistant Director of Army Contracts and as Chairman of the War Office Committee for the purchase of Medical Supplies, and he has an infinite capacity of taking pains and getting work done and done to the appointed time. The organisation of the Chemical Exhibit at Wembley was very largely his work; the amount of work done by Dr. Levinstein and his committee was immense, but the man behind the gun was Mr. Woolcock and after the exhibit had been arranged he was indefatigable in the attention to detail, getting the exhibits there, seeing they were duly placed, explaining to multitudes of visitors, from Royalty down to editors, the significance of the scientific features and doing all that was possible for one man, and that an exceptional man, to make the Chemical Exhibit a worthy one.

As General Manager of the Association of British Chemical Manufacturers almost from its commencement he has had a difficult task to perform and he has done it well. He has many important pieces of work in front of him; he has to continue the progress of the Bureau of Chemical Abstracts, initiated during Dr. Armstrong's term of office, he has to see that a Chemistry House is duly provided as urged also by his predecessor, and he has several other pieces of constructive work to do, which will fill up his spare time pretty effectually. He has good health, a good appetite for everything, including work, and a youthful appearance; he does not look more than forty, but calculation, based on the known facts of his career, shows that he must be either forty-five years old or approximately that age. So he may be regarded as about to attain the prime of life.

The Messel Medal will be given this year to Viscount Leverhulme. The medal has been designed and the die made by Mr. E. G. Gillick, who is also the artist who made the beautiful Harrison War Memorial at the rooms of the Chemical Society in Burlington House. A photograph of the Messel Medal appears in this issue. The first recipient, as readers of this JOURNAL will remember, was Prof. H. E. Armstrong

The present meeting is the Society's fifth visit to Liverpool. The first meeting held there was in 1886 under the Presidency of Mr. E. K. Muspratt. The second was in 1893, the President being Sir John Evans, F.R.S., and the Lord Mayor of Liverpool, Mr. R. D. Holt, welcomed the members on behalf of the Corporation. The third meeting was in 1902, the President being Mr. Ivan Levinstein

On this occasion the members were welcomed by Principal Dale of University College. The last meeting was in 1913, the president being Prof Marston T. Bogert, and Sir J. S. Harmood Banner, M.P., the Lord Mayor, welcomed the Society on behalf of the Corporation.

The idea of forming the Society originated in Lancashire and among the many distinguished men who took part in the formation of it were Muspratt, Hurter, Mond, Carey, Gamble, Hargreaves, Campbell Brown, and Roscoe, all Lancashire men.

PRESIDENTIAL ADDRESS

By Dr. E. Frankland Armstrong, F.R.S.

Introductory Remarks

The year, which has elapsed since we met at Cambridge, may be regarded justly as a period of steady progress towards the realisation of those ideals of co-operation which many of us consider essential before the chemical profession can attain the status which all chemists claim for it. In spite of this progress, however, the position to my mind is still one of considerable anxiety as there are certain indications of increasing competition between the chemical societies such as is bound to have a serious effect on their financial position if it is not checked. It is more than ever urgent that the energies of those who take an active part in such matters, and they are all too few in number, should be directed to a common object and not dissipated in rival schemes.

The outstanding achievement of the year is indubitably the collective exhibit of the British Chemical Industry at the Wembley Exhibition, including the scientific section. For once—a portent for the future—Chemistry has been first in the field. Our Manufacturers' Association was the first to agree to a collective exhibit and we are the only industry to associate our science so definitely with our trade exhibits. It is a subject for congratulation that the latter part of the scheme originated with our council and that the success of the scientific exhibition is largely due to the energy put into the scheme by Dr. Levinstein, our representative on the joint committee and its chairman. It is difficult to find words to commend the work put into everything connected with Wembley by our President-elect, Mr. Woolcock—for those of us who know him it is most accurate to express our appreciation by saying he has enjoyed it. The scientific publications associated with the Exhibition have particularly been the work of our Society and they form a precedent which I personally hope will often be followed. The popular pamphlets are a real necessity and we must have more of them. Our book, "Chemistry in the XXth Century," is an achievement of which all chemists can feel proud: it can seldom have been the lot of an editor to find so many willing helpers. Lastly, a word of grateful recognition is due to Messrs. Benn Bros., for their enterprise in publishing our productions: it is improbable that a book of this size and nature was ever put more quickly through the press.

Altogether we may feel proud of Wembley and our share in it: may I hope further that we record faithfully the lessons we shall learn from our experience, as I am convinced that much more has to be done by us, both collectively and individually, than in the past to educate both the nation and the individual to the importance and indeed the very meaning of the chemist and his knowledge.

The report of your council details the chief happenings of the year so that I need only refer very briefly to one or two events of outstanding interest. The formation of the Bureau of Chemical Abstracts, under the chairmanship of Prof. J. C. Philip, is perhaps the first step in the unification of all British chemical publications. Composed of representatives of the Chemical Society and of our own Society, it is aiming to secure uniformity in the abstracts on pure and applied chemistry published by the two societies, to prevent any overlap, and to explore the possibility of further co-operation. Progress must necessarily be slow, steps once taken cannot easily be retraced and the problem is the more complex on account of the financial considerations involved. We look to the Bureau during the next five years to unify transactions as well as abstracts and to bring the publications of other societies within its scope. No paper should be abstracted more than once in British literature. It should not be impossible to meet the desire of the smaller specialist societies for more general papers, not always containing new matter, and for fuller abstracts than are at present supplied: it must be remembered that many of their members are not chemists in the strict sense of the word. Our weekly journal, *Chemistry and Industry,* will facilitate the publication of general papers and it should not be impossible to abstract all papers dealing with the glass industry, for example, such as now appear under Group VIII. in our abstracts, once a month, the section being sent by itself to members of the particular society. I attach the greatest importance to the magic of "together"; we must have both ideas and ideals.

The Federal Council must this year play an active part in bringing us together: the representatives of the societies on it must not hold a watching brief, but be prepared actively to engage in constructive effort. I venture to suggest that a definite constructive programme be drawn up by the Federal Council this autumn, or sooner, if it be possible, that it be submitted to the constituent societies for their approval before Christmas so that the way is cleared for immediate action in 1925. I must confess to a feeling of disappointment that the proposals I put forward in outline a year ago have not yet been examined either by the Federal Council or by the various Chemical Societies. Still I realise that in the chemical world things move slowly for various reasons; and it is a source of satisfaction that, in this and some other instances during my term of office as President, seeds have been sown which may lead to important results, although there is but little to show at the moment to some of us.

The most obvious next step towards the consolidation of the chemical profession is the establishment of Chemistry House, where a common meeting ground can be found for most of our societies, and the way made easy for closer co-operation. Such a scheme has long been a dream of the future with many of us: its realisation has been brought nearer by the munificent bequest of the late Mr. Leonard. What I consider to have been a practical scheme was under discussion in the opening months of this year, and I cannot help the feeling that had a little more energy been displayed and a real desire evinced to establish a home we might by now have

been in possession of it under advantageous financial conditions.

During this last year the scheme has received an important impetus; it is for my successor in office and for the general body of chemists, especially the younger ones, to maintain this impetus and accelerate it. So long as the matter is not allowed to drift I shall be well satisfied.

The desiderata for our first scheme are:—

(1) Office accommodation in one building in a convenient central position for the administration of the Chemical Society, Society of Chemical Industry, Association of British Chemical Manufacturers, Institution of Chemical Engineers and such other Societies, including the Institute of Chemistry, as are willing to take part.

(2) Suitable council and committee rooms, so that all such meetings can be held in the one building.

(3) Social meeting rooms, so that the Chemical Industry Club can definitely be associated with Chemistry House from its inception.

(4) Offices for the Bureau of Chemical Abstracts and all other journals issued by the participating societies.

(5) A lecture theatre sufficient for all but the very large meetings.

It is believed that suitable premises could be obtained at a capital cost which is within the range of practical politics.

The ultimate larger scheme which is at present far beyond our realisation would include, in addition to the above, a library, full accommodation for a club including bedrooms and a restaurant, and also for the Institute of Chemistry which is not mentioned more specifically in the foregoing, since it already possesses its own house.

We meet this year in Liverpool, commercially one of the centres of the world. By river, canal, road and rail, the products of industrial Lancashire and Yorkshire are brought to its wharfs to be carried by its ships to all the countries of the world—the ships bring back with them raw products of every kind which pass into Lancashire and Yorkshire to be manufactured. Liverpool has made much of its opportunities, its citizens are justly proud of their city, of its civic and corporate life and of its University whose hospitality we are enjoying to-day. The very existence of the University, munificently endowed by local generosity, though its needs are still many, proves the recognition which Liverpool gives to science. That our science in particular is not forgotten is shown by the fact that there are, or soon will be, five chairs in Chemistry here. Chemical science is also represented locally by active sections of our own society and of the Institute of Chemistry. If such a gathering as this may leave a message behind it, surely, in congratulating Liverpool on all that it has achieved in the past, in honouring its many great traditions, we may urge it in the future to redouble its encouragement of science and the prosecution of scientific research, and to be ever zealous in applying the results of science for the service of its citizens.

SOME RECENT WORK ON THE SOIL

The ultimate practical object of the study of the soil in relation to plant growth is the improvement and standardisation of methods of soil management—or, in other words, the achievement of as full a control as possible of the processes going on in the soil which affect the growth of economic plants for good or ill. It is evident that before great advances on established principles of soil management can be made, the fundamentals of soil science must be put on a firm basis. All aspects of the subject require investigation whether or not there is prospect of an immediate practical application.

Soil problems are, however, notoriously complicated and the difficulty of disentangling the factors involved is very great, so that, in spite of the increasing volume of work turned out, it will probably be a long time before cut and dried schemes for soil management under widely varying conditions, based on accurately known facts, can be drawn up with confidence.

Much useful work on questions of fundamental importance in soil science has been carried out in the last few years, particularly in connexion with the physical properties of soils and with the micro-organisms and their activities.

The water relations of soil are of primary importance both in respect of the direct supply of water to the plant and of the effect upon the tilth of alternate shrinking and swelling brought about by varying moisture content. Recent work has shown that the nature and amount of the colloids present determines these relationships to a very large extent, and a good deal of attention has been given to the study of the evaporation of water from soils and other colloidal materials. It has long been realised that the old division of soil water into hygroscopic, capillary and gravitational water was incomplete and unsatisfactory, and in 1921 Bouyoucos (*J. Agric. Res.*, **20**, 587; *Soil Sci.*, **11**, 33, 255), applying dilatometer and freezing-point methods to the study of the soil solution *in situ*, came to the conclusion that some of the water does not occur actually as liquid but is "unfree" and must be physically adsorbed or chemically combined or in solid solution. Bouyoucos' interpretation of his results has been criticised from various points of view by Keen (*Trans. Faraday Soc.*, 1922, **17**, 228), Parker (*Soil Sci.*, 1922, **13**, 43; *J. Am. Chem. Soc.*, 1923, **43**, 1011) and Fisher (*J. Phys. Chem.*, 1924, **28**, 360). The curve for the evaporation of moisture from soil is found to be of a type peculiar to materials containing both colloidal and non-colloidal substances and is determined by evaporation at the same time of imbibitional or gel water held by the colloid and of capillary or interstitial water held between the soil grains (Fisher, *Proc. Roy. Soc.* (*A*), 1923, **103**, 139, 664; *J. Agric. Sci.*, 1923, **13**, 121; 1924, **14**, 204).

Wilsdon's investigations on the distribution of water in soils indicated a reticulate structure for the colloids present. It is now generally accepted that the colloidal coating round the soil grains is in the form of an inelastic emulsoid gel consisting of vesicles enclosed by walls and that water held by the swollen

gel is partly adsorbed in the walls and partly fills the vesicles. According to Hardy (*J. Agric. Sci.*, 1923, **13**, 243) the shrinkage of moist soils and clays on drying is due solely to loss of "vesicular" water. The varying behaviour as regards shrinkage of soils of similar colloid content but belonging to different geological types is explained as due to a specificity in soil colloids, which differ in the ratio of the amount of water held as adsorbed (hygroscopic) water to that held in the vesicles. A simple means of measuring shrinkage of clays and soils has been devised by Haines (*J. Agric. Sci.*, 1923, **13**, 296), who has studied the details of the process. He shows that it takes place in two stages, both having a linear relationship to the moisture content.

Another important function of the colloid constituents of soil which has a direct effect upon moisture relationships and tilth is flocculation. The mechanism of the flocculation of soils by lime and chalk has been investigated by Comber (*J. Agric. Sci.*, 1921, **11**. 450; 1922, **12**, 372); and the practical effect of chalking in reducing the power required to carry out cultivation operations has been demonstrated at Rothamsted by dynamometer measurements of the draw-bar pull on a plough and other implements. On chalked land there is a saving of power which under certain soil conditions may amount to as much as 15 per cent.

The physico-chemical investigation of soils would be rendered easier if a recognised system of characterisation by one or more physical properties existed. As pointed out by Robinson (*Trans. Faraday Soc.*, 1922, **17**, 224), such physical measurements must be capable of application to soil in its natural condition in the field and the determinations must be simple so that large numbers of soils can be examined. The density, pore space, water-holding capacity and swelling of soils on moistening are known to be related to the percentage of clay or organic matter (Keen and Raczkowski, *J. Agric. Sci.*, 1921, **11**, 441), and the possibility of utilising one or more of these constants as a kind of soil index is under investigation. For the genetic classification of soils, a mechanical analysis is necessary, and if the difficulties of ensuring complete dispersion of the soil sample in water can be overcome, the more rapid and convenient methods for this analysis which have been worked out recently will prove of great value (*cf.* Joseph and Martin, *J. Agric. Sci.*, 1923, **11**, 293; Robinson, *J. Agric. Sci.*, 1922, **12**. 306; Odén, *Trans. Faraday Soc.*, 1922, **17**, 327; Jennings *et al.*, *Soil Sci.*, 1922, **14**, 485; Krauss, *Int. Mitt. Bodenkunde*, 1923, **13**, 147).

In addition to investigations such as those already referred to, which deal with the soil water *in situ*, many attempts have been made to separate the solution and study it independently. Parker (*Soil Sci.*, 1921, **12**, 209) uses a displacement method which gives good results except, perhaps, with heavy soils. The use of high pressures has also been tried (Lipman, Burgess, *Soil Sci.*, 1922, **14**, 159) and other methods are advocated by Tulaikov and Kusmin (*Soil Sci.*, 1923, **15**, 235) and by Groh (*Int. Mitt. Bodenkunde*, 1923, **13**, 107). Burd and Martin (*J. Agric. Sci.*, 1923, **13**, 265) have recently combined the displacement and pressure methods, and bring forward a good deal of evidence to show that the displaced liquid does really represent the soil solution as it exists in the soil under natural conditions, at all events when more or less coarse-grained soils are used. Their results in the main confirm those of Parker, but it is perhaps too early to say that the difficulties in the way of obtaining the actual soil solution have been finally overcome. If the hypothesis, mentioned above, as to the manner in which water is held in the soil is correct, it is obvious that when much colloidal material is present, as in heavy soils, the separation of the soil solution as such is certain to be difficult.

Turning now to some recent work on the activities of the soil population, it is becoming more and more evident that, in regard to the supply of nitrogen, the part played by soil organisms as competitors with our crops is as important as their rôle in rendering nitrogen available. Not only is there, under certain conditions, an actual loss of gaseous nitrogen due to the action of certain organisms; but in addition, some of the nitrate produced by the breaking down of organic nitrogenous materials is utilised by bacteria, fungi and other organisms for their own purposes, and though such nitrogen is not lost to the soil, a certain proportion will remain permanently out of reach of plants. Such nitrate consumption has been shown to be especially active when the organic matter available as the source of energy for the micro-organisms contains only a low percentage of nitrogen. As the result of some work by American investigators (Lyon, Bizzell and Wilson, *J. Amer. Soc. Agron.*, 1923, **15**, 457), it appears that the retarding effect of growing plants on the production of nitrates, which is a well-known phenomenon, is probably to be accounted for by the fact that the organic matter arising from the roots has a low nitrogen content, and consequently nitrate consumption by soil organisms is promoted in the immediate neighbourhood of the plants.

On the other side of the account, the bacterial fixation of nitrogen and the conditions under which the process is favoured or checked continue to be studied in detail. Claims have been put forward from time to time, most recently by Wann (*Amer. J. Bot.*, 1922, **8**, 1), that soil algæ also possess the power of fixing atmospheric nitrogen. It has, however, been shown at Rothamsted by Bristol and Page (*Ann. App. Biol.*, 1923, **10**, 378), that the analytical methods employed by Wann were open to criticism, and a careful repetition of the experiments produced no evidence of the ability of algæ to fix nitrogen.

So far as is known at present, the chief economic significance of the soil algæ, whose mode of nutrition when living below the surface of the soil, away from light, is wholly saprophytic, lies in their competition with crops for the available nitrogen. Excluding pathogenic forms, this is probably also the case with the fungi of the soil. Unfortunately, no really satisfactory technique has yet been found for counting algæ and fungi though it is known that they are present in the soil in very large numbers. The whole

subject is one of great interest and is being actively pursued at Rothamsted and elsewhere.

A considerable amount of quantitative data has been obtained on the relations between beneficial soil bacteria and protozoa, the work arising out of Russell and Hutchinson's hypothesis that bacterial numbers in field soil are normally limited by the activities of protozoa. Cutler, Crump and Sandon (*Phil. Trans.* (*B*), 1922, **211**, 317) have demonstrated that there is an inverse relationship between the numbers of the active forms of certain protozoa and of bacteria; and, in continuation of this work, it was found that when bacteria only are introduced into *sterilised* soil, the numbers remain high but that in the presence of protozoa also, they are very much reduced (Cutler, *Ann. App. Biol.*, 1923, **10**, 137). On the other hand, the activities of one group of bacteria—*Azotobacter*, nitrogen-fixing organisms—appear to be favoured when soil protozoa are present (Nasir, *Ann. App. Biol.*, 1923, **10**, 122); and Waksman and Starkey (*Soil Sci.*, 1923, **16**) maintain that soil fungi are the chief factor limiting the numbers of bacteria under normal conditions by their competition for the available supply of food. It is not unlikely that both fungi and protozoa are important in this connexion and there may be other factors. The work on this subject illustrates the complexity of soil problems and the difficulties in the way of any attempt at control of the soil population

The equilibrium between the various groups of soil organisms can, however, be disturbed and the balance altered by such means as "partial sterilisation" by heat or chemical treatment; and with further and more intimate knowledge of the soil population there is hope of useful development towards control.

The literature dealing with soil problems is very scattered and one welcomes the appearance of books in which the results already arrived at are brought together and correlated. Two have come to hand recently of quite different types. Drs. Honcamp and Nolte* ("Agrikulturchemie"), have collected the agricultural chemical literature published in the years 1914 1920 and review the more important advances during that period. The volume is one of a series dealing in a similar manner with various branches of natural science and it is hoped to include later work in future editions. The book is divided into four sections dealing respectively with Soils, Plant Nutrition, Animal Nutrition, and Research Methods. References are included to all the papers mentioned. German work is to some extent given prominence, but this will tend to make the book more rather than less useful to English investigators and teachers, since work published in German periodicals which are not always easily accessible, is included. The collection and sifting of the material must have been a laborious task, which the authors have accomplished with a considerable measure of success.

The other book† ("Soil Management"), by Mr. Firman E. Bear, Professor of Soils in the Ohio State University, is written with the purpose of indicating the application of established facts to the management of soils and is primarily intended for use in agricultural colleges. Reference to the Table of Contents shows that the subject-matter is treated under the main headings Requirements of Crops, Characteristics of Soils, Utilising, Conserving, and Supplementing Soil Resources; but these divisions are not indicated in the body of the book, with the result that the sequence of the chapters is sometimes difficult to follow. Chapter VI, for example, is on biological processes in soils, but not till Chapter XIII do we get an account of the organic matter of soils, the intervening chapters being devoted to the physical properties and cultivation: again, chapters on limestone economy and liming materials are separated by discussions of animal manures and soil sanitation. The arrangement hardly seems logical.

When this has been said in criticism of the general plan, it must be added, however, that the book is full of accurate information which will be most valuable to agricultural students, clearly set down and illustrated from the results of field experiments. The treatment of the nitrogen question and the economic use of fertilisers generally seems to the writer admirable. Prof. Bear throughout lays special stress on the immense importance of taking full advantage of natural nitrogen-fixing agencies by the proper use of leguminous crops for maintaining and increasing the fertility of the soil. C. T. GIMINGHAM

* "Agrikulturchemie." By Dr. F. Honcamp, assisted by Dr. O. Nolte. Pp. viii+160. Dresden and Leipzig: Th. Steinkopff. Price 0·95 dollar.

† "Soil Management." By F. E. Bear. Pp. vi+268. New York: J. Wiley & Sons., Inc.; London: Chapman and Hall, 1924. Price 10s. net.

NITROGEN FIXATION IN FRANCE

The last report of the "Azote Français" summarises in an interesting fashion the researches and results obtained by this company in the production of nitrogen. Results obtained with the arc process show (1) the industrial application of a very simple and cheap furnace with a yield at least comparable to that of arc furnaces now working; (2) the final perfecting of the recovery of the oxides of nitrogen produced in the arc process by cooling without risk, and in the form of liquid nitrogen peroxide. This recovery enables the yield to be greatly increased, and the production of a concentrated product in which the unit of fixed nitrogen possesses higher market value. (3) The direct manufacture from this peroxide of concentrated chemically pure nitric acid, of metallic nitrites and of nitro compounds At present, despite improvements, the arc process gives barely 12 per cent. of the theoretical yield but this, however, is a paying quantity. The company owns at Luchon Marignac one of eight groups capable of producing 33,000 tons of cyanamide annually. Two continuous furnaces for nitrifying the carbide are now being worked at the Cie d'Electricité Industrielle at Marignac, with yields higher than those of the discontinuous furnaces employed in other works. For the production of ammonia with electrolytic hydrogen the company has obtained the rights of the Pechkranz electrolyser in France.

FUEL ECONOMY QUESTIONS *

By H. WOMERSLEY

Owing to present economic conditions, we are all thoroughly alive to the necessity of fuel economy, and the aim of this short paper is to point out a few of the questions that emerge in regard to this problem.

In the first place, I would emphasise the fact that a steam-boiler plant is a manufacturing department in itself. Too often does one fail to realise that it is concerned with raw material and finished product. We start with coal or other fuel, and by its means we convert water into the product, steam. In other words we buy heat, and after conversion into a more usable form, sell it again to the other departments. It stands to reason, therefore, that to make the plant a paying concern, we must know :—

1. How much heat we are buying.
2. What our conversion losses are or, conversely, our efficiency of conversion.
3. The amount of steam taken by departments.

Now, the heat we purchase is, of course, the calorific value, whether we express it as B.Th.U.s per lb., Calories per lb., or Calories per kg.

This is the point that I wish to make. Are we justified in buying on this factor alone, or, as is usually done (although it amounts to the same thing) on the ash and moisture content ? My own opinion is that it all depends on the coalfield from which supplies are drawn. If all supplies come from one field, then we can be guided by this factor, but the coals vary so much in different districts in regard to other qualities, that practical experience must be employed to discriminate in cases where otherwise the calorific values may be the same.

In this respect different coals have different rates of combustion under similar conditions. Northern coals are, as a rule, open and quick burning, whilst Somerset coals are almost non-burning, at least, very slow. Forest of Dean coals, on the other hand, are intermediate, and considering freightage, are the most satisfactory for steam raising in this district. Apropos of this rate of burning we tried to burn Somerset coals some time ago, and from that experience we calculated that to get our normal output of steam, we should have had to, at least, treble the boiler plant, which, with its resultant increase of labour, would have made it a very dear proposition in spite of a lower price for the coal. As to the cause of this character, it would appear, from Illingworth's work, to have something to do with the resinous constituents of coal, and thus neither an elementary or a proximate analysis would indicate it.

There is just another point here in regard to the purchase of low-grade fuels. It is well known that a higher quality coal can be burnt at a higher efficiency, and when this is taken into account together with the smaller amount of labour required for handling ash and other work, it will be seen that a higher price than is proportionate to its increased calorific value can be profitably paid. Conversely, coal of lower value is not necessarily a paying proposition.

The following figures may help to make this clear :—

	Low quality	High quality	
B.Th.U. per lb.	12,500	14,500	
Ash content	12%	6%	
Price per ton	22/-	27/-	Equiv. price 25/6 on B.Th.U. basis
Max. efficiency week in, week out	75%	80%	
Coal per 80,000 lb. steam per hour	4·32 tons	3·49 tons	
Cost of coal per hour	95/-	94·3/-	
Tons ashes per hour	0·52 tons	0·21 tons	
Cost of ash removal at at 2/- per ton	1·04/-	0·42/-	

CONTROL OF THE BOILER PLANT

Now I come to the boiler itself. We can, and to know what we are doing, must regard the boiler plant as a chemical factory in itself. Thus it is essential to know with reasonable accuracy, how much coal we are burning, and how much steam we are getting as a result. In other words, we must find whether we are getting the best efficiency out of it.

I do not propose to say more about the importance of the carbon dioxide in the gases, except to emphasise the importance of continuous tests. Snap tests for controlling fire are of little use, in fact, by noting the temperature at the end of the centre tubes of Lancashire boilers, a practical man can exercise quite as much control over the fires.

To control the fires the carbon dioxide record from the centre tubes is alone sufficient, always avoiding carbon monoxide, of course, and with a recorder installed, then systematic snap tests at such important points as the side flues, immediately before the boiler, dampers are very necessary for detecting leakages in the flues themselves, and thus enabling the resultant losses to be avoided. Another very useful implement is the electrical pyrometer, especially if this also has a continuous recording apparatus attached. At the centre tubes of Lancashire boilers where a carbon dioxide apparatus is installed, this is not essential, but at the position in the side flues already alluded to, it should be used in conjunction with the carbon dioxide apparatus. On water-tube boilers, positions for test are chosen with the same aims in view, viz., control of fires, and detection of leakage of air through brickwork. Where economisers are installed similar observations should be made continuously at the gas inlet and exit.

As coal consists mainly of carbon, the chief product is carbon dioxide, and this is used as the control. Theoretically, as the molecular weight of O_2 occupies the same volume as the molecular weight of CO_2, complete combustion of carbon should result in a gas containing 21 per cent. carbon dioxide when such carbon is burnt in air. Practical considerations, however, require an excess of air, otherwise there is a tendency to only partial combustion, resulting in carbon monoxide. When we come to coal, we get a reduction also in the theoretical percentage of carbon dioxide that we can obtain, due to the hydrogen in it. With the usual semi-

* Read before the Bristol Section on March 6, 1924.

gallon, if the Permutite is partially exhausted, the reaction is just as likely to go the reverse way, and the total hardness of the water be increased.

Another plant, that by the Kestner company, is now being pushed on the English market, and their system of treating the water by the excess alkali and heat of the continuously blown-down water from the boilers, together with a degasifying plant, seems to the author to require the careful consideration of those concerned with boiler plants, especially where new plants are being installed.

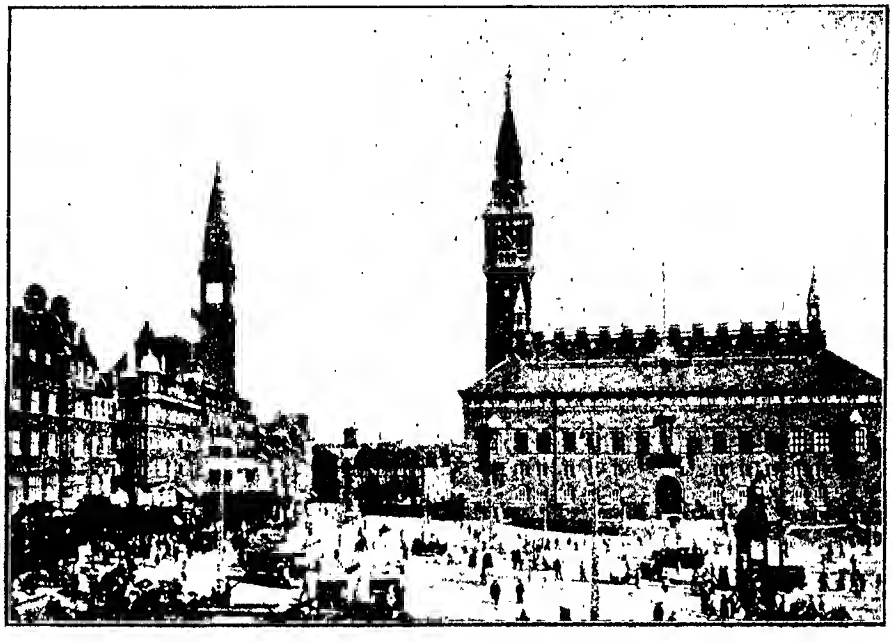
In conclusion I have to express my indebtedness to Messrs C. Thomas and Bros., Ltd., for permission to publish these notes.

Messrs. C. Thomas and Bros., Ltd ,
Broad Plain Soap Works,
Bristol.

THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

The Union Internationale de la Chimie Pure et Appliquée held its Annual Meeting in Copenhagen from June 26 to July 1. These annual meetings have a character of their own: some international bodies divide themselves into sections at which papers are read and discussions are encouraged; disputation is an ancient method of learning a subject; an old teacher of law wrote in the fifteenth century, "Home ne scavera de quel metall un campane est, si ne soit bien baté, ne le ley bien conus sans disputation." The Union Internationale divides itself into a variety of committees which after much debate internal draw up reports of considerable value. Intervals are usually found for lunches, receptions and banquets and in addition to the official feasts some of the more frivolous members have been found who despise not the small social parties graced with flasks of Samian and of Chian wine. The Union Internationale has held meetings in Brussels, Rome, Lyons, Cambridge and Copenhagen These have been attended by thirty or forty chemists of world-wide reputation, by as many others whose fame only reaches the borders of one country or one branch of chemistry and by some others who can only be considered as camp followers, wolves masquerading as chemists or whatever is the polite description.

Four English professors upheld the dignity of British chemistry, Profs. Pope, Drummond, Gibson and Harden; other familiar figures at the gathering were Messieurs Béhal, Lindet, Moureu, Matignon, Marquis, Marie, Kling, Nasini, Giordani, Bancroft, Noyes, Minovici, Votocek, Swartz, Cohen, Jorissen, Timmermans, Profs. Biilmann, Bjerrum, Bronsted and Holleman with several others, whose names and researches would be familiar to our readers if space permitted a nearly complete list of the delegates.



City Hall Square, Copenhagen

Of the places selected for these Annual Meetings Copenhagen is perhaps the least known to the majority of chemists, yet civilization advanced as rapidly, and by very similar stages, in Denmark as

in England or Belgium or Holland or the north of France. Denmark is a beautiful green country, well cultivated with beech woods and small lakes surrounded by higher ground, which it would be flattery to describe as hills. It has cattle tethered in the fields and red-tiled farm houses, which are certainly clean and seem to be prosperous. Copenhagen itself is full of handsome buildings, many of them palaces; its Town Hall is a striking example of modern Danish architecture and the reception given to the Union by the Civic dignatories in it was a delightful function. When we reached Copenhagen the school terms were just at an end and those boys and girls who were to proceed to the University as full-fledged students celebrated the occasion with due ceremony. A brake with four horses is adorned with green leaves, with flowers and with paper streamers. A dozen or so boys with white caps drive through the town in this equipage cheering and making other more or less musical noises. Similar parties of fair-haired, merry girls, dressed in white, drive in state laughing and cheering. It is evidently a red-letter day to emerge from the chrysalis state of school to the butterfly existence of the University of Copenhagen.

The Union Internationale is still busy with its own organisation. It does not yet include all the countries, its constitution is no longer adequate to its numbers. This year the Federal Council submitted a number of resolutions to ensure that decisions of the Union shall not become effective until an opportunity has been given to all those concerned to express their opinions. These resolutions were, with trifling modifications, adopted by the Union Internationale, and a small committee, consisting of four or five, has been appointed to consider how the organisation and procedure of the Union can be improved. Formal notice was given at Copenhagen that at the next meeting a proposition will be made for a revision of the rules so as to admit into the Union Internationale all countries who are members of the League of Nations. This will enable two or three important countries, now outside the Union, to become part of it, and perhaps by that time it will mean the inclusion of all the countries not now represented. It seems there is no opposition to this scheme; it has for some time been advocated by the French delegates, and experience has shown that in chemical matters the French require neither advice nor encouragement to persuade them to take a generous view of any situation.

The banquet was, as usual, a brilliant affair; speeches were made by Mr. Larsen, the Danish engineer, by Sir William Pope, Mr. Warming, Prof. Nasini, Prof. Bancroft and Prof. Béhal, who though only now in middle life was a member of the Institute when some of us were mere boys. Next year the Roumanian Government has invited the Union to meet in Bukharest, and the invitation has been accepted with joy and acclamation. However good Bukharest may be, those who attended the meeting in Copenhagen will long treasure the recollection of this pleasant City, its old-fashioned canals and harbours, its beautiful sea-shore and suburbs, its forests, its air of refinement, its splendid hospitality and its charming people.

WORLD POWER CONFERENCE AT WEMBLEY

The First Week's Papers

(From our Special Correspondent)

The first World Power Conference, organised by the British Electrical and Allied Manufacturers' Association, which is being held at Wembley from June 30 to July 12, is naturally of the greatest possible interest to the chemical industries, both directly since a number of papers that have been presented are on purely chemical engineering subjects, and, secondly, because every industry is very closely concerned indeed with all that relates to power.

As is well-known, the World Power Conference has been called to consider from an international point of view the whole question of the industrial and scientific sources of power and how they may be improved, conserved, and adjusted. It has called together civil, electrical, mechanical, marine and mining engineers, and other technical and scientific experts from nearly 40 different countries, and more than 400 papers are being presented, the last number of the printed schedule being 417.

It is, of course, impossible to give any adequate idea of the vast mass of material represented by these papers, although a number of them are very short, and, frankly, not very important, whilst the discussions are proceeding for nearly a fortnight. The best thing to do is to send for a schedule list of all the papers to the Offices of the World Power Conference, 36-8 Kingsway, London, W.C.2, the price of the different reprints being shown.

The papers under consideration in the first week include the subjects of the fuel and power resources of the various countries in the world, the economic aspect of power, especially the consideration of future developments, steam generation and utilisation, the preparation of fuels, illumination, and water power in all its branches. The latter, quite rightly, occupied a very large part of the proceedings, and over 50 papers were presented on this subject, dealing in the first place with the potential resources of many countries in the world, including Great Britain, Ireland, Holland, Hungary, Germany, India, Japan, New Zealand, Norway, Spain, Siberia, Sweden Switzerland, China, and Esthonia. Very valuable were many of the contributions relating to the troubles and difficulties of hydro-electric power and methods for improving the efficiency, and the papers in this section dealt with such varied subjects as the Kaplan turbine, the general conditions of water storage, ice troubles, general turbine design, the construction of dams and the developments in low-head work.

There is no question that a silent revolution in power production is proceeding in most countries, to an extent that is not generally realised in Great Britain. To-day, over 25,000,000 h.p. of water power is in operation, of which nearly half is in the United States, and more plant is being continually installed. According to a recent report of the United

States Geological Survey, the available inland water power of the world is over 425,000,000 h.p., and the greatest potential source of energy is in Africa, the Congo and its tributaries. In Great Britain we have about 1,000,000 h.p. available, all these figures being, of course, exclusive of the tides.

The section devoted to the preparation of fuels, comprising 18 papers, is also an interesting one, dealing with the complete gasification of coal, the utilisation of peat, low temperature carbonisation, oil refining, the use of wood refuse for power production, the hydrogenation of coal, and pulverised fuel.

Low-temperature carbonisation and hydrogenation of coal will be dealt with in the next article along with the gas and fuel section. Incidentally it may be mentioned that the method of attempting to divide up the papers into groups seems to be somewhat illogical and has not unnaturally given rise to some considerable confusion and much overlapping in the discussions.

Pulverised fuel, now making enormous strides in steam generation throughout the world, was dealt with very inadequately, and the papers and discussions give little idea of the real facts of the case. Strangely enough also, the latest remarkable developments in mechanical stoking, such as the suspended firebrick arch allowing single stokers up to 24 feet wide to be constructed, water cooled travelling grates, easy adjustment of the air supply at different stages of the travel, and furnace walls composed of water-cooled steel tubes, seem to have been given little attention. Mr. John Anderson, of Milwaukee, however, who is responsible for the first large power station in the world—Lakeside—to be equipped with pulverised fuel, and which remains to-day, as in 1920, the most efficient boiler plant in the world, enlivened the discussion.

As showing also the possibilities of power production from what might be termed rather unusual sources, comprising Section " F " of the list of papers, we had three papers, strangely enough all from Danish engineers, dealing with the utilisation of the wind, a contribution describing the well-known Larderello power station in Italy operated by natural steam from volcanic regions, and a paper on alcohol as a source of power.

It is curious that the modern scientific windmill, as used particularly in Holland, Germany, and Scandinavia, should be so completely neglected in Great Britain, as it is in many cases an invaluable source of energy for electric lighting and pumping on a relatively small scale, such as in agriculture, and up-to-date machines are constructed and supplied by British makers. The use of volcanic steam for power generation is certainly a striking example of the ingenuity of the modern engineer, but in spite of this one is glad to know that such developments are impossible in Great Britain

The fact that only one paper was given on such an important subject as power alcohol is certainly only one example of a number showing that the organisation of the next World Power Conference can be very considerably improved. Power alcohol is of particular importance to Great Britain because of the serious neglect of the cultivation of our soil and the fact that we do not possess natural liquid fuels, such as petroleum. There is no reason why several million acres of land should not be devoted to the scientific cultivation of potatoes for the manufacture of power alcohol.

Certainly the most interesting section, both to the chemical engineer and the general steam and power user is " D1," that relating to steam generation, and the 30 papers dealt with such varied subjects as the " Benson " super-pressure steam generator, the 1200 lb. pressure water-tube boilers now being erected in the United States, the production of a new steel alloy that maintains its strength even at 1920° F. —and of the utmost importance therefore for high-pressure steam work—the necessity for the determination of carbon monoxide and unburnt products in flue gases, the " Blomquist " horizontal revolving tube high pressure boiler, a review of recent developments in steam practice by P. Junkersfeld and G. Orrok (U.S.A.), high pressure water-tube boilers by Dr. Jacobus, several very important German papers on high pressure steam, including those of Dr. F Munzinger, and also by O. H. Hartmann. Finally also W. L. R. Emmet (U.S.A.) gave a paper on his remarkable mercury boiler and turbine.

Closely allied to these subjects is " D2," on steam turbines, comprising papers by the Hon. Sir Charles A. Parsons, C. F. Stork (Holland), V. Nordstrom (Sweden), and F. Hodgkinson (U.S.A.). It is, of course, impossible to do justice to fascinating subjects of this description within the space of an article, and the same applies to the discussion, in which each speaker was allowed about five minutes.

Certainly one of the most remarkable tendencies of the last few years in steam and power generation has been the rapid increase in steam pressure as applied to water-tube boilers. It took well over 100 years of evolution in steam boiler construction to reach 200 lb. working pressure, and not very long ago this was the standard power station practice. To-day 350 lb. per square in. and 700° F. temperature represent average steaming conditions for super station conditions, but this is now also passing and the era of say 500–600 lb. is approaching.

Most interest attaches, however, as far as ordinary water-tube boilers are concerned, to the remarkable work being carried out, both in the United States and Germany in the use of steam at about 1000 lb pressure. The best known installation in America has drums of steel forgings 4-in. thick, weighing 70 tons, and the working pressure is to be 1200 lb. It is expected that, on these lines, well over 25 per cent. thermal efficiency will be obtained from the raw coal to the switchboard, using condensing steam turbines. Even more remarkable is the work represented by the super-pressure steam generator, such as the " Blomquist " revolving wide-bore tube boiler, in which the problem of ebullition in tubes is surmounted by submitting the water contents to centrifugal action, the working pressure being 1500 lb. per sq. in. The " Benson " generator at 3200 lb. pressure has already been described in these columns, and it will be remembered that water at 706° F. under the above conditions of pressure

being converted into steam at the same volume without the absorption of latent heat.

The highly efficient principle of "bleeder" or pass-out steam was also discussed, that is the prevention of the serious steam loss in the condenser by using the exhaust steam from turbines, high-speed vertical engines, or slow-speed reciprocating engines in boiling and general process work. Although this method is now being extensively used in Germany, it has been developed to an equal extent by British engineers, and the fault of the comparatively slow progress made in this country until quite recently lies with the steam user and not the engine builder.

In the group of papers relating to the more efficient utilisation of steam perhaps the most important was that by Dr. Ruths, the well-known Swedish engineer, describing his now well-known steam accumulator, which is meeting with a wide application on the continent, especially Germany and Scandinavia. The principle is a particularly important one for the chemical industries, with the irregular demand for steam, and allows for example the use of high pressure steam generation, and the production of power by the drop in the pressure, as already discussed, through an engine or turbine, combined with the utilisation of all the exhaust steam for process work, irrespective of the fluctuating demand, by the use of the steam accumulator, which acts as a "fly-wheel" of steam supply for the whole factory, so that a condenser is not necessary at all as with the ordinary pass-out principle.

THE FRENCH CERAMIC CONGRESS

The Technical Congress of the Ceramic Industry was held in Paris from June 2-6 MM. Frion and Linke studied the utilisation of liquid fuels in pottery kilns and described tests carried out for two years at Sèvres with crude oil and tar. From 50 trials it was found that one kg. of crude oil replaced 7 kg. of wood, an economy of over 50 per cent of heat. One furnace, consuming 420 francs worth of wood for each firing, consumed fuel oil worth 250 francs. In addition the time of firing was reduced from 24 to 11 hours. MM. Hachon and Lecallier discussed artificial or natural draught and concluded that if artificial draught costs more than natural draught, it possesses many advantages, such as quicker working, more regular heating, and its use for cooling. M. M. E. Lafon, comparing natural with artificial draught, favoured the former.

The use of pulverised fuel was described by M. Coquillat, who stated that the process was advantageous and economical, although it still required study. Discontinuous or cellular driers were dealt with by M. Cazeneuve, and compared with continuous driers. In a monographic study on ceramic ovens Mons. Frion concluded that the Hoffmann furnace had been not sufficiently studied for typical forms to be described. The results obtained, however, were useful as a guide to the ceramist.

The Congress concluded with visits to ceramic works, quarries, and brick factories.

FORTHCOMING EVENTS

July [illegible]. **The Institute of Chemistry Students' Association (London).** Visit of Chemical Students to Wembley. At 9.45 a.m. an Inaugural Meeting will be held at University College, Gower Street, W.C. 1, at which the President of the Institute, Prof. G. G. Henderson, LL.D., F.R.S., will take the chair. Mr. W. J. U. Woolcock, General Organiser of the Chemical Section of the Exhibition and President-elect of the Society of Chemical Industry, will explain the objects of the exhibits and the special features of interest. Professor W. P. Wynne, F.R.S., President of the Chemical Society, hopes to support the speaker at the meeting. The cost of the visit, including return ticket to Wembley, entrance to the Exhibition, and ticket for luncheon, will be 5s. Further information can be obtained from Mr. G. S. W. Marlow, 30, Russell Square, London, W.C. 1, and applications should be made not later than June 28.

July 16. **Institution of Chemical Engineers**, Annual Corporate Meeting, at the Hotel Cecil, Strand, London, W.C. 2, at 11 a.m. At 12 noon the presidential address will be delivered by Sir Arthur Duckham. After luncheon at 1 p.m. (price 6s., excluding wines) Sir F. Nathan will review the work of the Educational Committee on "The Training of a Chemical Engineer," and at 3.30 p.m. the following papers will be read:—(1) "Self-balancing Centrifugals," by E. A. Alliott. (2) "Evaporation in Currents of Air," by G. W. Himus and J. W. Hinchley. After tea, at 5 p.m., members will proceed to the British Empire Exhibition, and a tour of the Chemical Hall will be made under the guidance of Mr. W. J. U. Woolcock.

Sept. 8 to 11. **Institute of Metals.** Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at the British Empire Exhibition. On September 10 further papers will be presented for discussion, the afternoon being devoted to visits to works. A reception will be held in the evening at the National Physical Laboratory, Teddington. A detailed programme will be issued in August.

Sept. 15. **British Empire Exhibition.** Conferences of Engineering Societies, to be held in Conference Hall No. 4, at 10.30 a.m. Short papers on various Engineering Subjects will be read and discussed. Further information and tickets may be obtained from the Secretary, Society of Engineers, 17, Victoria Street, Westminster, S.W. 1.

Prof. W. L. Bragg has been elected Dean of the Faculty of Science, W. Baker, M.Sc., and B. Cavanagh, B.A., B.Sc., become assistant lecturers in chemistry, and Dr. P. W. Clutterbuck becomes demonstrator in physiological chemistry in Manchester University.

THE INSTITUTION OF CHEMICAL ENGINEERS

The Council of the Institution met on July 2, 1924. The Annual Report was read and approved for presentation to the Annual Corporate Meeting. Owing to the fact that the organising work of the Institution is largely completed and its public work was assuming greater importance, it was decided that more publicity should be given to its doings.

Elections took place as follows :—

Members.—Charles Davidson, Alexander Cross and Sons, Ltd ; Harry Mackenzie Ridge, Ridge Roasting Furnace and Engineering Co., Ltd.

Associate Members.—Harold Joseph Hailstone, Rochdale Corporation Gas Works ; William Charles Peck, Messrs. Burgoyne Burbridges and Co., Ltd. ; Harry William Webb, Cardiff Technical College ; E. P. B. Wilson, Shanghai Municipal Council.

Student.—David Robertson Bean.

Correspondence was read from the President of the American Institute of Chemical Engineers suggesting a joint meeting in England in July, 1925, when about fifty members of the American Institute would be able to attend. A cable was despatched cordially accepting the suggestion. Steps were taken at once to arrange this joint meeting.

The arrangements for the second Annual Corporate Meeting on July 16 were considered and approved. An account of the arrangements will be found under Fortheoming Events on page 721.

SEVENTH DOMINION CONVENTION OF CHEMISTS

The Annual Convention of Canadian Chemists opened its sessions at Kingston on May 27th last with the meeting of the Canadian Sections of the Society of Chemical Industry. Mr. S. J. Cook briefly outlined production values in the various branches of Canada's chemical industry in his address entitled "Statistics Reflecting Recent Progress in Chemical Industries." Mr. R. T. Elworthy discussed developments of the natural gas resources of Canada, which were situated chiefly in southwestern Ontario and in certain parts of Alberta. The Wainwright field in Alberta had an intermittent flow of 600 barrels per day, and the product was an emulsion of about 60 per cent. oil and 40 per cent. water. No. 1 gas well in the Foremost field near Calgary had a helium content of 2 per cent. and 98 per cent. methane. Mention was made of the possible uses of these natural gas resources, of the possibility of recovering natural-gas gasoline, the production of carbon black from natural gas, and lastly the possibility of obtaining helium on a commercial scale. Prof. A. L. Gibson, of the Ontario Agricultural College, then discussed "The Chemistry of Some Butter Defects," and enumerated various methods of overcoming these defects, but pointed out that in dairying, as in health, "prevention was better than cure." The close co-operation of the chemist and bacteriologist was absolutely essential, and it was deplorable that there were so few scientific workers in the Canadian dairy industries. The morning session ended with a paper on "The Corrosion of Containers by Canned Foods and Its Effects," by Messrs. H. W. Powell and E. W. McHenry, of the Research Laboratory of Dominion Canners, Ltd.

Mr. F. J. Hambly presided at the afternoon session of the Canadian Sections, and Mr. Alfred Burton, secretary of the General Council of the Canadian Sections, informed the members of the Annual Meeting of the Society in Liverpool. Dr. W. H. Hatcher then described recent work carried on in the laboratories of the McGill University, concerning the physical and chemical properties of hydrogen peroxide. The progress being made in the extension of the Department of Chemistry of the University of Western Ontario was outlined by Dr. J. A. Gunton. Mr. G. E. Condé, superintendent of the Flint Varnish and Colour Works of Canada, Ltd., Toronto, in a paper on "The Manufacture and Application of Nitrocellulose Lacquers and Enamels," described developments in the manufacture of these lacquers and finishes, and outlined various tests. Prof. L. F. Goodwin, of Queen's University, gave the final address on "Nitrogen Fixation Processes," in which he reviewed the developments that had occurred during the past twenty-five years, from the time that Sir William Crooks had startled the world with his famous warning as to the depletion of Chilean nitrate as a source of nitrogen. Prof. Goodwin illustrated his resumé with lantern slides showing plant practice in Scandinavia, Germany, France and England.

The Annual Dinner was held in the evening at the Cataraqui Golf Club, just beyond the confines of the city, and beautifully situated, overlooking the lake, where 100 guests were present, Mr. Alfred Burton acting as toastmaster. Following the toasts, the most westerly representative present, Prof. Shipley, and Mr. Dawson, representing the east, were called upon for a few remarks. Prof. Shipley regretted that on account of the distance it was almost impossible for Western Canada to have many representatives at the Annual Conventions, but that in all probability Western Canada would organise a convention of its own.

On the morning of Wednesday the annual meeting of the Canadian Institute of Chemistry was held, and, with Prof J. W. Shipley presiding, a series of papers was delivered in the afternoon. In the evening a public address was delivered by Mr. Horace Freeman on the "Application of Chemistry to the Natural Resources of Canada," a film being shown of calcium carbide manufacture at Shawinigan Falls.

The last two days of the Convention were spent in visiting points of interest about Kingston. After visiting the locomotive works the party went to the Royal Military College, where the laboratories were inspected. The visitors lunched with General Sir A. MacDonell, Commander of the College, and spent the afternoon and evening on the river going through the Thousand Islands. On Friday visits were made to the plants of the Canadian Industrial Alcohol Co., at Corbyville, and the Deloro Smelting and Refining Co., at Deloro, thus ending a most successful meeting.

CORRESPONDENCE

A POINT OF ORDER

Sir,—At the last meeting of the Chemical Society (this vol., p. 665), Prof. Ingold represented styrene by the formula $\overset{+}{\mathrm{Ph}}.\overset{-}{\mathrm{C}}\mathrm{H}:\overset{+}{\mathrm{C}}\mathrm{H_2}$ and diphenylethylene by the formula $\begin{matrix}\overset{+}{\mathrm{Ph}}\\ \overset{+}{\mathrm{Ph}}\end{matrix}\!\!>\overset{-}{\mathrm{C}}:\overset{+}{\mathrm{C}}\mathrm{H_2}$. I gathered that in these formulæ the plus and minus signs were being used in the ordinary way to represent electrical charges, *i.e.*, a deficit or a surplus of one electron. If, however, they are used in this sense, the formula for styrene is clearly that of a *univalent kation* like $\overset{+}{\mathrm{N}}\mathrm{H_4}$, and not of a neutral molecule, whilst the formula for diphenylethylene would represent a *bivalent kation* like $\overset{++}{\mathrm{Mg}}$ or $\overset{+}{\mathrm{N}}\mathrm{H_3.C_6H_4.}\overset{+}{\mathrm{N}}\mathrm{H_3}$. These curious and undesired results would be impossible in face of a strict adherence to the valuable rules that (*i*) *in any ionised bond the positive and negative charges of an electrovalence replace instead of supplementing a non-polar bond*, and (*ii*) *these charges must always be introduced in pairs, since the electron lost by one atom is always transferred to another*. If these rules are adopted, it is clear that in the case of styrene the ionisation of the double bonds of the aromatic nucleus would leave the phenyl-group as a whole *neutral*, although the carbon-atom next to the side chain may be either positively or negatively charged, since the nucleus of a substituted benzene can be polarised in two opposite ways.

These rules suggest further that an unsubstituted phenyl-group is not likely to be very efficient in determining the sign of the charges assumed by the various atoms of an associated conjugated system when activated, since the carbon atoms of the aromatic nucleus (unlike the metal in a radical such as $\overset{-}{\mathrm{O}}\overset{+}{\mathrm{N}}\mathrm{a}$) can adapt themselves to either polarity in the side-chain. One might, therefore, expect the phenyl-group to behave "amphoterically" (although perhaps with a definite preference for one of the two alternative forms) and to act differently in different compounds, or even in the same compound under the influence of different re-agents. I gather from Prof. Lapworth, as well as from Prof. Ingold, that this expectation is in agreement with the experimental facts. The amphoteric character of the phenyl radical is also indicated by the fact that Prof. Robinson has already used the same idea in connexion with the electrolytic dissociation of hexaphenylethane (or triphenylmethyl)

$$\mathrm{PH_3C.CPh_3 \rightleftharpoons Ph_3\overset{+}{C} + \dot{C}Ph_3}$$

where he regards the phenyl-groups as being oppositely polarised in the two ions.

There is no need for me to defend the theory of induced alternate polarities, which is quite secure in its Manchester stronghold. My own responsibility has been incurred in suggesting an electronic mechanism, which makes the phenomenon inevitable in conjugated systems undergoing chemical change, but has also the effect (fortunate or unfortunate) of limiting it to conjugated systems—except, perhaps, in those cases where a single bond can be ionised or activated in the same way as the double bonds of a conjugated chain. My present object is, therefore, merely to object "on a point of order" to the use of symbols in such a way that ions and molecules are not clearly distinguished from one another.—I am, Yours, etc., T. M. LOWRY

Cambridge
July 1, 1924

SYNTHETIC RESINS

Sir,—In your news of the French synthetic resin industry published in the current number of *Chemistry and Industry* (p. 694), I imagine you are reporting a too generous estimate of the production of artificial resin in France. I believe that M. Georges Kimpflin estimated the figure as 100 tons per month, reducing the amount reported in your news item to one-tenth. It would be distinctly encouraging to the synthetic resin industry if the production of resin in France and America alone, amounted to over 70,000 t. annually.

It is of interest, I think, that M. Kimpflin in his address also quoted the amount of the production of artificial resin in Germany as being 300 t per month. He does not appear to refer at all to British manufacture, evidently regarding this as insignificant. I suppose the British production can be reckoned in tens of tons per month and not hundreds. If this is correct its insignificance compared with that of other countries is a surprising fact and must be due either to lack of enterprise and development by the British manufacturer, compelling the British user to go abroad for supplies, or to a restricted demand owing to the lack of realisation by the possible consumer (of insulating material, varnish, etc.) of the profitable results to be obtained with the various classes of artificial resins.

The need, of course, exists—as, according to M. Kimpflin, it exists in France—for further and continued research on the subject in order to extend the knowledge of the scientific principles involved, and thus—and only thus—to establish a sound and lasting industry.—I am, Sir, etc.,

ALAN A. DRUMMOND

Iver, Bucks
July 5, 1924

PERSONAL AND OTHER ITEMS

Prof. J. C. McLennan, of the University of Toronto, has been elected president of the Royal Society of Canada.

Mr. T. Thorne Baker has been awarded a silver medal by the Royal Society of Arts for a paper read before the Society during the past session.

Mr. A. W. Nash, B.Sc., M.I.Mech.E., at present lecturer in oil mining in the University of Birmingham,

has been appointed professor of oil mining in the same University.

Mr. George Douglas has been elected chairman and Sir Thomas Robinson, M.P., vice-chairman, of the Bradford Dyers' Association.

Dr. W. Campbell has been appointed the first Howe professor of metallurgy at Columbia University. The new chair was established in memory of the late Prof. H. Marion Howe. Dr. Campbell was born at Gateshead-on-Tyne, England, in 1876, and took the D.Sc. of the University of Durham in 1905, having also studied at the Royal School of Mines and at Columbia University.

Mr. Francis P. Garvan, president of the Chemical Foundation, New York, has left for Europe.

Beit Memorial Fellowships

At the recent meeting of the trustees, it was stated that, during the past year, research work had been carried on by one Senior Fellow, one fourth year Fellow, and twenty Junior Fellows. The reports of the directors of the laboratories where the Fellows were engaged indicate that their work was satisfactory and that valuable additions to science may result from their researches. The Advisory Committee has recommended the renewal for another year of the Junior Fellowships that do not now expire. Amongst those elected to Fellowships are the following names, the proposed researches being also given: Dr. A. S. Parkes, researches on breeding and on the feeding of animals (work on the latter subject is now proceeding in collaboration with Prof. J. C. Drummond). Dr. H. Cohen, work on the chemical composition of cerebrospinal fluid and on the introduction into it of therapeutic substances and other chemical problems of the blood system. Miss Margaret A. Boas, B.Sc., research on vitamins, including the effect of ultra-violet radiation. Mr. H. F. Holden, M.A., study of the optically active substances, other than glucose, in normal and diabetic protein-free blood.

Ramsay Memorial Fellowships

The second dinner in honour of the Ramsay Memorial Fellowship Trustees and the Ramsay Memorial Fellows was held on July 4 at University College. The chair was taken by Sir Gregory Foster, the Provost of University College, and the memory of Sir William Ramsay was honoured at the instance of Prof. J. Norman Collie, the chairman of the advisory council.

Sir Hugh Bell, in proposing "The British Dominions and Foreign Countries Associated with the Ramsay Fellowship Trust," said one of the most remarkable things about the Ramsay Fellowships had been the ardent response which had been forthcoming from foreign countries, and in this respect they could be said to be more of a real and active league of nations than anything else in the world. The Japanese Ambassador, responding to the toast, said man was engaged in a perpetual struggle with nature in an endeavour to discover her secrets, and it was largely due to the work of comparatively unknown men that secrets were wrested from nature for the benefit of mankind. They did not know how much they owed to the work of those men.

Prof. F. G. Donnan proposed "The Ramsay Memorial Fellowship Trustees." Sir John Brunner, who replied, said the Government did not do much, and therefore it fell to private enterprise largely to endow research. His firm were very pleased indeed with the results which the funds they had provided had produced.

The Chairman proposed "The Ramsay Memorial Fellows," and Dr. R. Winstanley Lunt and Dr. H. Weiss replied. (*The Times.*)

Honours for Distinguished Chemists

At the annual Degree Day of the University of Birmingham on Saturday last the honorary degree of Doctor of Laws was conferred by the Chancellor (Viscount Cecil of Chelwood) upon Professor F. Gowland Hopkins, F.R.S., Professor of Biochemistry in the University of Cambridge and the discoverer of vitamins; and Professor Percy Faraday Frankland, F.R.S., Emeritus Professor of Chemistry in the University of Birmingham.

In presenting Professor Gowland Hopkins, the Principal of the Birmingham University (Mr. Grant Robertson) observed that biochemistry was one of the most recent of our sciences to define its boundaries, to differentiate its subject matter, and to devise its special technique and to claim for itself and by its functions its separate right to self-determination in the world of exact science, and that place in the sun which lavish endowment alone could make warm, successful and secure. Professor Hopkins had been happy in attracting the endowment to his University of Cambridge and in asserting the right of biochemistry to self-determination and to indisputable achievement. Even the oldest and most ignorant had heard of vitamins and that day they were able to honour the discoverer of vitamins. Professor Hopkins as Huxley Lecturer at the Birmingham University was able to prove that he could be an intellectual vitamin, supplying just that indefinable element of stimulus essential to intellectual health. But the Sir William Dunn Professor had done much more than discover vitamins. He had shown by his researches how biochemistry was the indispensable ally of medicine on the one side and of organic chemistry on the other and he had marked out for it a career with an assured future and from its devoted servants a certain treasury of help to life, truth and social progress.

In presenting Professor Frankland, Emeritus Professor of Chemistry in the Birmingham University, for the distinction, Mr. Grant Robertson said it seemed almost unnecessary to explain the reasons why the Council and Senate had wished to bring there from his Scottish fastness their former Professor and to confer that particular degree. The son of the late Sir Edward Frankland, F.R.S., himself a brilliant chemist and an accomplished scientist. Professor Frankland had made his mark by his contributions to stereo-chemistry, to the science

of fermentation, to bacteriology and biology, and in the application of bacteriology to air, water and earth. In the science of sanitation he had inherited and continued the work of his father. Those achievements were, indeed, contributions to civic civilisation. But to-day they were not thinking so much of his eminence as a scientist, as of his work in and for Birmingham University and Birmingham. He came to Birmingham in 1894, to be a professor in Mason College and after the University was founded in 1900 he remained for nineteen years as the head of the department of Chemistry which grew mightily under his vigorous and exacting administration. He had distinguished colleagues three of whom, Poynting in physics, Lapworth in geology, Adrian Brown in the science of fermentation had passed away; but they had inherited the fruits of their labours. Professor Frankland created their Honours School of Chemistry—the first of their Honour Schools of Science—and he set up and developed a notable department of research which had been of vital importance to the industries of the Midlands. To these achievements he added in the four years of war a continuous series of services which proved that British brains and British science were more than equal to the brains and science of our foes. They welcomed his return to the scene of his life's work and assured him that the legacy he bequeathed to his department was not buried and that their Faculty of Science was determined to maintain and to develop the tradition and the ideals which inspired his efforts.

GENERAL

Sesamum Crop of 1923-1924 in British India

From reports based on a memorandum dealing with the final estimates of the sesamum crop in British India, the total yield for the year 1923-24 is estimated at 431,000 tons, from an area of 5,018,000 acres. The quantity exported by sea from British India to foreign countries during the year was 9537 t., as against 36,436 t. in 1922—23—(*Ind. Tr. J.*, *Apr.* 24, 1924.)

The World Production of Zinc

In 1913 the total output of zinc in the world was 981,000 tons, a figure which fell to 445,000 t. in 1921, rising to 722,000 t. in 1922, and over 864,000 t. in 1923. Of the 1923 production the United States produced the largest quantity, namely 418,000 t., Belgium following with 138,000 t.

Synthetic Methyl Alcohol

It is announced that methyl alcohol is now being synthesised on a commercial scale from water gas. In presence of a catalyst (iron filings covered with potassium carbonate) and under a pressure of 150 atmospheres and at a temperature of 400–450° C., the carbon monoxide is converted into methylalcohol, formaldehyde being the bridge product. An oily liquid is said to be produced from which the alcohol is obtained by distillation. The residue contains napthenes resembling those present in certain petroleums.

REVIEWS

Briquetting. By A. L. Stillman, M.Sc. Pp. x + 466. Easton, Pa.: The Chemical Publishing Co., 1923. Price $6·0.

Although briquetting has been for many years practised on an extensive scale in all civilised countries there has, until the publication of this work, been only one authoritative book on the subject, that of Prof. Franke, translated from the German during the war by F. C. A. Lantsberry. It may be considered with some degree of truth that one of the reasons for this is that briquetting as usually practised has been anything but an exact science, and those engaged in the industry have not always been able to devote time and incur expense in collecting technical and commercial information.

The present volume is particularly welcome at a time when renewed attention is being given to the scientific and economical development of the world's fuel resources, and to the treatment of ores and waste materials. Although written largely from the American point of view, practically every aspect of the briquetting of materials both combustible and metallic is dealt with in a methodical manner. All general information is, as far as possible, put into classified tabular form convenient for reference. Detailed and illustrated descriptions of the plant and processes follow. An important chapter is that descriptive of the various types of briquette press and briquetting machinery, and special mention should be made of a very practical chapter on laboratory research in briquetting. This contains much sound advice, but the statement (p. 418) that a hand press always gives better results than are obtainable in actual practice is hardly correct, except possibly with pitch as a binder.

The chapter on binders is excellent, although not quite up to date. No doubt a subsequent edition will make some reference to recent developments in the use of cassava starch, seaweed, and the vegetable binders which are being successfully developed in South Africa and in this country. The absence of a reference to the admixture of pitch by means of spraying is also noticeable. It has long been almost an axiom in the patent fuel industry that pitch is the only satisfactory binding material, but the crisis in the price of pitch last year is likely to have far-reaching results, and there are indications that a duplex binder containing only 2 or 3 per cent. of pitch for waterproofing purposes is likely to prove more economical and satisfactory.

Mention should also have been made of Macnab's vibration method of pressing, of Sutcliffe and Evans' pure coal briquette process, and of the possibilities of briquetting with inferior binders prior to low-temperature carbonisation. Much more stress should also have been laid upon the importance of accurate and scientific grading of the material to be briquetted, this being particularly important when binders other than pitch are used. In the Colonies and many foreign countries coal or lignite deposits are often of such high volatile content that carbonisation either preceded or followed by briquetting is the economic solution, having regard to the fact that the principal

usage is mainly for the railways. For the latter, complete waterproofness is unnecessary, particularly as in tropical countries the trucks are usually of the box type.

Mr. Stillman has given us an excellently written and illustrated treatise, which can be confidently recommended as a reliable survey of the briquetting field.

C. J. GOODWIN

PULVERISED COAL SYSTEMS IN AMERICA. By LEONARD C. HARVEY. Fuel Research Board. Special Report No. 1. Third Edition. Pp. 131. H.M. Stationery Office. Price 5s

This is the third edition (Jan., 1924) of Mr. L. C. Harvey's well-known and detailed volume which has always been indispensable to the library of everyone interested, directly or indirectly, in the subject of pulverised fuel firing. The additions bring the extremely valuable bibliography, one of the best features of the publication, up to July 31, 1923, although so rapid is the progress of pulverised fuel that much new material has since become available.

Some later results obtained with pulverised fuel in malleable-iron melting furnaces are also given, although the primary objection to this method of firing in competition with ordinary coal, oil, and producer (or other) gas is the slagging trouble, that is the melting of the ash. It is, of course, in steam generation that pulverised fuel firing has made the most remarkable developments during the past three or four years, and the new edition gives a list of a number of boiler plants on the "Lopulco" system. This list is incomplete to-day and necessarily cannot include some of the more remarkable examples, such as the extensions of the Colfax Station of the Duquesne Light Co. of Pittsburg and the Gennevilliers Station (Paris) of the Detroit Edison Co., nor, of course, the British installations now in progress at St. Pancras and Willesden, and the recent orders of the Birmingham Corporation.

There are a number of points in the latest methods of pulverised fuel firing of particular interest to the chemist and the chemical engineer which Mr. Harvey does not perhaps bring out quite clearly. In the first place the new vertical gravity coal-drier, using only about 10 per cent. of the hot gases from the chimney base mixed with cold air to give an average temperature of about 215° F., is undoubtedly a great improvement on the various horizontal driers, and the total heat or power required for drying is now only equivalent to about 3 k.w. per ton of coal, that is, the power necessary for the circulating fan. Also it means that the latest practice is merely to dry the coal from the point of view of the added or "mechanical" moisture only, and a typical specification is to dry down from 10 per cent. to 4 per cent. moisture. Incidentally it is high time we had some clear understanding of the difference, from the point of view of phraseology, between the added or external moisture and the natural moisture of coal, together with the water given off by actual decomposition of the coal substance; the term "hygroscopic moisture" is a particularly stupid phrase.

Pulverised fuel firing represents a revolution in the combustion of solid material from several points of view. In the first place, the contact between the particles of the fuel and the air is so intimate that an excess of only about 20 per cent. of air over the theoretical is required for complete combustion, the very best practice with the latest type of mechanical stoking being about 40 per cent. excess, whilst ordinary methods of combustion represent, say, 75-200 per cent. more air than the theoretical passing through the furnace. In this connexion detailed tests at Lakeside showed 10·7 to 25·1 per cent. excess depending on the rating, so that, combined with the fact that the moisture in the coal is cut down to 4 per cent., it is easy to see one of the reasons of the intensely hot flame in the combustion chamber and also why slagging or the melting of the ash has always been a difficulty with pulverised fuel. Another point, which certainly ought to be emphasised, is that, for the first time with solid material, pulverised fuel enables us to regard a furnace merely from the point of view of the number of British thermal units of heat to be put into it. That is to say, under normal conditions, a very large water-tube boiler may require, say, 225,000,000 B.Th.U. per hour (about 10 t. of coal), and with pulverised fuel we simply add the right weight of coal calculated according to the heat value. That is, we do not need any longer to worry about all kinds of factors, such as volatile matter, resinous content, coking properties, sulphur, moisture, ash and melting point of the ash, but merely add the weight necessary to give the B.Th. units, whereas many of the above items might easily run a mechanical stoker to a standstill. Just in the same way if we want more evaporation, we add more B.Th. units in a given space of time in a way impossible with any ordinary method of firing. The only fuel with which there is difficulty is low volatile anthracite, and this can easily be remedied by adding a little high volatile material.

It should be noted, also, that the objections to pulverised fuel have long been due to the furnace, and the preparation, that is, crushing, drying and pulverising, is to-day comparatively a minor matter. The invention of the large volume combustion chamber with hollow air-cooled walls and the water screen are really more responsible for the great advance in pulverised fuel firing than Mr. Harvey seems to indicate.

DAVID BROWNLIE

RESINES ET TÉRÉBENTHINES LES INDUSTRIES DÉRIVÉES. By M. VEZES and G. DUPONT. Encyclopedie de Chimie Industrielle. Pp. 656. Paris: J. B. Baillière et Fils, 1924. Price, Paper 60 fr., Bound, 70 fr.

In the preface of the book the authors show that the output of the French Naval Stores Industry (turpentine and rosin) is 15 per cent. of the world's production compared with 75 per cent. from U.S.A., but France is easily first among the European producers. The

history of the development of the cultivation of *Pinus maritima* is admirably outlined, and tribute is paid to Haller, Béhal, Grignard, Barbier and the younger scientists, *e g.*, Darmois, Pariselle and Vavon for their endeavours to develop in France an industry in which the raw material is produced in the country. Part 1 of the treatise deals with balsams and resins; Part 2 deals with terebenthines (oleoresins) and forms more than half the contents of the book; Part 3 comprises an account of the rosin oil industry and the manufacture of other rosin products. The classification of the balsams and resins is the same as in Coffignier's "Les Vernis," and the copals, together with the natural and synthetic resins other than oleoresins, are only briefly described. In this section the references to the literature already published are not sufficiently up-to-date, and the work of investigators outside France has not received adequate attention. Nevertheless, in the preface the authors are careful to state that the work has no pretensions to be complete or to exhaust the vast subject which its title indicates. It is in Parts 2 and 3 that the interest of the reader will be centred. The authors show the superiority of cultivation and "gemmage" in the French industry, but at the same time they criticise the customs of the "*résiniers*," and appeal for a proper appreciation of factory requirements. They call attention to the defects in the present methods of treatment of the oleoresin in the French turpentine districts, and to the lack of adequate standards for some of the French products The extraction of turpentine in Russia, Spain and other countries is described in an effective manner The readers of Part 2 of the book will not fail to be impressed by the authoritative character of the information given. In Part 3 the development of the rosin oil industry is well discussed and the methods of manufacture and properties of a number of rosin products, *e.g.*, soaps, siccatives, rosin esters, printing inks, pitches and blacks, are concisely given with an adequate amount of detail. The authors consider that a description of the products from turpentine, viz., borneol, camphor terpineol etc, is worthy of a special volume The application of the knowledge of chemical composition to industrial processes is fully appreciated by the authors. The chemistry of the terpenes and abietic acid is well given, but the formula for retene on page 433 is incorrect, and the modification of Easterfield and Bagley's formula for abietic acid is not in keeping with the results of recent work by Ruzicka. The importance of investigations instituted in the faculty of Sciences of Bordeaux during the last twenty years must be acknowledged, and the results have proved to be of value to manufacturers in the south west and other regions of France and abroad

Considering the extent of the ground covered by the authors their treatment of the subject is very lucid. The book contains a fund of information on matters pertaining to resins, and is a valuable contribution to the literature on the subject written by experts with a profound knowledge of the Naval Stores Industry.

R. S. MORRELL

REPORT

SIXTIETH ANNUAL REPORTS ON ALKALI, ETC., WORKS, 1923. By the CHIEF INSPECTORS. Pp. 40. H.M. Stationery Office, 1924. Price 1s 6d.

No general revival of chemical industries has taken place during the year, though in the tinplate trade there has been exceptional activity. The superphosphate industry has been brought almost to a standstill by foreign competition. The number of registered works in England and Wales was 1219 and of separate processes 1995, being a decrease of 21 and 10 respectively on the previous year. Complaints against registered works have not been excessively numerous and usually related to short-lived escapes of fumes due to accidental occurrences. Advice has been given in cases of complaints of nuisance arising from certain non-registrable processes, such as petroleum distillation, the bleaching of wool by means of sulphur dioxide and from excessive smoke from coke ovens.

Alkali and Copper (*Wet Process*) *Works* —Work has been of a limited character due to the competition of synthetic hydrochloric acid and the increased use of sulphur in place of copper pyrites in the manufacture of sulphuric acid. Condensation of hydrochloric acid has been satisfactory at all works

Cement Works.—Chamber kilns are still much in favour, especially in the South of England and continue to hold their own. No advance has been made in the recovery of potash salts owing to the impossibility of competing with the natural product.

Smelting Works-- Progress in the collection of metallic oxides from chimney gases by means of cyclone dust-catchers is recorded An increased amount of sulphuric acid is being made by the calcination of zinc blende, notwithstanding the difficulty caused by the presence of lead in the Australian concentrates now chiefly used.

Sulphuric Acid Works. The employment of sulphur in place of pyrites and the use of mechanical sulphur burners is extending. During the year one more works has adopted electrostatic deposition of dust in connexion with a chamber plant. There has been no great demand for concentrated acid and there is now no valid reason for any nuisance caused by local fumes. The installation of scrubbers fed with soda solution in connexion with the exit gases from Grillo plants has led to good results, the total acidity being reduced to less than 1 gram of SO_3 per cubic foot and a high-strength bisulphite made.

Chemical Manure Works. -At such works as have been operating results have been satisfactory.

Sulphate of Ammonia and Gas-Liquor Works.—Reference is made to cases in which trouble has been caused by oxide purifiers having been too small or too few for their work or by leaky joints. Whilst the treatment of the effluent from the distillation of ammonia liquor made from horizontal retorts in dephenolating towers is satisfactory, this is not the case with vertical retort liquor. This contains polyhydric phenols which are not destroyed and also a notable quantity of thiocyanate and thiosulphate.

Ammonia plant effluent mixed with town sewage can, however, be dealt with by treatment on the land, if the proportion of effluent is small and reasonably constant. A detailed report of experimental work on this subject is given.

Chlorine Works. There has been more activity in the manufacture of chlorine products other than bleaching powder. A wide field for the use of liquid chlorine is opening up.

Muriatic Acid Works. Control in the synthetic process for the manufacture of the pure acid has been excellent. Fibre separation works have been rather more active. In tinplate flux works, where great activity has prevailed, the use of size in the pickling process has considerably extended.

Tar Works.—Complaint is made of the poor condition of pitch coolers at some works and of pitch being discharged at an excessive temperature. Tar distilled during the year amounted to 1,457,200 tons and pitch produced to 587,818 t.

Report on Scottish Works. During 1923 there were 161 registered works in Scotland, operating 303 scheduled processes. Production data include: Pyrites and spent oxide burned 104,613 t., phosphates and bones dissolved 54,144 t., ammonia made (as sulphate), 97,594 t., tar distilled 224,968 t., pitch produced 89,544 t. The last three items show considerable increases over 1922. Of the tar 90,000 t. was partially distilled to road tar.

An experiment is reported, in a sulphuric acid chamber plant, in feeding the second Gay-Lussac tower with a small quantity of water instead of a large volume of strong acid. The resulting exit gases were normally very low in acidity and the cost of pumping acid was reduced. In tar works trouble with pitch fumes has occurred in some cases. This has been avoided in one works by drawing the fumes by a fan through a closed range of pipes with condensation to oil. Two deaths occurred owing to a sudden rent in a charged tar still. The setting of the still adjacent was under repair and two men at work in the flues were caught and suffocated by the fire which broke out.

The technical side of the Report will be dealt with in a later issue of the Abstracts (B.) issued by the Bureau of Chemical Abstracts.

COMPANY NEWS

W. & T. AVERY, LTD.

A further dividend on the ordinary shares is recommended of 10 per cent., making 15s. per cent. for the year, less tax. The carry forward is £38,111 and £10,000 is placed to reserve.

DISTILLERS COMPANY

The report states that after providing for depreciation and payment of debenture interest the profit and loss account shows a balance for the year of £677,914, which with £107,545 brought forward makes available £787,459. There has been added to reserve fund £211,420, to fire insurance fund £5000, and to superannuation fund £25,000. The directors recommend a final dividend on the ordinary shares of 6 per cent., making 10 per cent., tax free, for the year, leaving £119,530 to be carried forward. The balance of profit for the previous year was £620,637, and £98,770 was brought forward. The reserve fund received £200,000, fire insurance £5060, and superannuation £30,000, while the ordinary dividend was also 10 per cent. During the past year the reserve fund was capitalised to the extent of £911,420. This fund, with the £211,420 added, now stands at £250,000, the fire insurance at £155,600 and superannuation and provident fund at £165,971.

MIDLAND BANK, LTD.

The directors announce an interim dividend for the half-year ended June 30 last at the rate of 18 per cent. per annum less income tax, payable on July 15. The dividend for the corresponding period of 1923 was at the same rate.

MOND NICKEL CO., LTD.

The profit and loss account for the year ended April 30 shows a net surplus of £276,458 (against £307,774 in the preceding year). The year's Preference dividend takes £175,000, and the dividend on the Ordinary shares absorbs £112,500. The latter dividend is equal to $12\frac{1}{2}$ per cent., less tax, and compares with 10 per cent., free of tax, for 1922-23. After allowing for directors' fees (£13,823), the balance to be carried forward is £40,403, as against £65,268 brought in.

BRITISH GLASS INDUSTRIES, LTD.

On June 4, the High Court of Justice (Chancery Division) confirmed the reduction of the capital of British Glass Industries from £5,000,000 to £2,255,218.

ENGLISH OILFIELDS, LTD.

The report for 1923 states that the policy of the reconstituted Board to exercise strict economy has been maintained. The directors have concluded, after wide consultation, that there is no reasonable prospect of commercial success in the production of oil from the company's properties. They have therefore decided to free the company at the earliest moment from the heavy and increasing rent obligations under their mining leases. Meanwhile proposals for the utilisation of the costly plant at Setch or for its realisation are under consideration. Proposals for securing valuable interests for the company in other directions are under examination, and something has already been accomplished on favourable terms. The directors' policy is, at the proper moment, to submit proposals for writing down the capital drastically, so that it may be represented by tangible assets, and to build up a new business as the only alternative to a liquidation which would yield little or nothing for the shareholders. The balance-sheet for 1923 shows that with development and administrative expenses amounting to £21,158 during the year this liability now stands at £102,120

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 6d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	7d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	45s. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	4s. 10d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton. Fair demand.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall. 60% O.P. Market dull.
Solvent	5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£46 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d.—6¾d. per lb. Better inquiry.
Crude 60's	1s. 9d. per gall. Market flat. Only odd lots being offered.
Acid Cresylic, 97/99	2s 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—1s. 11d. per gall. Steady demand.
Dark	1s. 10d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	9½d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d. per gall.
Pure	1s. 10d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.

Creosote—	
Cresylic 20/24%	9d.—9½d. per gall. Few inquiries.
Middle Oil / Heavy / Standard Specification	6d.—6½d. per gall according to grade and district. Market weaker.
Naphtha—	
Solvent 90/160	1s. 3d.—1s. 5d. Demand declining.
Solvent 90/190	1s. 2d.—1s. 4d. Fair business, passing.
Naphthalene Crude—	
Drained Creosote Salts	£6—£6 10s. Demand falling off.
Whizzed or hot pressed	£9 per ton. Little business.
Naphthalene—	
Crystals and Flaked	£16—£17 per ton.
Pitch, medium soft	57s. 6d.—60s. per ton f.a.s. for next season.
Pyridine 90/160	20s.—21s. per gall. Market less firm.
Heavy	12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

There has been an appreciable increase in dye-stuffs business during the past week. Prices remain constant.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 6d. per lb.
Acid H	4s. 3d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1½d. per lb. Steady demand.
Acid Sulphanilic	9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	1½d. per lb. Demand steady.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	4s. 9d. per lb. d/d., packages extra, returnable
Dimethylaniline	2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. per lb. d/d.
Monochlorbenzol	£63 per ton.
β-Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 1d. per lb. d/d.
Nitrobenzene	5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis
m-Phenylene Diamine	4s. 2d. per lb. d/d.
p-Phenylene Diamine	10s. 3d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 5d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 6d. per lb. naked at works.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The demand for pharmaceutical chemicals is better for export to the British Dominions than for the Home trade.

Acid, Acetic 80% B.P.	£47 per ton.
Acid, Acetyl Salicylic	3s. 2d.—3s. 3d. per lb. Better demand.
Acid, Benzoic B.P.	3s. 6d. per lb. Larger supplies available. Market easier.
Acid, Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6¾d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic	Prices quoted from 2s. per lb. down to 1s. 7d. for ton lots. Market still weak. Keen competition and smaller demand.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1¾d.—1s. 2d. per lb. less 5%. Better tone but not yet very active. Cheap offers of second hand parcels of foreign acid. Higher prices expected in view of firmness of raw materials.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 3d. per lb. for quantity. Demand slow. Prices shaded to secure large orders.
Amidopyrin	13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. per lb. Quiet market.
Benzonaphthol	6s. per lb. Small inquiry.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
,, Citrate	11s. 1d.—13s. 4d. ,,
,, Salicylate	10s. 2d.—12s. 2d. ,,
,, Subnitrate	10s. 9d.—12s. 9d. ,,
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Market firm.
Potassium	11d. per lb.
Sodium	1s. ,,
Ammonium	1s. 1d. per lb.
Calcium Lactate	Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate	3s. 7d.—3s. 9d. per lb., duty paid.
Chloroform	2s. per lb. for cwt. lots. Very steady
Creosote Carbonate	6s. 6d. per lb. Little demand.
Formaldehyde	£55 per ton, *ex* works. English make.
Glycerophosphates—	Fair business passing
Calcium, soluble and citrate free	7s. per lb.
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. ,,

Guaiacol Carbonate	11s. per lb. for cwt. lots. Slightly cheaper.
Hexamine	3s. 6d. per lb. for English make. Market quiet and steady.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	English make offered at 120s. per oz.
Hydroquinone	4s. 3d. per lb. in cwt. lots. Foreign make.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 2d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	52s. 6d. per lb. Weaker.
Synthetic	26s.—35s. per lb., according to quantity. English make. Strong demand.
Mercurials	Market firm.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	2s.—2s. 3d. per lb. for carboys. Not much demand. Holders would accept 1s 11d. for ton lots.
Methyl Sulphonal	26s. per lb.
Metol	11s. per lb. British make.
Morphine and Salts	Reduced by 1s. to 1s 3d. per oz.
Paraformaldehyde	3s. per lb.
Paraldehyde	1s. 6d. per lb. in free bottles and cases, according to holder and quantity. Firmer.
Phenacetin	6s. per lb. Ample stocks available.
Phenazone	7s. 3d. 7s. 6d. per lb. Quiet.
Phenolphthalein	6s. 6d. per lb Easier with supplies more plentiful
Potass. Bitartrate—99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 10d —2s. 2d. per lb
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Quinine Sulphate	2s. 3d. per oz., in 100 oz. tins. Very heavy demand.
Resorcin	5s. 6d. per lb. Sales slow.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d.—3s. 11d per lb. Easier in sympathy with other salicylates.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 9d. per lb. In quantity for British product.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity. Firm in common with other citrates.
Sod. Hyposulphite—	
Photographic	£13—£15 per ton, according to quantity, d/d. consignee's station in 1 cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	75s.—82s. 6d. per cwt., according to quantity. Market quiet.
Sod. Salicylate	Market more active. Powder 2s. 2d.—2s. 6d. per lb. Crystal at 2s. 5d.—2s. 8d per lb. Flake 2s. 9d.—2s. 10d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol	Very scarce indeed.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.
Aubepine	14s. 6d. ,,
Amyl Acetate	2s. 9d. ,,
Amyl Butyrate	6s. 9d. ,,
Amyl Salicylate	3s. 3d. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 10½d. ,,
Benzyl Alcohol free from Chlorine	2s. 10½d. ,,
Benzaldehyde free from Chlorine	3s. 6d. ,,
Benzyl Benzoate	3s. 6d. ,,
Cinnamic Aldehyde Natural	15s. 6d. ,,
Coumarin	20s. ,,
Citronellol	16s. ,,
Citral	10s. ,,
Ethyl Cinnamate	15s. ,,
Ethyl Phthalate	3s. 3d. ,,
Eugenol	10s. 6d. ,,
Geraniol (Palmarosa)	35s. ,,
Geraniol	11s.—18s. 6d. per lb.
Heliotropine	7s. per lb.
Iso Eugenol	15s. 9d. ,,
Linalol ex Bois de Rose	26s. ,,
Linalyl Acetate	26s. ,,
Methyl Anthranilate	9s. 6d. ,,
Methyl Benzoate	6s. ,,
Musk Ambrette	45s. ,,
Musk Xylol	16s. 6d. ,,
Nerolin	4s. 9d. ,,
Phenyl Ethyl Acetate	12s. 6d. ,,
Phenyl Ethyl Alcohol	16s. ,,
Rhodinol	57s. 6d. ,,
Safrol	1s. 10d. ,,
Terpineol	2s. 4d. ,,
Vanillin	24s.—24s. 9d. per lb. Price reduced. Demand steady.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.
Anise Oil	2s. 8d. per lb.
Bergamot Oil	19s. 6d. per lb.
Bourbon Geranium Oil	30s. 6d. ,,
Camphor Oil	75s. per cwt.
Cananga Oil Java	10s. 6d. per lb.
Cinnamon Oil, Leaf	6½d. per oz.
Cassia Oil, 80/85%	8s. 9d. per lb.

Citronella Oil—		
Java 85/90% ..	.. 6s. per lb.	
Ceylon	.. 3s. 9d. per lb.	
Clove Oil	. 7s. per lb.	Cheaper
Eucalyptus Oil 70/75%..	2s. per lb.	Cheaper
Lavender Oil—		
French 38/40% Esters	29s. per lb.	Dearer
Lemon Oil ..	.. 3s. 2d. per lb.	
Lemongrass Oil	.. 3d. per oz.	
Orange Oil, Sweet	.. 13s. 3d. per lb.	Cheaper.
Otto of Rose Oil—		
Bulgarian ..	.. 27s. 6d. per oz.	
Anatolian .	.. 23s. 6d. per oz.	
Palma Rosa Oil ..	.. 19s. per lb.	
Peppermint Oil—		
Wayne County	.. 20s. 9d. per lb.	
Japanese ..	. 14s. 3d. per lb.	Cheaper.
Petitgrain Oil ..	.. 10s. per lb.	
Sandal Wood Oil—		
Mysore	.. 26s. 6d. per lb.	
Australian ..	.. 21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents, those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than Sept. 2nd; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C., on July 17th.

I.—Applications

Badder. Evaporating and drying colloidal materials from solutions. 15,471. June 27.

Calder and Palmer. 15,261. See II.

Nathyan. Obtaining solid matter from a solution, suspension or emulsion. 15,160. June 23. (Ger., 22.6.23.)

Wauthier. Pulverizer. 15,124. June 23. (Belgium, 21.6.23.)

I.—Complete Specifications Accepted

7828 (1923). Deschamps. Facilitating physical or chemical reactions. (197,374.)

11,268 (1923). Brutzkus. Effecting chemical reactions in the interior of compressors. (217,717.)

32,188. Linden. Separating and recovering liquids and solids of different densities. (217,851.)

II.—Applications

Calder and Palmer. Scrubbers for scrubbing gases etc. 15,261. June 24.

Carpmael (Chemische Fabriken vorm. Weiler-ter Meer). Process for obtaining gases rich in ethylene. 15,436. June 26.

Chadburn. 15,324. See XII.

Koppers Co. Testing coal etc. 15,545. June 27. (U.S., 12.9.23.)

Rude. Gasification of fuel and production of gas. 15,497. June 27.

Rudeman. Manufacture of peat briquettes. 15,318. June 25.

Schwalbe. Wet carbonisation of wood etc. 15,252. June 24. (Ger., 25.6.23.)

Smith. Gas-producers. 15,299. June 25.

II.—Complete Specifications Accepted

34,628 (1922). Hackford. Production of oil gas. (217,613.)

7221 (1923). Becker. Coking retort ovens. (205,460.)

7836 (1923). Duffield. Apparatus for producing gas from powdered carbonaceous matter. (217,645.)

IV.—Applications

Akt.-Ges. für Anilin-Fabrikation. Manufacture of dyestuffs. 15,169. June 23. (Ger., 23.6.23.)

Ellis (Haeffely). Manufacture of dyes for vegetable fibres. 15,529. June 27.

IV.—Complete Specifications Accepted

11,900 (1923). Ransford (Cassella und Co.). Manufacture of alkyloxyacridines. (217,715.)

14,671 (1923). Bloxam (Durand et Huguenin Soc. Anon.). Manufacture of chlorinated amines. (217,753.)

19,837 (1923). Farbenfabr. vorm. F. Bayer u. Co. Manufacture of indigoid dyestuffs. (205,790.)

V.—Applications

Higgins. Preparation of cellulose fibres etc. from waste. 15,069. June 23.

Vains. Continuous chlorination of cellulosic materials. 15,600. June 28.

V.—Complete Specification Accepted

2699 (1924). Alsa Soc. Anon. Manufacture of glossy and hollow artificial threads. (214,497.)

VI.—Applications

Alcock, Ryley, and British Celanese, Ltd. Solutions, compositions, etc. for textiles etc. 15,510, 15,511. June 27.

Bonnet Ainé et ses Fils, Veuve. Machine for mercerising etc. skeins of thread. 15,591. June 28.

Durand et Huguenin Soc. Anon. Process of dyeing and printing textiles etc. 15,539. June 27. (Ger., 2.7.23.)

Green. Dyeing and printing. 15,374. June 26.

Poulson. Desizing, washing, and bleaching fabrics etc. 15,570. June 28.

Schlumpf. Dyeing and washing textile material. 15,278. June 24. (Switz., 29.6.23.)

Schlumpf. Machine for treating yarns in hanks with liquid. 15,279, 15,280. June 24. (Switz., 1.7.23, and 25.9.23.)

VI.—Complete Specification Accepted

15,002 (1923). Mitchell and Wordsworth. Dyeing and like machines. (217,758.)

VII.—Applications

Finlayson, Smith, and Woodall-Duckham, Ltd. Manufacture of suspensions of iron compounds. 15,267. June 24.

Shimadzu. Process of manufacturing lead oxide. 15,421. June 26.

Vains. Continuous manufacture of hydrate of chlorine. 15,599. June 28.

VII.—Complete Specifications Accepted

34,479 (1922). South Metropolitan Gas Co., Parrish, and Wright. Distillation of ammoniacal liquors. (217,611.)

9478. Aus. and Chem. Werke vorm. Auerges. Regenerating alkaline liquors. (217,685.)

VIII.—Complete Specification Accepted

9602 (1924). British Thomson-Houston Co. Quartz working. (214,630.)

IX.—Applications

Bremner. Cement manufacture. 15,350. June 25.

Marks (Polysius). Manufacture of artificial stone. 15,273. June 24.

IX.—Complete Specification Accepted

7251 (1923). Marks (Master Builders Co.). Colouring mortars and concretes. (217,633.)

X.—Applications

Breitenbach. Metallurgical furnaces. 15,330. June 2[illegible]

Edwards. Manufacture of iron or steel alloys. 15,266. June 24.

Lockwood. Concentration or separation of minerals. 15,327. June 2[illegible]

Reid. Reduction and alloying of metals. 15,268. June 24.

Soc. Anon. de Commentry-Fourchambault et Decazeville. Treatment of ores in blast furnaces. 15,343. June 2[illegible] (Fr., 3.7.23.)

XI.—Applications

Dutt. Electrolytic cells. 15,499. June 27.

Silumminite Insulator Co., Ltd., and Wythes. Electric insulating-materials etc. 15,514. June 27.

XII.—Application

Chadburn. Purification of oils. 15,324. June 25.

XIII.—Complete Specification Accepted

4691 (1923). Pollak. Manufacture of condensation products from formaldehyde and urea or thiourea and its derivatives (193,423).

XIV.—Complete Specification Accepted

34,613 (1922). Pratt. Aqueous dispersion of rubber, balata, or gutta-percha. (217,612.)

XV.—Applications

Akt.-Ges. fur Anilin-Fabrikation. Manufacture of tanning-materials. 15,540. June 27. (Ger., 29.6.23.)

Bechhold. Manufacture of glue etc. 15,410. June 26.

Cutter, Drew, and Duncalfe. Manufacture of gelatin from bone etc. 15,226. June 24.

XVII.—Complete Specification Accepted

16,782 (1923). Ling and Nanji. Treating starch for the production of maltose and other substances. (217,770.)

XVIII.—Applications

Aktiebolaget Separator. Method of making wort. 15,232. June 24. (Sweden, 5.7.23.)

Munton and Baker (Bedford), Ltd., and Reffell. Extraction of malt. 15,331. June 25.

XIX.—Applications

Akt.-Ges. fur Anilin-Fabrikation. Fungicides. 15,204. June 24. (Ger., 25.6.23.)

Jameson, Wilson, and Taylor. Pectin products. 15,601. June 28.

XIX.—Complete Specification Accepted

7592 (1923). Parker, and Co-operative Wholesale Society, Ltd. Pasteurisation of milk. (217,641.)

XX.—Applications

Carpmael (Chemische Fabriken vorm. Weiler Ter Meer). 15,436. See II.

Jena. Recovery of transformed healing and strengthening media. 15,270. June 24. (Ger., 26.6.23.)

Marks (Carbide and Carbon Chemicals Corporation). Process of combining ethylene with sulphuric acid. 15,155. June 26.

Ransford (Cassella and Co.). Production of arsinic acids. 15,260. June 21.

Ransford (Cassella and Co.). Production of arseno compounds. 15,528. June 27.

Wade (Karpen and Bros.). Manufacture of hexamethylenetetramine. 15,253. June 21.

XX.—Complete Specification Accepted

14,671 (1923). Bloxam (Durand et Huguenin Soc. Anon.). See IV.

XXI.—Application

Baker. Preparation of chemical substances for use in radiography. 15,130. June 23.

XXI.—Complete Specification Accepted

13,919 (1923). Allott, and Allott, Jones and Co., Ltd. Photographic printing-processes. (217,741.)

XXII.—Complete Specifications Accepted

34,738 (1922). Nolan, Clapham, and Nobel's Explosives Co., Ltd. Production of tetryl and ethyl tetryl. (217,614.)

7879 (1923). Etabl. Davey, Bickford, Smith et Cie. Explosives. (196,593.)

25,484 (1923). De Wendel et Cie. Preparation of explosive charges containing liquid air or oxygen. (217,169.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35 Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number: *Australia*: Hardware, machinery, engineers' requisites (The Official Secretary, Commercial Bureau, Australia House, Strand, London, W.C. 2. Ref. No. 412/7/1/1/254); *Australia (New South Wales)*: Sulphuric acid, carbonate of soda (The Agent-General for New South Wales, Australia House, Strand, W.C. 2. Ref. No. 356/5); *British India*: Steel, brass (The Directors of the Madras and South Maharatta Railway Company, Ltd., 25, Buckingham Palace Road, Westminster, London, S.W. 1); Iron, porcelain, aluminium (The Director-General, India Store Department, No. 10, Belvedere Road, Lambeth, London, S.E. 1). *Brazil*: leather, paper, (29); *Italy*. Hides, varnish, metal (9); *Latvia*: Agricultural instruments, (10); *Netherlands*: Silk (11); Surgical supplies (12); White lead, red lead, and zinc white (14); *Smyrna*: Ironmongery, metal (25); *South Africa*: Steel, A.X./1090); *Spain*: Varnish gums (20); Hardware, optical supplies (21); Machinery, photographic supplies (22), *Uruguay*: Paint, paper (35), Rubber insulated cords (B.X./1056); *Yugoslavia*: Tin (18).

Dyestuffs Production in the United States

The final report of the United States Tariff Commission places the output of dyestuffs in 1923 at 93,500,000 pounds, or 1,500,000 pounds more than was shown on the preliminary report issued two months ago. The value of the dyes was approximately \$51,050,000. Total sales are reported as 6,000,000 or 7,000,000 pounds less than production, indicating a normal stock on hand at the close of the year. There was an increase in production of nearly 4 per cent over 1922, a record production, exceeding largely that of 1920, a year in which the largest recorded output was attained.

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during June has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 411, of which 316 were from merchants or importers. To these should be added 9 cases outstanding on June 2, making a total for the month of 420. These were dealt with as follows:—Granted—296 (of which 278 were dealt with within 7 days of receipt). Referred to British makers of similar products—65 (of which 54 were dealt with within 7 days of receipt). Referred to Reparation Supplies available—24 (all dealt with within 2 days of receipt). Outstanding on June 30, 1924—35. Of the total of 420 applications received, 356 or 85 per cent. were dealt with within 7 days of receipt.

PUBLICATIONS RECEIVED

WHERE TO BUY EVERYTHING CHEMICAL, 1924 EXPORT EDITION. Pp. 227. London: S. Davis and Co., 1924.

CATALOGUE OF LEWIS'S MEDICAL AND SCIENTIFIC CIRCULATING LIBRARY, including a classified index of subjects. Supplement, 1921-23. Pp. 84. London: Lewis's Library, 1924. Price 1s.

APPLIED CHEMISTRY. By I. D. Garard. Pp. vii+196. New York and London: The Macmillan Company, 1924. Price 15s.

REPORT ON THE ECONOMIC, FINANCIAL AND INDUSTRIAL CONDITIONS OF FINLAND DATED MARCH, 1924. By C. H. Mackie. Department of the Overseas Trade. Pp. 68. H.M. Stationery Office, 1924. Price 2s.

REPORT ON THE FINANCIAL, COMMERCIAL AND ECONOMIC CONDITIONS IN ROUMANIA, DATED MARCH, 1924. By A. Adams. Department of Overseas Trade. Pp. 66. H.M. Stationery Office, 1924. Price 2s.

REPORT ON THE COMPOSITION OF COMMONER BRITISH WINES AND CORDIALS (ALCOHOLIC AND NON-ALCOHOLIC). By G. C. Hancock, C.B.E., M.R.C.S., L.R.C.P., together with Report by the Government Chemist on the Examination of Samples. Reports on Public Health and Medical Subjects, No. 24. Pp. 58. H.M. Stationery Office, 1924. Price 1s. 6d. net.

PUBLICATIONS OF THE DEPARTMENT OF THE INTERIOR, Bureau of Mines, Washington: Government Printing Office, 1923-4:—

ANALYSES OF SAMPLES OF DELIVERED COAL, collected from July 1, 1915, to January 1, 1922, with a chapter on The Tidewater Pool Classifications. By N. H. Snyder. Bulletin 230. Pp. iv+174. 1923. Price 20 cents.

ACCIDENTS AT METALLURGICAL WORKS IN THE UNITED STATES DURING THE CALENDAR YEAR 1922. By W. W. Adams. Technical Paper 350. Pp. 31. 1923. Price 5 cents.

METAL-MINE ACCIDENTS IN THE UNITED STATES DURING THE CALENDAR YEAR 1922. By W. W. Adams. Pp. v+72. 1924. Price 10 cents.

PUBLICATIONS OF THE DEPARTMENT OF COMMERCE, Bureau of Standards, 1924. Washington: Government Printing Office:—

A NEW ELECTRICAL TELEMETER. By B. McCollum and O. S. Peters. Pp. 737—777. Technological Papers of the Bureau, No. 247. (Part of Vol. 17.) Price 15 cents.

LEGAL WEIGHTS (IN POUNDS) PER BUSHEL OF VARIOUS COMMODITIES. Circular of the Bureau, No. 10. Pp. 17. Price 5 cents.

PUBLICATIONS OF THE KENTUCKY AGRICULTURAL EXPERIMENTAL STATION. Lexington, Ky., 1923:—

STUDIES ON DAIRY CATTLE II. MILK PRODUCTION. No. 248. Pp. 20.

CALCIUM METABOLISM IN THE LAYING HEN. No. 250. Pp. 34.

A LIST OF THE BOOKS, BULLETINS, JOURNAL CONTRIBUTIONS, AND PATENTS BY MEMBERS OF MELLON INSTITUTE OF INDUSTRIAL RESEARCH DURING THE CALENDAR YEAR 1923. Bibliographic Series, Second Supplement to Bulletin No. 1. Pittsburgh, 1924.

PUBLICATIONS OF THE DEPARTMENT OF COMMERCE, BUREAU OF STANDARDS. Washington: Government Printing Office, 1924:—

EMISSIVE TESTS OF PAINTS FOR DECREASING OR INCREASING HEAT RADIATION FROM SURFACES. By W. W. Coblentz and C. W. Hughes. Technologic Papers No. 254. Part of Vol. 18. Pp. 171—187. Price 5 cents.

ELIMINATION OF WASTE, SIMPLIFIED PRACTICE. (1) FACE BRICK AND COMMON BRICK. Pp. 5. Price 5 cents. (2) METAL LATH. Pp. 6. Price 5 cents. (3) MILK AND CREAM BOTTLES AND BOTTLE CAPS. Pp. 3. Price 5 cents.

UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR COAL-TAR PITCH FOR WATERPROOFING AND DAMP PROOFING. Specification No. 83. Circular No. 155. Pp. 11. Price 5 cents.

CIRCULAR OF THE BUREAU OF STANDARDS, No. 136. Department of Commerce. United States Government Specification for Numbered Cotton Duck. Pp. 4. Washington: Government Printing Office, 1924. Price 5 cents.

REPORT OF THE GOVERNMENT CHEMIST FOR THE YEAR 1923, SUDAN GOVERNMENT. Wellcome Tropical Research Laboratories, Khartoum. Chemical Section, Publication No. 30. Pp. 37. Sudan: McCorquodale and Co. (Sudan), Ltd.

PUBLICATIONS OF REPRINTS FROM THE MEMOIRS OF THE COLLEGE OF SCIENCE, KYOTO IMPERIAL UNIVERSITY. Series A. Vol. VII. No. 3, 1924.

METALLOGRAPHISCHE UNTERSUCHUNG ÜBER DIE NAHNADELN. By Denzo Uno. Pp. 124—133.

ÜBER DIE ZEMENTIERUNG KLEINER EISENSTÜCKE. By Denzo Uno. Pp. 108—121.

LA PRODUCCION FRUTICOLA I SU COMERCIO. By J. P. Alessandri, Viaje por los EE.UU. de Norte América. Pp. 47. Santiago de Chile: Imprenta Fiscal de la Penitenciaria, 1923.

THE FUNDAMENTALS OF INTENSIVE LAC PRODUCTION. Reprinted from the Journal of the Science Association, Maharajah's College, Vizianagram, Vol. I, No. 4. Pp. 133—145. By M. Srinivasayya. Bangalore: Indian Institute of Science, 1924.

JAHRBUCH DER ORGANISCHEN CHEMIE. By Prof. J. Schmidt. X. Jahrgang: Die Forschungsergebnisse und Fortschritte im Jahre, 1923. Pp. xvi+284. Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1924. Price, bound, 18 goldmarks; paper, 15·50 gm.

KURZES LEHRBUCH DER CHEMIE. By Werner Mecklenburg. Second edition. Pp. xvi+793. Braunschweig: F. Vieweg and Sohn Akt.-Ges., 1924. Price, paper 20 M., bound 23 M.

New Books.—Messrs. Longmans, Green and Co. announce that the following books are in the press or nearly ready: "The Simple Carbohydrates and the Glucosides," by Dr. E. F. Armstrong, F.R.S. (new edition); "The History of Bleaching," by S. H. Higgins, M.Sc.; "Metallurgy," by E. L. Rhead (new, enlarged edition); "Applied Elasticity," by Dr. J. Prescott; and "Mathematics for Technical Students," by E. R. Verity.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

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VOL. 43 NEW SERIES — LONDON, JULY 18, 1924 — NO. 29

EDITORIAL

THE Society of Chemical Industry has held its carnival; a round of banquets and lavish hospitality, interrupted only by a business meeting lasting a couple of hours and by some capital papers making a total of about equal duration. Nearly five hundred members, wives, daughters and friends, took some part in the Annual Meeting; it was consequently the largest that has been held, one of the most interesting, one of the most important, probably the best organised, one of the busiest and, for those who attempted every item on the programme, one of the most fatiguing. The weather was excellent though inclined at times to be so hot as to make one lazy; everything went off without a hitch, the speeches were short, sharp and to the point, some of them distinguished by considerable humour. Liverpool has magnificent buildings, good cooks, attentive butlers, generous hosts, enthusiastic presidents, assiduous secretaries and grateful guests. After a sumptuous lunch, a visit to a works, an equally sumptuous dinner, a few good speeches made to an audience surrounded by a somewhat ethereal or ethylic atmosphere we returned, some late at night, some early in the morning, to that brief interval between days which has for many centuries sufficed to content the Britons; *Minima contenos nocte Britannos*, from which it appears we had this reputation at least as early as the days of Juvenal. Even when we reached our hotel we stayed awhile gossiping or in mutual accusation spent the fruitless hours, unwilling to retire though weary. We complain of these late hours, but we enjoy them and in our secret hearts it is of our faults we are proud. The remedy is simple but we refuse to take it.

> All covet life; yet call it pain:
> All feel the ill, yet shun the cure:
> Can sense this paradox endure?
> Resolve me, Cambray, or Fontaine

* * *

Viscount Leverhulme is, as we all know, a very remarkable man but his Messel Lecture was a revelation to the majority of us. It was far and away the most important and interesting feature of the meeting and it deserves to be read and pondered by a larger circle than the members of the Society of Chemical Industry. It was a bold thing for any man except a philosopher or student of ethics by profession, to address a body of industrial chemists in Liverpool in the year 1924 on the principles of religion as applied to the works and the laboratory. These principles are not the topics to which we are accustomed: scientific people have been too apt to consider a number of religious principles, especially the dogmatic ones, as not so verified by experimental evidence as the chemical and physical truths which they hear or propound in lecture theatres. And here comes a hard-headed manufacturer, hard-headed enough to make what is reputed to be a comfortable fortune in a difficult period of our history, and tells us studious people his views on the faiths which govern religious and scientific people respectively. And he tells us these in an interesting way and proves to us after the first few sentences that he can not only think clearly, but can write clearly, that what he

has to say is sound sense, that he has a conception of some very fundamental truths which have been undetected or forgotten or ignored by us and that it would have been better for this country and perhaps some of the other countries if he had written this address years ago and published it so that its teaching was familiar to us all. His audience was surprised and delighted by the lecture and it will be read with pleasure. Lord Leverhulme told us that sixty years ago or thereabouts when he was a grocer's apprentice in Bolton he attended some evening classes in chemistry and he claimed in his modesty that he was therefore almost worthy to be one of us. He did not explain—perhaps he thought we already knew it—perhaps he thought, whether we knew it or not, the information would come better from someone else—that when he began to make money and to buy pictures, it occurred to him that his workers, the captains, the corporals and the privates in his army, would also like some pictures. Acting on this idea he built himself a picture gallery in Hampstead, filled it with choice examples of the art of Lawrence, Linnell, de Laszlo, David Cox and other masters and built another and a larger gallery in Port Sunlight for the gratification of the public there and filled it with pictures as excellent and more numerous than those he has in his own house. He turned a rather dull and swampy tract of inferior country into a beautiful and happy town and then talks to us and jokes with us as if we were a society of very superior people who had paid him a compliment. If you wish to understand the Messel Memorial lecture properly, go to Port Sunlight and look at the pictures—not to the accompaniment of dance music and with the distractions of a bevy of young daughters of the gods, divinely tall and more divinely fair, but simply to see the pictures and the town, then, as you return in the train to London, or Stoke-on-Trent, or Rotherham, or Wigan, or Airdrie or wherever you happen to live, read the lecture. You will miss Lord Leverhulme's twinkling eyes and nimble mind but you will get to the root of the matter:

But Cristes lore, and his apostles twelve,
He taughte, and first he folwed it him-selve.

* * *

The account which Mr. F. H. Carr gave to us of the manufacture and properties of insulin was delightfully simple and modest. All three papers read at Liverpool were good, dealing not with trivialities but with matters of fundamental importance to mankind—health and disease; the use of volcanic heat as a source of power; the composition and origin of coal; but there was a human interest attaching to Mr. Carr's subject which took us some way out of our wonted selves. We gather that insulin is probably an enzyme but we do not quite know, not having any profound knowledge of organic chemistry, what an enzyme is. An alternative name, preferably Greek, is at least better than bare ignorance. It is like a dress suit for a man which is a sign of respectability and puts him on terms of equality with all others similarly blessed. Ten guineas will raise the outcast to the level of a duke or a cabinet minister. A Greek lexicon is an abomination to the Lord, but to the chemist is a very present help in time of trouble. Can no small token of gratitude be arranged for the latest editor of Liddell and Scott? Well, this enzyme can be extracted from many animal tissues and hopes are held out to us that some day a vegetable source may be available. The body is engaged three or four times a day in converting carbohydrates, such as starch, into sugar and converting the sugar into carbon dioxide and other substances. The normal body keeps only a small proportion of sugar dissolved in the blood, the rest being stored up in other organs and in some other form. The insulin acts as a safety valve, a regulator, or a ferment. The process seems to be similar to the making of bread recently described in our columns. In the diabetic subject the amount of sugar dissolved in the blood instead of keeping to its proper low constant level becomes very large and the whole process is thrown out of gear. The insulin somehow gets rid of the extra quantity of sugar in the blood, what the exact process of doing this is, we are not yet told in detail, but the system gets a fresh start and the cures which have been effected are most surprising and impressive. The labours of Mr. Carr and his co-workers have brought down the cost of insulin to one-tenth of what it was, a triumph of patience and skill, of experience in chemistry and engineering. The paper is printed in this week's *Transactions*. The comparison of the human body to a loaf of bread in an oven was forcibly brought to our notice a few days ago when we walked up and down our domestic quarter-deck in an atmosphere with a temperature reported to be 85 in the shade. Concentration of mind and the transference of mind into matter are difficult in these circumstances and abundantly account for any incoherency in the argument we are venturing to submit. If only the heat is as great when any reader peruses this, we shall be forgiven.

* * *

Chemists will experience a sense of regret on hearing of the approaching retirement of Prof. J. B. Cohen, F.R.S., from the chair of organic chemistry in the University of Leeds. After receiving his early education in chemistry at Owens College, Manchester, and after a period in the works of the Clayton Aniline Co., he was appointed demonstrator in chemistry in Manchester in 1884. In 1890 he became lecturer in organic chemistry in the Yorkshire College, Leeds, and when the chair of organic chemistry was established in the University of Leeds in 1904 he became the first professor, a position which he has held ever since. His work on problems of the constitution of organic compounds, his valuable textbooks and his success as a teacher are familiar to all chemists, and the regret on hearing of his retirement will be tempered by the knowledge that he will probably continue his research work in one of the University laboratories. Prof. Cohen, who is an Original Member of the Society of Chemical Industry, has served as a member of Commissions on smoke abatement and chemical warfare and was a vice president of the Chemical Society in 1920-21.

SOCIETY OF CHEMICAL INDUSTRY

THE ANNUAL GENERAL MEETING,

LIVERPOOL, JULY, 1924

MEETING OF COUNCIL

The monthly meeting of Council was held in the Arts Theatre, The University, Liverpool, on July 9, the President (Dr. E. F. Armstrong, F.R.S.) in the chair.

Letters of thanks had been received from Dr. Ernest Fourneau and Dr. Armand Solvay for conferring on them the Honorary Membership of the Society.

The Honorary Treasurer reported that it was a matter of satisfaction to know that the cost of the *Journal* for the first six months of the year is strictly within the estimate laid down six months ago.

Seven new members were elected—Home, 5; Overseas, 2. Attention was drawn to the loss in membership during the year, and certain suggestions were put forward for bringing in new members. It was decided to discuss the whole question at the October meeting.

A very cordial vote of thanks was given to the retiring President for the excellent work he had done during his period of office.

LIST OF MEMBERS ELECTED,

JULY 9, 1924

Beet, Frederick, 30, Northfield Road, Ponders End, Enfield, Middlesex. Metallurgist.

Freeth, Francis Arthur, Heathercroft, Hartford, Cheshire. Chemist.

Harris, Bert A., 19, Russell Square, London, W.C. 1. Engineer.

James, Frederick O., c/o S. A. des Huileries du Congo Belge, Kinshasa, Belgian Congo. Chemist.

Mittberg, Charles H., 10, rue J. J. Rousseau, Asnieres-Seine (France). Chemical Engineer.

Scott, Percy D., Marley Hill Chemical Co., Marley Hill, Co. Durham. Chemist.

Walthew, Reginald C., c/o Miss Ormrod, Kingsway House, Frodsham, Warrington. Fuels Technologist.

ANNUAL MEETING

The Society of Chemical Industry has held more than forty Annual Meetings; that which was held last week in Liverpool was, in the opinion of all competent judges, the best. There was a large attendance of the well-known members of the Society including the President, Dr. E. F. Armstrong and Mrs. Armstrong, the Hon. Treasurer, Mr. E. V. Evans and Mrs. Evans, the Hon. Foreign Secretary, Sir William Pope, K.B.E., the President Elect, Mr. W. J. U. Woolcock, Sir Max Muspratt, Bart., and Lady Muspratt, Mr. and Mrs. Edwin Thompson, Mr. Emile Mond, Mr. and Mrs. C. S. Garland, Prof. G. T. Morgan, Dr. and Mrs. R. T. Colgate, Mr. and Mrs. A. Trobridge, Dr. and Mrs. J. A. Cranston, Mr. S. F. Burford, Dr. and Mrs. E. B. R. Prideaux, Dr. and Mrs. H. Levinstein, Mr. B. A. Burrell, Mr. and Mrs. J. H. Young, Mr. and Mrs. S. J. Pentecost, Mr. and Mrs. L. G. Radcliffe, Mr. and Mrs. F. H. Carr, Prof. P. P. Bedson, Dr. L. L. Lloyd, Mr. E. Gabriel Jones, Dr. A. Holt, Mr. John Allan, Mr. J. A. Reavell, Prince Ginori Conti, the Viscount Leverhulme, the Hon. W. Hulme Lever, Sir Richard Threlfall, K.B.E., Dr. R. S. Morrell, Mr. and Mrs. C. J. Goodwin, Mr. S. J. Tungay, Mr. H. M. Ridge, Mr. and Mrs. R. B. Brown, Mr. E. F. Hooper, Mr. E. Grant Hooper, Mr. T. H. Butler, Dr. W. Cullen and Miss Cullen, Mr. W. H. Coleman, Mr. C. N. Kemp, Mr. W. G. Wagner, Prof. C. O. Bannister, Mr. J. P. Bowley, Mr. J. Bernard, Prof. E. C. C. Baly, Dr. J. T. Conroy, Dr. and Mrs. A. C. Cumming, Mr. and Mrs. W. A. Davis, Dr. P. Dvorkowitz and Miss Dvorkowitz, Dr. J. V. Eyre, Prof. F. Francis, Prof. and Mrs. I. M. Heilbron, Mr. F. E. Hamer, Dr. R. Lessing, Mr. R. Muspratt, Mr. G. W. Marlow, Mr. W. Macnab, Mr. and Mrs. T. H. Pope, Prof. W. H. and Mrs. Roberts, Mr. H. Wigglesworth and Dr. and Mrs. J. P. Longstaff.

Professor C. J. van Nieuwenburg represented the Dutch Chemical Society, of which he is President. Dr. A. C. Fieldner represented the American Chemical Society. Dr. and Mrs. Adan represented the chemical industry of Belgium.

It is becoming customary for members to bring their wives and daughters and so soon as this is more widely known the practice will spread. Chemists are more frivolous than formerly, they are more human, less learned, better dressed, have prettier wives and sit up later. Possibly this is true of other classes of mankind, but this tendency towards light-heartedness and away from solemnity is a sign of the times. The editorial department of the *Journal* cannot escape the infection or fashion try as it will. The editorial columns of *The Times* and *Morning Post*, of the *Railway Gazette* and the *Investors Chronicle* are not so serious as they were before the War. Confident in their Socialist Governments, Kings attend race-meetings and Princes enjoy Scenic Railways. As we travel through life let us laugh by the way: what is all the world to a man when his wife is a widow? It is true one old, perhaps an original, member, Mr. Grant Hooper, sighed for the earlier, worthier days obviously disliking the originality of some of the Society's journalistic features. But even he was not angry about it: he protested but in so good-natured a fashion that it could almost be supposed that saying he would ne'er consent, he consented. So long as the *Journal*

never delays or refuses a serious piece of real work, and this is a cardinal feature of the Society's practice even now, let the chemists have their badinage. But if badinage be accompanied by spending money faster than it comes in, the jest has a hollow sound. When the columns of this *Journal* become really serious, Mr. Cullen and Mr. Grant Hooper should be very suspicious that financial anxiety worries the Council and black care sits behind the editorial horsemen.

On Tuesday evening the members assembled at the Midland Adelphi Hotel and were received by the President and the Local Committee. No one can say of the President, facetious as he can be, that mere prattle, without practice, is all his chemistry; that may be true of some who masquerade as chemists; but when the President chooses he can be in deadly earnest. Has he not provided a monumental address on the "Chemistry of Fats," and also organised a book "Chemistry in the XXth Century," which might be described as Coke described Littleton's "Tenures"? "the most perfect and absolute work that ever was written in any humane science . . . a work of as absolute perfection in its kind and as free from error as any book that I have known to be written of any humane learning."

The Formal General Meeting was held on Wednesday morning in the Arts Theatre of the University of Liverpool. The proceedings are fully reported in the Society's Transactions and require but little comment. The Honorary Treasurer very kindly complimented the editorial staff on their alacrity in effecting economies when called upon to do so and shown how. Cutting down printing and paper expenses is the sort of economy which delights an editor; enough of it would enable some editors to have a fairly restful time, practise billiards and read Horace. Does not this favourite author say in the "Ars Poetica" that even a very mediocre lawyer, not so eloquent as the President and not so erudite as the previous President, may be nevertheless of some use, *nec tamen in pretio est?* Some of these old classical authors are full of most up-to-date matter.

The visit to the White Star Liner the "Celtic" was very pleasant. How often have chemists in the Atlantic or the Indian Oceans longed for so placid a water as the Mersey! Oh sweet as to the toil-worn man, the far-off sound of rippling river, as to cadets in Hindustan the fleeting remnant of their liver—and so on. Here were all the comforts and the luxuries of a floating palace with none of the disadvantages: the Mersey is a good place in which to practise ocean voyages and a few trial trips in the "Celtic" on its waters would be a good training for many amateur sailors.

In the evening the Lord Mayor received the Society in the Town Hall: dancing and dancers were pursued until midnight; the reflections which such a spectacle induces in a philosophic mind have been already set forth.

The visit to the works of Messrs. Joseph Crosfield and Sons, Ltd., on July 10, was exceptionally well organised. During the lunch the Brass Band of the works played good music and played it well; it is much more agreeable to have good music as an accompaniment to a good lunch than the singular substitute in which the saxophone plays so strident a part. The works itself is an interesting one, well planned and with a variety of processes carried on; the majority of the visitors preferred the perfumery department, the printing, the box-making and the packing departments to the actual soap-boiling. Great pains had been taken to arrange the visitors in small parties, to keep these distinct from each other, to explain to each what was of special interest, and to ensure a steady flow of these parties along the ordained route. A fire-drill display was equally well arranged, the girl guides, boy scouts and firemen carrying out their duties in a manner which denoted frequent practice. Many of the visitors considered this visit the most interesting item in the whole programme but they were hardly in a critical mood, having been allowed a cool room in which to take tea and to rest, and being presented on leaving with soaps, perfumes and brilliantine. A suitable frame of mind is essential to a sound judgment. Did not someone comment on a well-known passage?: "Swap his whole kingdom for a hoss, a hoss, mind you, he hadn't seen, let alone not being in a condition to be a judge of hoss flesh!"

THE ANNUAL BANQUET

The Annual Banquet was held in the Midland Adelphi Hotel, and was quite a brilliant gathering. About three hundred guests were present and were seated at small tables, so that there were good opportunities for conversation. The President announced that in reply to the Society's telegram to the King, His Majesty had been pleased to send the following message

TELEGRAM

From
BUCKINGHAM PALACE
To
THE PRESIDENT, SOCIETY OF CHEMICAL INDUSTRY, UNIVERSITY, LIVERPOOL.

THE KING SINCERELY THANKS THE MEMBERS OF THE SOCIETY OF CHEMICAL INDUSTRY ASSEMBLED AT THEIR ANNUAL MEETING FOR THE LOYAL ASSURANCES CONTAINED IN THEIR MESSAGE WHICH HIS MAJESTY AS PATRON MUCH APPRECIATES.

PRIVATE SECRETARY.

The speeches were facetious rather than of the formal variety. The President proposed "The City of Liverpool and the Liverpool Section of the Society of Chemical Industry." He dealt with the means of getting on in the world, and gave as an instance Lord Leverhulme who was sitting close by. Lord Leverhulme, he said, had kept his mind open for humanity as well as for business and science. He pleaded for a broad outlook on the part of chemists, that they should not be merely chemists with a belief that it was improper for them to have any understanding of anything else. Liverpool was the natural home of the heavy chemical industry. Its facilities for export, its proximity to the brine and salt of Cheshire and to the coal-fields of Lan-

cashire and Yorkshire, together with the exceptional brains of those who had founded or were now carrying on the industry, had combined to place it in a secure position, from which with smiling face they could withstand the competition of the world.

The Lord Mayor of Liverpool, Mr. Arnold Rushton, in reply said they were proud of their city, and when they spoke of it everything was spoken in the superlative; they were proud of their industries, even one industry which they preferred to keep at a safe distance, such as Widnes.

Mr. Edwin Thompson, the chairman of the Liverpool Section and a prominent member of the City Council, also replied to this toast, and paid a pleasant tribute to Mr. Gabriel Jones, the Honorary Secretary, and to others who had helped to make the meeting the success it was.

Mr. W. J. U. Woolcock, the president-elect of the Society, proposed the health of "The President" and briefly dealt with the important services to industrial chemistry rendered by Dr. E F Armstrong during the two years of his presidency.

Dr. Armstrong briefly replied.

After the conclusion of the banquet dancing was begun and continued until midnight. In Liverpool, Presidents, Lord Mayors, Viscounts, and other holders of dignified office appear to enjoy dancing as much as ordinary mortals; their proficiency is strong presumptive evidence of many mis-spent hours.

THE LARDERELLO NATURAL STEAM POWER PLANT

By PRINCE GINORI CONTI

The natural steam springs of Tuscany, containing boric acid, which are more generally known under the name of "soffioni boraciferi," have been often described in geological and chemical treatises.

They are to be found in several spots in the neighbourhood of a large village called Castelnuovo Val di Cecina, which is situated near the southern border of the Province of Pisa, not far from the ancient town of Volterra.

These springs are evidently the remnants of the very remote volcanic activity which contributed to the formation of the hilly range running roughly parallel to the Tuscan coast and which is named "Catena Metallifera" from the presence of metallic ores (copper, iron, zinc, lead and antimony). The mountainous system of the island of Elba is probably connected with it, and traces of thermal activity can also be found at some distance from the actual region of the "soffioni," such as hot springs in the neighbourhood of Massa Marittima and sulphurous vents called locally "Putizze."

The territory of the soffioni covers roughly an extension of about 225 square kilometres, and the groups of soffioni, which are situated within it, are those of Larderello, Castelnuovo, Sasso, Monterotondo, Lago, Lustignano and Serrazzano; another group, Travale (of minor importance) lies several kilometres to the east, towards Siena.

Larderello, the better known of these groups of soffioni, was so called after the founder of the Tuscan boracic industry, Francesco De Larderel, who, in 1818, started manufacturing boric acid (the presence of which had been ascertained since 1790 in the waters issuing from the soil together with the natural steam, and subsequently in waters resulting from the condensation of the same steam) by concentrating these boric solutions by means of natural heat, thus genially utilising the steam of the soffioni.

For this purpose, it was necessary to provide sufficient quantities of steam and since the initial

Prince Ginori Conti

period of the works, special wells were bored in the volcanic soil.

It is needless here to mention the various stages of development of the chemical industry of the Larderello Works; details can be found in various publications, pamphlets and scientific journals, from the pen of distinguished scientists of all countries who visited and described this singular phenomenon. Suffice it to say, that, whereas the purely geological and chemical side of the question was amply studied, the other and equally interesting question, viz., the feasibility of utilising natural steam as a means of generating mechanical and electrical power, was ignored till the beginning of 1904, when as general manager of the Larderello Works I first attempted the use of natural steam with a small engine of a few h.p. The problem was a fascinating one and contained several incognita.

The presence, in the soffioni steam, of considerable volumes of gases (carbon dioxide, sulphuretted hydrogen and others, amongst which helium) was evidently the first of these incognitæ, especially with regard to action on metals.

The results, however, were quite satisfactory, and a further experiment was carried out in 1905 with a larger engine of about 20 h.p., driving a dynamo for the illumination of the works. This engine has worked, practically without interruptions, for over ten years without the slightest inconvenience.

New wells were drilled and systematic studies were carried out regarding the measures of output in steam, constancy of temperature and pressure, etc.

In 1912 I was elected chairman of the Società Boracifera di Larderello, a limited company resulting from the incorporation of two other minor concerns with the Larderel Company, and decided to attempt a larger experiment with a 250 k.w. steam turbo-alternator, and finally, in 1914, the erection of the Larderello Power Station was begun. This plant is actually composed of three turbo-alternators of 2500 k.w. net power each, two of which are running, the third being held in reserve.

The direct use of natural steam with turbines was not then feasible, because the available pressure from the wells was very low and therefore the efficiency of the turbines depended entirely on the vacuum in the condenser, and an enormous dissipation of energy would have been inevitable in order to remove the gas contained in the steam.

It was therefore necessary to use natural steam as a means of producing pure steam for feeding the turbines. Special evaporators were consequently installed, similar in principle to water tube boilers. This evidently stood for complication of plant and loss of efficiency, and experiments were immediately pursued with the object of eliminating gas from natural steam. Signor Bringhenti, one of the company's engineers, very genially solved the problem by means of an extremely simple apparatus which, better than a boiler or an evaporator, can be styled as a deparator. The steam issuing from this apparatus contains only a very slight portion of the original quantity of gas, and can therefore be used for feeding the turbines. The advantages of this apparatus are numerous and the principal one is the total abolition of tubes, which were a source of disturbance and of considerable expense. These tubes could not be made of iron or steel, because the H_2S contained in the steam by which they were externally heated, soon formed a coating of sulphide of iron which greatly diminished the coefficient of conductivity. It was imperative to use a suitable metal, and aluminium was tried with tolerably good results, but it will be readily understood that corrosion could not be entirely avoided, while the mechanical properties of aluminium did not prove to be entirely satisfactory. Leakages consequently occurred, allowing natural steam with gas to enter the tubes, thus altering substantially the working conditions of the turbines.

As noted above, up to a short time ago, practically all the wells drilled at Larderello gave steam at very low pressure. In fact the available pressure corresponding to maximum output was barely 2 atm. abs. The pure, or "secondary" steam generated by the evaporators has a pressure of 1·5 atm. abs. and the working pressure of the turbines is only 1·25 atm. abs. The turbines are therefore low-pressure types, similar to exhaust turbines, and depend mainly on condenser vacuum. This explains the importance of having to deal with limited and constant quantities of gas in the condenser itself, the air pumps being proportioned to certain percentages of gas, the varying of which alters very materially the output of the turbines.

The condensers were originally of the surface type, but they have been since modified as jet condensers in order to obviate the necessity of tubes. Cooling water is provided by means of 3 large refrigerating towers.

No distinctive features are to be noted in the turbines, which are of the reaction double flow type, and are running at 3000 r.p.m. They are coupled to 3-phase alternators, generating current at 50 periods and 4000 volts. The electrical plant is entirely normal, and the only noticeable item is the extensive use of aluminium for bus bars, etc., in order to avoid, as much as possible, trouble with sulphuretted hydrogen in presence of copper.

The weak boric solutions which are the result of the condensation of the natural steam in the evaporators, are subsequently used for making boric acid. Thus, about 500 kilos of boric acid are obtained daily from the Larderello power plant.

The current generated by the turbo-alternators is elevated to the different voltages required. These are: 16,000 volts for lines conveying power to the neighbouring villages, to the town of Volterra, and to the different works of the company (which are 8 in number, including Larderello, and have all electric power, excepting the small and distant works of Travale), and 33,000 to 39,000 volts for main lines joining Larderello to the large systems of the power companies for Central Italy. Larderello is generally working in parallel with the hydraulic power stations near Terni (in Umbria, not far from Rome), and they are all occasionally in parallel with the Northern Italian lines belonging to the Adamello plant (on the Alps above Brescia).

At the Lago works, another small power station has been erected. It contains the first 250 k.w. unit formerly at Larderello, and has been extensively used for experimental purposes.

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Since the erection of the plant which has been summarily described in the preceding paragraphs, several new wells have been drilled by the Società Boracifera, using more powerful machinery which has allowed greater diameters and greater depths to be reached. The results have surpassed all expectations. At Castelnuovo and at Serrazzano (two of the works where it was not considered that very high outputs in steam would be obtained) two very remarkable wells have been drilled. The Serrazzano well gives about 24,000 kilos of steam per hour at maximum output and fully open, at a pressure of 2 atm. abs., but the output does not

fall so rapidly as in the generality of the former wells when the valve is partially closed and the pressure rises, so that about 13,000 kilos per hour have been measured at a pressure of 5 atm. eff. At Castelnuovo an extremely powerful well gives 60,000 kilos of steam per hour at 2 atm. abs., but again the output does not fall rapidly when higher pressures are obtained. At Larderello a new well gives 35,000 kilos per hour: the mean output of the former largest wells being about 25,000 kilos.

A more complete idea of the importance of the phenomenon will be obtained by considering that in Larderello alone actually over 150,000 kilos of steam are emitted per hour.

It is hardly necessary to emphasise the importance of these results. The possibility of having very considerable quantities of steam at higher pressures than those available with the actual plant opens quite a new outlook on the problem, and the necessary studies and experiments are being carried out to determine the most efficient manner of utilising these very considerable sources of power.

Another experimental turbine has been installed at Serrazzano. It exhausts direct into the atmosphere and is fed with natural steam. The exhaust steam is utilised for heating concentrating apparatus for boric solutions. Thus all complications arising from evaporators and condensers are abolished and the ideal simplicity of this plant amply compensates for higher steam consumption.

It is proposed to follow up the very satisfactory results obtained by this little plant by installing units of appropriate power fed with natural steam at about 2 atm. eff. with exhaust into atmosphere.

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Several conjectures have been made as to the origin of the "soffioni" and also as to the presence of boric acid in the steam, but the various theories proposed have only, as yet, the value of hypothesis.

The phenomenon is obviously due to latent, or better, to nearly extinct volcanic activity and it is quite reasonable to suppose that the various spots of the soffioni region are linked to a main centre of activity.

Geological differences between the soil of these various spots can account for slight variations in the composition of the steam, such as greater or smaller percentage in gas, but the data are as yet incomplete and it can only be hoped that the systematic studies which are being pursued will enable us to obtain more complete knowledge of this fascinating problem.

It is hardly necessary to explain the importance of the Larderello plant as an entirely novel method of obtaining power which has been very appropriately called "Geothermal."

Sources of natural steam are quite abundant in various parts of the world where volcanic activity has been at work.

In the Italian Peninsula itself, the "Solfatara" of Pozzuoli, near Naples and the regions round Etna, as well as the islands of Stromboli and Vulcano, are being studied from this point of view.

A very wide field of research is America. In Alaska, the "Valley of Ten Thousand Smokes" has been very completely explored by the geologists of the U.S. Government. The phenomena are not very different from those of Tuscany, but the volcanic region is far greater in size. In California experiments are being made, and very fair amounts of steam have been obtained.

In South America (Chile and Bolivia), near the now extinct volcano "Tatio," steam springs of remarkable importance have been found. The ones on the Chilean side have been studied, with a view to erecting a power plant, by one of the engineers of the Larderello Company.

Japan is another land where natural steam springs abound. Several enquiries have been made by Japanese engineers and scientists as to the methods followed at Larderello and considerable interest has been shown regarding my work.

Finally, New Zealand can be quoted. The Rotorua region is certainly very rich in natural steam and very interesting results could be obtained from the study of that neighbourhood.

PLEA FOR CHEMICAL GRADUATES

Professor G. T. Morgan, F.R.S., head of the Chemical Department of the University of Birmingham, in a letter to the Birmingham newspapers (in which he refers to the degree lists recently published), makes an appeal to manufacturers on behalf of chemical graduates. He observes: "Apart from recommendations to many teaching appointments, I have, during the last four years, assisted in placing some seventy chemical graduates in industrial posts. The geographical distribution of these positions is, however, curious and intriguing. In the majority of cases these appointments are outside the Birmingham area. A chemical graduate, like the prophet of old, is not without honour save in his own country. Yet it seems to me that many local industries, being largely based on chemical principles, would profit from the co-operation of fresh young minds chemically trained, and many of them sharpened by research experience. My experience gained in other districts is that a well trained young chemist will earn his salary (which is usually not princely at the outset) plus a reasonable profit for his employer.

"From time to time I am requested to give expert advice to local manufacturers wishing to make a new chemical product or to improve an existing process, but owing to the pressure of multifarious duties I have but little time and energy left to devote to such problems. To these enquirers I would suggest a better and more efficacious way—namely, to enlist the whole-time services of a chemical graduate, to give him reasonable facilities for working out the problem, and not to be too disappointed at the slow rate of progress during the first year. The astute directors of one London firm of world-wide reputation have found that a chemical research laboratory staffed almost exclusively with Birmingham graduates saves them annually many thousands of pounds in their contracts for raw materials. Obviously a similar plea could be made out in regard to the utilisation of students trained in other branches of learning."

THE WORLD POWER CONFERENCE AT WEMBLEY

The Second Week's Papers

(From our Special Correspondent)

The second week's papers comprise the sections devoted to power transmission and distribution, including power-station transmission lines, cables, and high voltage D.C. transmission; gas and fuel sections; internal-combustion engines; power in industry; power for road and air transport; research; the domestic uses of power, and also agricultural applications, electro-chemistry; industrial welfare; power for rail transport; electro-metallurgy; publicity, power for water transport; technical and commercial education; standardisation, and various general meetings from the point of view of the future possibilities of making the World Power Conference a permanent institution.

As before, it is impossible to attempt to give any summary of these multitudinous papers, and still more so of the discussion, so one can only pick out a few subjects which are of more particular interest to the technical chemist and chemical engineer.

Lately, we have heard much of super-power station schemes, and apparently we are now going to hear much more with the publication of two "Government" Reports, one of which, "Coal and Power," has appeared. The world seems fated to erect larger and larger electricity stations, and we are well within sight in America of the 500,000 k.w. installation, of which it is difficult to give any idea of the magnitude. Thus, to supply the cooling water would require a river about twice as big as any in the United Kingdom, so that the trend of super-power station sites would seem to be necessarily towards the sea. In the super-power station, about which opinions greatly differ, one of the chief problems is the transmission of the power, since the tendency is to concentrate production in a few areas. Mr. C. H. Mertz's paper, "Transmission and Distribution of Electrical Energy," is thus very interesting to power users. He states that, roughly, the capital cost of the transmission and distribution of electricity over a considerable area is about the same as the capital cost of the station itself, and apart from fuel, the working costs of the two are also about equal. Mr. Mertz is of the opinion that in the future it may be possible to use single core underground cables at no less than 132,000 volts, although this is not feasible at present. Further, he thinks that various distributing net-works should be inter-connected, in spite of the increased complexity and risks of faults. It is interesting to note, also, that switchgear to-day bears too high a proportion of the capital cost of the station, and that considerable economy in this direction remains to be effected. Altogether this section on the transmission of electrical energy seems to be one of the main items at the Conference.

From the point of view of the technical chemist, certainly the most important section in the second week was that relating to gas and fuel, together with the allied subject of low-temperature carbonisation, which seems to have strayed over from last week, along with pulverised fuel and various other subjects, at any rate as far as the discussion was concerned. Low-temperature carbonisation has received extremely scant attention at the Conference, there being only one paper, by Dr. C. H. Lander, of the Fuel Research Board, although it is also referred to in another paper by Sir George Beilby. It is unfortunate that papers have not been read by some of the many people who have had almost lifelong experience of large scale low-temperature carbonisation. In the discussion considerable attention was given to one of the most interesting of all processes, that is the "Caracristi," which is now about to be operated by the Ford Motor Co. It is well-known that at Detroit the Ford Company has probably one of the most remarkable boiler plants in the world, burning pulverised raw coal and blast furnace gas on enormous boilers, a second section of which – at a cost of about 6 million dollars—is just to be started up. It is the intention of this company to adopt the scientific method of burning in a pulverised condition low-temperature fuel after the more valuable paraffinoid liquid products have been separated, thus at the same time obtaining a large supply of motor fuel. Whether a practical success will be achieved remains to be seen, but certainly the Ford Company has an uncanny knack of carrying through what it sets out to accomplish.

It is interesting to note, with regard to Sir George Beilby's paper, in which he describes some work that has been undertaken by the Fuel Research Board on carbonising roughly-crushed coal in shallow trays, that this principle seems to have been first used about the year 1860. The real pioneer of this method of carbonisation is R. S. Richards of the "Richards-Pringle" process, who realised that in order to carbonise coal in this way it is necessary to divide it up into narrow segments by means of metal divisions, so as to increase the heat transmission to the heart of the layer.

Incidentally it is much to be regretted that one of the scientific pioneers of low-temperature carbonisation, Prof. S. W. Parr, of Pittsburg, who originated many of the modern principles, such as for example coal-blending, the preparation of briquettes direct from a semi-viscous charge of heated coal, and the carbonisation of briquettes in general, could not have been present or contributed a paper.

The whole question of the science of coal carbonisation, whether by high or low temperature methods, seems to be in a state of flux, and not the least interesting feature is the fact that metallurgical coke itself is now being threatened, as was pointed out in the discussion, from two sources. The first is the low-temperature reduction of iron ores by means of pulverised raw coal, which would eliminate blast-furnace metallurgical coke altogether, and, secondly, there is the preparation of fuel by the carbonisation of briquettes, resulting not only in paraffinoid liquid products, but at the same time a material which is harder than metallurgical coke and is also much more chemically re-active.

With regard to the gas industry, Dr. J. S. G. Thomas and D. Chandler read a paper on the advan-

tages of illumination by gas, which seems to go over very well-covered ground in most respects. It seems, however, to be quite a new idea that the blackening of ceilings is not due to defects in gas lighting, but is really now one of its greatest advantages, since, to use Dr. Thomas' own words: "The flame of gas lighting burners effectively destroys the myriads of potentially harmful micro-organisms present in the air of living rooms . . . The flame is their crematorium, and their charred remains are found on the ceiling above the flames." One looks forward with considerable interest as to what our friends, the electrical people, will have to say on the matter.

The general impression gathered from reading somewhat hastily the various papers under these sections, and listening to the discussions, is that the gas industry is, very wisely, strongly opposed to any further Government control, and that the question of some proper scientific system of co-ordination in dealing with coal supplies is obviously required. Dr. E. W. Smith had a paper on this question, and the subject was also dealt with in varying degree by several other speakers. Dr. Lessing and Mr. Sinnatt, for example, discussed the question of conveying about the country millions of tons of ash, which ought to be washed out of the coal, whilst the importance of moisture is also not generally realised. It is certainly a curious, not to say uncomfortable, fact that very nearly 200,000,000 tons of coal is purchased every year in Great Britain without the slightest guarantee as to its quality, especially as regards the heating value and the percentage of ash and water. There is no real reason why coal should not be sold in most cases, especially to large consumers, on a sliding-scale basis depending on the heating value, and whilst naturally there are many complications in this connexion the general principle would be infinitely more satisfactory than at present. It is common knowledge, as compared with pre-war days, that coal has deteriorated in quality, so that gas works and electricity stations, for example, are particularly badly hit, since coal is by far their largest item of expenditure.

In general, the World Power Conference can certainly be written down as a success, although there are many points that afford material for criticisms. It is unfortunate that the discussions have played such an extremely small part in the proceedings, and many of the most famous engineers in the world, who have congregated together practically for the first time, have been limited to a scanty five minutes, which seems hardly adequate. Also, serious confusion appears to have arisen with regard to the length of the papers.

We can only recommend, as previously stated, that everyone interested should send to the World Power Conference, 36-8 Kingsway, W.C. 2, for a complete schedule of the 417 papers, the price of each reprint being clearly marked.

Prof. H. Precht, who was closely connected with the development of the German potash industry, has died, aged 72 years.

FORTHCOMING EVENTS

Sept. 4 and 5. IRON AND STEEL INSTITUTE, Autumn Meeting at British Empire Exhibition, at 10.30 a.m. each day. (1) "Changes of Volume of Steels During Heat Treatment," by L. Aitchison and G. R. Woodvine. (2) "Investigations on the Herbert Pendulum Hardness Tester," by C. Benedicks and V. Christiansen. (3) "Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on some Magnetic Properties of Steel," by E. D. Campbell and G. W. Whitney. (4) "Pickling: The Action of Acid on Iron and Steel, and the Diffusion of Hydrogen Through the Metal," by C. A. Edwards. (5) "Examination of Iron from Konarak," by J. N. Friend and W. E. Thorneycroft. (6) "On the Nature of High-Speed Steel," by M. A. Grossman and E. C. Bain. (7) "Improvements in the Brinell Test on Hardened Steel, including a New Method for Producing Hard Steel Balls," by A. Hultgren. (8) "Present Position of the Theories of the Hardening of Steel," by W. Rosenhain. (9) "Effect of Free Surfaces on the Plastic Deformation of Certain Metals," by F. C. Thompson and W. E. W. Millington.

Sept. 8 to 11. INSTITUTE OF METALS. Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at the British Empire Exhibition. On September 10 further papers will be presented for discussion, the afternoon being devoted to visits to works. A reception will be held in the evening at the National Physical Laboratory, Teddington. A detailed programme will be issued in August.

Sept. 15. BRITISH EMPIRE EXHIBITION. Conferences of Engineering Societies, to be held in Conference Hall No. 1, at 10.30 a.m. Short papers on various Engineering Subjects will be read and discussed. Further information and tickets may be obtained from the Secretary, Society of Engineers, 17, Victoria Street, Westminster, S.W. 1.

BRITISH RESEARCH ASSOCIATION FOR THE WOOLLEN AND WORSTED INDUSTRIES

Particulars have been issued of research fellowships and advanced scholarships awarded by the above Association. The Fellowships are of the annual value of £200, and are granted for one year, but may be renewed for a second year. The advanced scholarships will cover fees and adequate maintenance and are intended to enable students to specialise. No limitation is placed on the kind of work to be undertaken, and the scholarships are open to all suitable persons. Applications must be sent to the Secretary of the Association, Torridon, Headingley, Leeds, before July 31. Applicants for fellowships should give particulars of training, qualification; the suggested investigation and the place where it is proposed to carry it out.

THE KELVIN CENTENARY

The centenary of the birth of Lord Kelvin was celebrated on July 10 at the Institution of Civil Engineers in presence of a distinguished audience. In presenting the Kelvin Medal to Prof. Elihu Thomson, Sir Charles Morgan said the medal was founded in 1914 to be awarded triennially as a mark of distinction for work of the kinds with which Lord Kelvin was particularly identified. In reply, Prof. Thomson said it was very gratifying that the medal testified to a broad appreciation of scientific effort and of engineering efforts of which his own career was accepted merely as an example, but he regarded it as a tribute to the labours of his fellows in America and elsewhere. Lord Kelvin was an example of what a man great in science and engineering should be: thought and work unceasing. He was lovable as a man, unequalled as a scientific exponent; and our earliest and greatest electrical engineer. Sir J. J. Thomson, F.R.S., then delivered the Kelvin Oration, in which he pointed out how much British science owed to Lord Kelvin, who had made vast additions to our knowledge and left an example of unremitting devotion to a great ideal.

The Kelvin Centenary Dinner was held on July 11, in the Connaught Rooms. Lord Balfour (who presided), in giving the toast "in memoriam Kelvin, 1824-1924," said that Kelvin instinctively applied knowledge derived from the pure study of natural law to the needs of mankind. He was not merely a man of science, but also a great inventor. The future would look back to him as the founder of that sure knowledge of the fabric of the world on which must be based most of our hopes for the material advance of humanity.

ACADÉMIE DES SCIENCES

On July 7 Prof. Le Chatelier communicated several papers. In one, Monsieur Lebeau described his investigations on the gas produced on heating graphite. The second, by M. Lemarchand, dealt with equilibria in saline solutions; in the third, M. Jolibois discussed the action of tetra-ethyl lead in internal-combustion engines; and in the last paper M. Chassevent examined the question of the heat of solution in setting plaster. Prof. Perrin communicated a paper by M. Job on the decomposition of ethyl iodide by light. Prof. Lindet discussed a paper by M. Brioux on the influence of spraying dilute sulphuric acid on weeds and on the soil. M. Guignard stated that according to some work by M. Goris, three glucosides existed in fermenting green vanilla, and that one of these glucosides was the cause of the aroma of vanilla, an aroma not possessed by synthetic vanillin. Describing work by MM. V. and R. Sartory, M. Guignard stated that bichromate of copper was twice as strong an antiseptic as potassium bichromate in treating the potato disease due to *Phytophthora infestans*. M. Delandre stated that M. Végard at the Cryogenic laboratory at Leyden had shown that the aurora borealis was due to cathode rays acting on liquid nitrogen.

CORRESPONDENCE

THE ACTION OF LIGHT ON CONDENSED MILK

Sir,—In the examination of sweetened condensed milk I have recently noted that light has a very pronounced effect upon the colour of the material. Condensed milk left exposed to ordinary daylight in transparent glass vessels for two hours only, showed a darkening on the surface towards the light, whilst the portion lying away from the light remained practically unchanged. Similar samples kept in the dark remained unchanged.

In my opinion this phenomenon explains to some extent the "dead" or brownish appearance noted in many samples of freshly manufactured sweetened condensed milk which are otherwise quite satisfactory; the light probably causes the change while the product is undergoing cooling in open mixer-cylinders. This suggestion is borne out by the observation that the material, when cooled in the dark (as it is in some cases) is superior in appearance.—Yours faithfully, STEPHEN B. BOWYER

Edward Sharp & Sons, Ltd.,
Maidstone.
July 11, 1924

THE ENGLISH LANGUAGE

Sir,—I have read with interest the communication from Mr. A. W. Allen in the issue of May 23, also the editorial remarks thereon, and I should like to reply to the important points raised.

In like manner to Mr. Allen I hold no brief for any particular British book, as I consider that every book, British or American, has to stand or fall on its own merits. There are two reasons why I thought it desirable to draw attention to Dr. Abbott's "How to Write Clearly." The first is that it is a book of only seventy-eight pages, giving valuable information in the form of rules, each followed by examples showing both their use and the effect of their neglect. Numerous exercises follow, each with reference numbers to the rules that should be applied. Bearing in mind that many chemists and engineers are extremely busy men, it seems to me that a concise book such as this is the very thing for them. Secondly, being an old pupil of Dr. Abbott, it is a pleasure to draw the attention of readers of this *Journal* to one of the smaller works of an eminent scholar who was Senior Classic of his year at Cambridge and the winner of many University prizes.

Next, I must entirely dissociate myself from any "peevish antagonism" to transatlantic writers on any subject. The Americans are well-known, for example, as Dictionary makers. Up to a point I swore by Ogilvie's "Imperial Dictionary," but when I saw Funk and Wagnalls' "Standard Dictionary" I bought it at once, and when their "New Standard Dictionary" was announced I sent an order to their London office for a copy as soon as ready. The up-to-date information that this work contains is simply surprising, and scarcely a week passes without my consulting it. In addition to this chemical works by Wiley, Leach, Sadtler, Prescott, Leffmann and many others are on my

book shelves and in frequent use. According to my experience American chemists are held in high esteem on this side.

To return to Mr. Allen's criticisms, " some dozen " means about a dozen, say eleven or fourteen, the word " some " not being here used in the colloquial sense of big in number or size (*e g*, Wembley is *some* Exhibition). Mr. Allen's statement that, " we are realising the economic value of condensation and the beauty of simplicity to an extent that was not recognised when Dr Abbott's book was first published," is entirely wide of the mark, as rules aiming at conciseness, clearness and force in expression form the very foundation of Dr. Abbott's book In proof of this let me quote the author's third rule: " Avoid useless circumlocution and ' fine writing.' "

I used the abbreviation " etc " simply to save space in our *Journal* by avoiding repetition of an extract previously given in full. I was merely having a sly dig at present-day Members of Parliament and others.

In conclusion, let me express the hope that the discussion that originated in an editorial paragraph in our *Journal* for last December may bear fruit in a more clear, concise and effective use of our English language by chemists and engineers, both American and English. - I am, Sir, etc ,

A. E JOHNSON

24, Parkdale Wolverhampton
July 12, 1924

Sir,— In your May 30 issue appear two letters that invite comment. One is from Pedant, whose method of signature suggests the nobility, but whose appellation is not in Whitaker. The writer infers and modestly attempts to prove that he is a purist ; and one would therefore expect to find that a pseudonym, if used, would be placed between what he terms inverted commas- a designation that a real purist would avoid, by the way, because of obvious inapplicability and inaccuracy. Pedant, therefore, as a " splitter of hairs," is as inconsistent as the majority. To reply to his criticisms, however Etc. is an abbreviation to be found in standard English Dictionaries. In spite of correction, I still believe that its use is common and accepted as " good English " , the quotation marks were added purposely to prevent a literal interpretation of the last two words in the sentence. Moreover, I see no inaccuracy in the direct statement as to " The use of etc . . . ' Pedant suggests that the sentence in which these words were used was meaningless to him, to which I would reply that my letter was not written as evidence of an ability to satisfy self-styled purists and local interpreters of the niceties of composition in all the English-speaking countries. My mistake was one of omission : I should have mentioned that the abbreviation is sometimes permissible, to prevent needless repetition. Thus, in a recent discussion, the title of a paper on electrochemical work in Chile was referred to as " the Electrolytic Tank House, etc ," to emphasize the words to which attention needed to be drawn, without repeating what was well known to every reader. Its use at the end of letters to your *Journal* may be justified on similar grounds.

Mr. Hugh F. K. Picard's letter is of the red-herring order. He has discovered and wishes it to be known that the author of " Technical Writing," published in the United States, was born of English parents, and that he received a technical education in London. He might have added that Mr Rickard first saw the light in Italy, and acquired his earliest literary impressions from a German nurse and a Russian tutor, speaking the language of both before he spoke English. But what has this to do with Mr Johnson's original inference that any effort originating in the United States to help writers and to simplify technical composition should be considered presumptuous and a work of supererogation ?

I repeat, I hold no brief for any particular publication on technical or scientific composition. I differ from Mr. Rickard in regard to several of his contentions, and I am not in entire agreement with Sir Clifford Allbutt ; but I believe that the good resulting from the study of any book of the character under discussion, whether written in England or in the United States, greatly outweighs the harm that might possibly be done by an occasional overstressing of the personal viewpoint, inevitable in so controversial a subject, and by a commission of minor errors that indicates the fallibility of humans, including the best writers and the most experienced literary critics Mistakes must be admitted by all except the dead, those " out of the running " and the few who evade personal responsibility by the adoption of a pseudonym.

Professors are not all-wise ; parents are not perfect ; preachers are not invariably free from frailty in moral matters ; nevertheless, the consequences of fallibility among the members of each group are considered insufficient to justify a suspension of all educational or corrective action. But when an effort is made to help the scientist to become articulate and intelligible to ordinary mortals, to lead the technician to appreciate the economy and force of brevity and clarity in the use of the English language, a scramble occurs among purists and " hair splitters " as to who can be the first to demonstrate once again what editors and experienced writers are fully aware the imperfections of missionary effort and the vulnerableness of critics. The pity is that such action discourages initiative and fosters self-satisfaction among slovenly writers. I am, Sir, &c

A. W. ALLEN

Berkeley, California

THE WASTE OF COAL

Sir,- With regard to the statement made in a recent issue (July 11 1924) of *The Times* by Mr Evan Williams, of the Mining Association of Great Britain, extracts from which have been reproduced broadcast in the press, will you allow me to correct one extremely misleading impression given by this statement. We are informed that the colliery proprietor is not responsible for waste of coal after it has been brought to the surface. The fact is that he is wasting about 6,000,000 tons of saleable coal per annum on his own boilers at the pit head. Of the 260,000,000 tons raised in Great

Britain per annum, $6\frac{3}{4}$ per cent. that is 17,500,000 tons, is used by the collieries themselves to provide the necessary power to work the pit. I have shown that the efficiency of colliery steam boiler plants is $55\frac{1}{2}$ per cent., and this could be raised to 70 per cent. by adopting scientific methods, that is, 3,625,000 tons of saleable coal is being wasted every year. But also a further 2,500,000 tons of saleable coal could be saved per annum if the collieries would burn on efficient lines some of their own refuse fuels now thrown away, and the total amount to be saved every year is therefore over 6,000,000 tons. I do not mean to infer that the colliery industry is much worse than any other, and I have shown Great Britain is wasting 20,000,000 tons of coal every year on stationary land boiler plants alone; but do let us have the elementary facts right I am, Sir, etc., DAVID BROWNLIE

Ealing, London
July 14, 1924

PERSONAL AND OTHER ITEMS

Dr. F. A. Freeth has been awarded the degree of D.Sc., of the University of Liverpool.

The late Mr. A. T. Hawes, J.P., a director of Brunner, Mond and Co., Ltd., and of the Castner-Kellner Alkali Co., Ltd., left estate of the gross value of £91,724, with net personalty £85,662.

Prof. J. S. S. Brame has been appointed Honorary Adviser to the Home Office and to the Board of Trade on petroleum questions. These posts were formerly held by the late Sir Boverton Redwood.

Brigadier-General Hon. F. C. Stanley, C.M.G., has resigned the chairmanship of the Associated Portland Cement Manufacturers, Ltd., the British Portland Cement Manufacturers, Ltd., and their allied companies.

The Italian Industrial Delegation now in London includes representatives of the paper making, artificial silk, textile, brass-founding, and hydro-electric industries.

Rockefeller Medical Fellowships have been awarded to, *inter alia*, R. K. Cannan, M.Sc., senior assistant in biochemistry, University College, London, and W. Robson, B.Sc., chemical assistant in the Therapeutics Department, University of Edinburgh.

Professor Sir Wm. J. Pope has been elected a foreign member of the Reale Accademia Nazionale dei Lincei of Rome in the Section of Physics and Chemistry and their Applications.

The King of the Belgians has appointed Dr. L. H. Baekeland, president of the American Chemical Society and the originator of bakelite, as commander of the Order of Leopold.

Amongst those who have been appointed to the Superior Committee of Commerce and Industry in France are the following, who are well-known in the chemical industry:—MM. Duchemin, Coignet, Donat, Agache, Aubrun, Bienaimé, Cavallier, de Peyerimhoff, Pinot, H. de Wendel.

In the will of the late Miss Marie Corelli, the novelist, directions are given for the formation of a perpetual trust to control and use her estate at Stratford-upon-Avon "for the benefit of distinguished persons visiting Stratford-upon-Avon from far countries . . . and as a meeting-place, as and when required by the President of the Royal Institution of Great Britain for the annual or provincial gatherings of scientists connected with that Institution."

The Annual Prize of the Société des Ingénieurs Civils de France has been awarded to Monsieur Clansel de Goussergnes, for his papers on the manufacture of electric iron and steel. Other awards include the Nozzo prize to Monsieur G. Claude for his paper on the synthesis of ammonia, and the Robin prize to MM. Chevenard and Poitevin, for their investigations on methods of research and control in metallurgy, and on light and ultra-light alloys.

Awards of research fellowships tenable at the Imperial College of Science and Technology during 1924–25 include the following names:—Gas Light and Coke Company's Research Fellowship of £200 (renewal) to F. R. Weston, A.R.C.S., for a continuation of his spectroscopic research on the flames of carbon monoxide and hydrogen and matters cognate thereto; Beit Research Fellowship. . Dr. W. E. Downey for research on photo-c.. problems, and to R. Quarendon, A.R.C.S., B.Sc work on the combustion of gases in nitrous oxide.

It is announced that the Woodrow Wilson Memorial fund, which is expected to reach $2,500,000, will be used to found a college in Georgia, in which the subjects taught will be those that interested the late President, *e.g.*, history, social and political economy. The humanities will be given an important position, but science will be taught, not with a view to make scientists, but as a part of the necessary equipment of educated persons and with particular regard to its history.

Mining Notes from Canada

The British Empire Steel Corporation has closed contracts for the delivery, during the year, of a further 300,000 tons of Wabana iron ore to iron masters in Germany and 110,000 with English firms. The present annual output is 700,000 tons.

The recently discovered bed of arsenical ore at Wellington, Yarmouth, Nova Scotia is being opened up. Analysis of some of the larger leads give 43·7 per cent. of metallic arsenic.

The United States Gypsum Co., of Chicago, is increasing operations at its quarry at Wentworth, Nova Scotia. This material will be shipped direct to Atlantic ports in U.S.A., replacing gypsum supplied from the interior of New York State.

Large seams of copper have been disco' New Rouyn district, of Northern Ontario, in proximity to railway transportation.

The Britannia mine, British Columbia, is operating again, shipping copper concentrates amounting to 200 t. per diem, with approximately 21·5 per cent. copper content.

REVIEWS

(1) Pulverised and Colloidal Fuel. By J. T. Dunn. Pp. 197. London: Ernest Benn Ltd., 1924. 25s. nett.

(2) The Utilisation of Low-Grade and Waste Fuel. By W. F. Goodrich. Pp. xix+368. London: Ernest Benn Ltd., 1924. 42s. nett.

(1) The matter contained in this book will not be new to those who have studied the literature of the subject which has emanated from America during recent years, but a very useful purpose is served by bringing together a judicious selection of matter within the covers of one volume. The author is to be congratulated upon the way in which he has done this, for his book might well serve as a model for any similar treatise upon a specialised technical subject.

The methods of grinding material such as coal to a particular degree of fineness at a minimum cost are of interest to technicians in a number of fields and these are described in some detail, but we are left with the impression that little is known as to how the design of plant should be altered to give a odu of different fineness. The author's statement, p. 65, that "the choice of a mill . . . may depend upon the required fineness," and that "if burners should be devised . . . to burn coarser material satisfactorily . . . one (mill) less efficient than another in producing extremely fine material might be more efficient or more economical in producing coarser stuff," does not lead us very far. Future developments in fuel technology will compel engineers to study this question more closely.

Fears have been expressed that the widespread adoption of pulverised fuel firing would lead to the ation of a nuisance by the deposition of dust. is interesting to note, therefore, the author's sonal experience that the dust is dispersed over ch a wide area that no trace of it can be found in the district immediately surrounding the installation. The further development of the processes described both in connexion with the combustion of low-grade solid fuels and in conjunction with the combustion of gas will be followed with very great interest.

(2) This book is characterised throughout by considered statements of the fuel situation which are calculated to counteract the influence of much loose thinking. In his enthusiasm for the utilisation of waste the author does not omit to show quite clearly the limitations of the quantities of waste fuel available. We do need to be reminded, at times, that the English peat deposits, for example, are of a different order of magnitude from the Morwell brown coal deposits, and that the utilisation of coke breeze has been developed so energetically within the gas industry that this fuel can be classified no longer as a waste product. Indeed, this volume will just its appearance if it leads to that accomplishment with other low-grade fuels which has been achieved already with coke breeze, a development which we are led to expect.

The fuel value of town's refuse, the recovery of fuel from ashes, briquetting, and the combustion or gasification of various low-grade materials are discussed in an exhaustive manner. The ground covered, however, is wider than indicated by the title and the excellent chapters upon steam boilers and upon furnaces and firing will prove to be a valuable guide to the generation of steam, either from best steam coal or from the contents of our dust bins.

There are a few examples, of awkward literary style and, perhaps, too many illustrations. Had some of the studies of rural life in Somerset, the Hawaiian seascape (Fig. 89), and some of the extracts from catalogues in chapter xiii. been omitted the publishers might have been able to offer the book at a price which would have attracted a wider circle of readers.

H. Hollings

Trattato di Chimica Fisica. Translated by Michele Giua from the Fourth American Edition by H. C. Jones. Pp. xxiii+731. Milan: Ulrico Hoepli, 1923. Price 56 lire.

This is the second Italian translation of the well-known text-book by the late professor of physical chemistry at the John Hopkin's University. The scope and treatment of the subject are approximately as in previous American editions, and the book, which is free from any but elementary mathematics, contains a large amount of matter laid out clearly and, on the whole, with good judgment. The historical method of exposition is largely employed.

Prof. Giua has considered it desirable to fill in a number of the more glaring gaps of the original version by inserting sections dealing with the classification of the elements, Walden's inversion, optical activity and molecular asymmetry, viscosity and chemical constitution, absorption of light, X-rays and crystalline structure, the colloidal state of matter, electro-syntheses of organic compounds, the chemical action of light, etc.

Even so, the attention paid to some of the subjects treated cannot be regarded as other than inadequate. For example, the kinetic theory of gases, including the derivation of the van der Waal's equation, occupies only two pages. Then, too, the question of isotopes surely deserves something more than dismissal in twenty lines, even although references are given to Aston's monograph and to an article in the *Nuovo Cimento*. No reference is made to the important subjects of hydrogen-ion concentration and its measurement; a large omission, this, at the present time.

In spite of these few blemishes, however, the book is well worthy of perusal and may be guaranteed not to lead the student very far astray. The translation is smooth and readable without furnishing justification for the saying "translators, traitors," and the paper, printing, and general finish are of the high standard expected of Hoepli publications. The rather long list of corrigenda tucked away, after the index, at the very end of the book, might well be accorded a more prominent position.

T. H. Pope

SCHWEFEL-UND STICKSTOFFSTUDIEN. By Dr. F. RASCHIG. Pp. vi + 310. Leipzig: Verlag Chemie G.m.b.H., 1924.

The veteran author of this book explains that the opportunity of writing it was afforded him by the sentence of five years' imprisonment, with a fine of 500 francs, passed on him by the French authorities in 1923, by reason of the discovery of two unsurrendered locomotives on his works. He has made excellent use of his time, and the *New Pilgrim's Progress* which is before us renders us obliged to the powers for providing the author with leisure. Dr. Raschig, is known as an indefatigable experimenter and a bold, if somewhat rash, theoriser. His classical researches on the compounds of nitrogen and sulphur are of the greatest interest and technical value. Most of this work is hardly mentioned in the text-books, and it is very convenient to have it summarised in this way. The style is interesting, and the descriptions of the experiments so clear that the reviewer could not resist the repetition of some of them. The subjects dealt with include the action of nitrous acid and its salts on sulphurous acid and its salts, new oxides of nitrogen (all purely imaginary !), iodide of nitrogen, monochloramine, nitroxyl, sulphonic acids of hydroxylamine, polythionic acids, and others. The hypotheses on oxides of nitrogen and on the mechanism of the oxidation of ammonia are hardly likely to meet with assent, since they involve the negation of Avogadro's law, and are not supported by any valid experimental evidence, but the rest of the book is full of the most clever experiments and reasoning. There can be few chemists who are not interested in some of the subjects dealt with, and those who are not will become interested on reading the book.

J. R. PARTINGTON

JAHRBUCH DER ORGANISCHEN CHEMIE. By Dr. JULIUS SCHMIDT. Vol. X. Die Forschungsergebnisse und Fortschritte im Jahre. 1923. Pp. xvi + 284. Stuttgart: Wissenschaftliche Verlags gesellschaft M.B.H., 1924. Price, bound, 18 Goldmarks; paper, 15.50 Gm.

In consequence of the War the appearance of the Year-book of organic chemistry was interrupted and no issue was published after 1914, the last volume being No. VII. The author therefore intends to include in the two Vols. VIII and IX still lacking reports for the intervening eight years, so that the Year-book will then form a continuous series up to the present date.

The author's object has been, as formerly, to give a brief summary of the more important contributions to organic chemistry and, with the object of covering a wider area of experimental work, to curtail or omit some of the theories and generalisations of less interest. He points out that owing to the development of biochemistry in recent years it has become necessary to include such subjects as hormones, enzyme chemistry, and the relation between structure and physiological action. Very short chapters on these subjects are to be found at the end of the book.

So far as one can judge from the large mass of material which occupies something like 270 pages of print, few of the more outstanding researches of the year have been overlooked, although it must be admitted that certain foreign contributions have not received the attention which has been accorded to some of lesser moment of German origin. This is perhaps only natural. None the less the work has been carried through with German thoroughness, and forms a valuable book of reference. It is arranged in accordance with the usual classification; it is well printed, with a good subject and author index, a bibliography of German publications for 1923, and a few short obituary notices of chemists who have died during the year.

J. B. COHEN

REPORT

REPORT ON THE COMMERCIAL AND INDUSTRIAL SITUATION IN HUNGARY, FEBRUARY, 1924. By R. J. E. HUMPHREYS, Commercial Secretary, Budapest. Department of Overseas Trade. Pp. 48. H.M. Stationery Office, 1924. Price 1s. 6d.

Since the last report was issued (*cf. Chem. and Ind.*, 1923, 859) Hungary has passed through great difficulties, and it seemed at one time that a complete collapse of the country must occur. Loans, however, were floated in Great Britain and Italy and the period was tided over, a good harvest strengthening the feeling of optimism which was produced.

The country is essentially agricultural, about one half of the population being employed on the land. Exports of cereals, peas, beans, etc. in 1923 totalled 395,240 t., and of fruit, vegetables, etc., 146,718 tons. Wines are exported, principally to Austria and Czechoslovakia, but this trade has decreased very greatly, compared with the previous year. The iron and engineering industries were developed to be self-contained in the former monarchy, but now have to depend for raw materials on importation, and also have to meet competition from Germany and Czechoslovakia in all their markets. Brown coal was mined to the extent of $7\frac{1}{2}$ million tons, but 775,000 t. of hard coal had to be imported. Textile industries made great progress during the year.

Although there was an improvement in industry and production in 1923, there was a falling off in the imports of manufactured goods, largely owing to legislative restrictions. Imports into Hungary in 1923 totalled 3,754,000 t., and exports 1,209,000 t. This adverse balance is much less than that of previous years. Imports of fuels, ores, and animal products increased; the principal articles showing increased export were agricultural produce. Imports from Great Britain decreased, largely owing to the reduction in the textile trade, but exports to this country, by reason of a considerable increase in the sales of sugar and chilled poultry, almost doubled.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Beet-Sugar Factories

Answering Mr. Baker, Mr. W. R. Smith stated that there were at present two beet-sugar factories in this country, one at Cantley in Norfolk, and one at Kelham, in Nottinghamshire. During the last manufacturing season—lasting from October to December—Cantley employed 795 men and produced 8957 tons of white sugar, whilst Kelham employed 433 men and produced 4322 t. of white sugar At present 251 men were employed at Cantley and 83 at Kelham. A third factory was under construction at Colwick, near Nottingham, and was expected to be ready in time for the next manufacturing season. -- (July. 8.)

Income-Tax on Research Fellowships

During the debate in Committee on the Finance Bill, Sir G. Butler, of Cambridge University moved a new clause exempting from income-tax a studentship or fellowship granted by a trust to a person exclusively for the purpose of his pursuing research studies under the auspices of any university in Great Britain. Mr Graham in resisting the new clause, said that already a very large measure of exemption from income-tax was given in that direction. The logical position pointed to the limitation of the concession to its present extent. The remedy lay in larger grants to the universities. On a division the clause was rejected by 185 votes to 100 (July. 10).

Dangerous Drugs

Answering Captain W. Benn, Mr. Henderson said the imports of opium by firms licensed under the Dangerous Drugs Acts was 125,833 lb. in 1923. The amount of morphine and its salts manufactured in 1923 was 254,337 oz., of which 166,397 oz. was converted into heroin, codeine or other derivatives of opium, leaving a net total of 87,940 oz., of which 78,611 oz. was exported. The amount of heroin manufactured in 1923 was 11,575 oz., and the total export of heroin was 12,011 oz. The output of codeine in 1923 was 162,036 oz., of which 160,910 oz. was exported As codeine was not subject to the Dangerous Drugs Acts, its movements were not recorded after it leaves the manufacturers, and it was not therefore known whether any other amounts of codeine were exported during 1923 by persons other than the manufacturers. (July 14.)

COMPANY NEWS

ALLEN-LIVERSIDGE, LTD.

At the annual meeting it was stated that the new factory at Liverpool has been put in complete working order. Compressing stations will shortly be opened at Belfast and Manchester, a new factory in Glasgow, and negotiations are practically completed for a site at Southampton. Regarding the issue of shares, the directors were able to offer them to their own shareholders on such terms as represented a very acceptable bonus. The report was adopted.

BRITISH OXYGEN CO., LTD.

In moving the adoption of the report and accounts, Mr. E. B. Ellice-Clark, the chairman, stated that the net profit of the company showed an increase of £18,478, or 14 per cent., as compared with the previous year, this satisfactory result being due to improved and more economical methods of production and the installation of larger plants to cope with the increasing demand, owing in some measure to the reduction in prices. The further issue of 75,000 shares at par, whilst enabling the company to continue its development policy without depleting its reserves or the profits earned, would have the effect of maintaining its very strong liquid resources at their present satisfactory figure. Referring to the proposed capitalisation of £175,000 of the share premium account balance of £176,655, Mr. Ellice-Clark said this bonus distribution of 35 per cent. was made out of money subscribed by the shareholders and utilised in the development of the company's business, and not out of profits. It could not, therefore, be unfavourably criticised by labour protagonists or those who had profited by the company's enterprise in providing factories in so many industrial centres to meet the demand for oxygen.

WELSBACH LIGHT CO., LTD.

After crediting £23,897, the amount received in settlement of excess profits duty less taxes, the accounts for the year ended March 31 show a net profit of £24,397. For 1922–23, the net profit was £26,397, including profit on sale of investments and debenture stock redemption, together £18,092. The past year's profit includes £17,945 brought forward. The directors propose to pay a dividend of 5 per cent., less tax, and to transfer to general reserve £6480, including discount of £770 on debenture stock redeemed. A balance of £22,966 is carried forward, subject to income and corporation taxes. For the preceding year a dividend of 5 per cent., less tax, was paid, together with a bonus of 2½ per cent., less tax, whilst the transfer to general reserve amounted to £7520, being the discount on debenture stock redeemed.

UNITED LUBRICANTS, LTD.

An issue is about to be made on behalf of a company which has been formed under the title United Lubricants, with a share capital of £120,000, of which £100,000 is in 8 per cent. cumulative preference shares of £1 each, and £20,000 in the form of ordinary shares of 1s. each The whole of the preference shares, together with 50,000 of the ordinary, will be offered at par, each subscriber for two preference shares being entitled to take up one ordinary.

The company will acquire the whole of the issued shares of London Lubricants (1920), which itself is an amalgamation of six undertakings and controls several others. The business is that of refining, blending and manufacturing lubricating oils, greases and kindred products, while the undertaking is said to number among its customers practically every Government department and the principal railway companies and municipalities throughout the country, in addition to engineering works and other consumers.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech.	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric	3s. 9d.–6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.–£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d., Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.–3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.–4s. 6d.
Potash Caustic	£30–£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.–4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s per ton d/d.
Soda Caustic, solid	Spot lots delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.–£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18–£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd 96%	£13 5s.–£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.–1s. 4d. per lb., according to quality.
Crimson	1s. 3d.–1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24–£26 per ton according to quantity.
Carbon Black	7d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.–6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	45s per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10–£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	4s. 10d. per lb.
Zinc Sulphide	7½d.–1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19–£20 per ton. Fair demand
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.–£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. ,, ,, 24° Tw.
Red Liquor	10d.–1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s per gall. 60% O.P. Market dull.
Solvent	5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£46 per ton.

TAR PRODUCTS

Prices in this section show some irregularity according to district. In the North East counties, for instance, anthracene, oil, solvent naphtha and naphthalenes are cheaper than in Lancashire or London. On the other hand, crude carbolic and creosote are dearer.

Acid Carbolic—	
Crystals	6½d.–6¾d. per lb. Fair inquiry.
Crude 60's	1s. 9d.–2s. per gall., according to district. Still quiet but slightly firmer.
Acid Cresylic, 97/99	2s 1d.–2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.–1s. 11d. per gall. Steady demand.
Dark	1s. 10d.–1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	8½d.–9½d. per gall. Quiet.
Unstrained	7½d.–8½d. per gall.
Benzole—	
Crude 65's	10½d.–1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.–1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.–1s. 10d. per gall. ex works in tank wagons.

Toluole—90%	1s. 5½d. per gall.
Pure	1s. 8d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	9d.—9½d. per gall. Few inquiries.
Middle Oil Heavy	5½d.—6d. per gall. according to grade and district. Market weaker.
Standard Specification	6d.—8d. per gall.
Naphtha—	
Solvent 90/160	1s. 1d.—1s. 4d. per gall. according to district. Rather better inquiry.
Solvent 90/190	1s. 1d.—1s. 2d. Fair business passing.
Naphthalene Crude—	
Drained Creosote Salts	£4—£6 10s. Quiet.
Whizzed or hot pressed	£9 per ton. Little business.
Naphthalene—	
Crystals and Flaked	£13—£17 per ton in Yorkshire and London respectively. Market quiet.
Pitch, medium soft	52s. 6d.—57s. 6d. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160	19s.—20s. per gall. Market less firm.
Heavy	12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

There has been an appreciable increase in dyestuffs business during the past week. Prices remain constant.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb.
Acid H	4s. 3d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1d. per lb. Improved demand.
Acid Sulphanilic	9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4½d. per lb. Demand steady.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	2s. 3d.—3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s 9d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. per lb. d/d
Monochlorbenzol	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis
m-Phenylene Diamine	4s. 2d. per lb. d/d.
p-Phenylene Diamine	10s. 3d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 5d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 6d. per lb. naked at works.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P	£47 per ton.
Acid, Acetyl Salicylic	3s. 3d. per lb. Very heavy demand. Price firm.
Acid, Benzoic B.P.	3s. 6d. per lb. Larger supplies available. Market easier.
Acid, Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6½d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic	1s. 6d—1s. 8d. per lb. Market still weak.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d.—1s. 2d. per lb. less 5%. Better tone but not yet very active. Cheap offers of second hand parcels of foreign acid. Higher prices expected in view of firmness of raw materials.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 3d. per lb. for quantity. Demand slow. Prices shaded to secure large orders.
Amidopyrin	13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. per lb. Quiet market.
Benzonaphthol	5s. 3d. per lb. Small inquiry.
Bismuth Salts	A steady market. Prices according to quantity :
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
,, Citrate	11s. 4d.—13s. 4d. ,,
,, Salicylate	10s. 2d.—12s. 2d. ,,
,, Subnitrate	10s. 9d.—12s. 9d. ,,
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Prices vary. Local stocks are being cleared and forward prices are higher. There are rumours of a coming shortage and higher prices in Germany.
Calcium Lactate	Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate	3s. 10d. per lb. in jars. Carboys about 2d. less.
Chloroform	2s. per lb. for cwt. lots. Very steady
Creosote Carbonate	6s. 6d. per lb. Little demand.
Formaldehyde	£55 per ton, *ex* works. English make in casks. About 8s. per cwt. extra for carboys.

Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. ,,
Guaiacol Carbonate	.. 11s. per lb. for cwt. lots. Slightly cheaper.
Hexamine ..	.. 3s. 6d. per lb. for English make. Market quiet and steady.
Homatropine Hydrobromide	.. 30s. per oz.
Hydrastine hydrochlor ..	English make offered at 120s. per oz.
Hydroquinone ..	.. 4s. 3d. per lb. in cwt. lots. Foreign make.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. ,,
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £26 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 2d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P	.. 52s. 6d. per lb. Weaker.
Synthetic ..	. 26s.—31s. per lb., according to quantity. English make. Strong demand.
Mercurials ..	.. Market firm and more active.
Red oxide ..	.. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. ,,
White precip. ..	.. 4s. 7d.—4s. 8d. ,,
Calomel ..	.. 3s. 11d.—4s. ,,
Methyl Salicylate	.. 1s. 11d.—2s. 1d. per lb. Tendency still in buyers' favour
Methyl Sulphonal	.. 26s. per lb.
Metol	.. 11s. per lb. British make.
Morphine and Salts	.. Reduced by 1s. to 1s. 3d. per oz.
Paraformaldehyde	.. 3s. per lb.
Paraldehyde .	.. 1s. 6d. per lb. in free bottles and cases.
Phenacetin ..	.. 6s.—6s. 3d. per lb. Price and demand steady.
Phenazone ..	.. 7s. 3d.—7s. 6d. per lb. Quiet.
Phenolphthalein .	.. 6s. 6d. per lb.
Potass. Bitartrate—	
99/100% (Cream of Tartar) ..	.. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues heavy.
Potass. Metabisulphite ..	7½d. per lb., 1-cwt. kegs included.
Quinine Sulphate	. 2s. 3d. per oz., in 100 oz. tins. Very heavy demand.
Resorcin	. [illegible]s. 6d. per lb. Firmer.
Saccharin	.. 63s. per lb., in 50 lb. lots.
Salol	.. 3s. 6d.—3s. 11d. per lb.
Silver proteinate ..	.. 9s. 6d. per lb.
Sod. Benzoate, B.P	.. 2s. 9d. per lb. In quantity for British product.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity. Firm in common with other citrates.
Sod. Hyposulphite—	
Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	.. 75s.—82s. 6d. per cwt., according to quantity. Steady market, good demand.
Sod. Salicylate ..	.. Market more active. Powder 2s. 2d.—2s. 6d. per lb. Crystal at 2s. 4d.—2s. 8d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol	.. 16s. 6d. per lb. Very scarce indeed. Still rising.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.
Aubepine	.. 14s. 6d. ,,
Amyl Acetate ..	.. 2s. 9d. ,,
Amyl Butyrate ..	.. 6s. 9d. ,,
Amyl Salicylate ..	.. 3s. 3d. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 10½d. ,,
Benzyl Alcohol free from Chlorine ..	.. 2s. 10½d. ,,
Benzaldehyde free from Chlorine ..	.. 3s. 6d. ,,
Benzyl Benzoate	.. 3s. 6d. ,,
Cinnamic Aldehyde Natural ..	.. 15s. 6d. ,,
Coumarin ..	.. 20s. ,,
Citronellol ..	.. 16s. ,,
Citral ..	.. 10s. ,,
Ethyl Cinnamate	.. 15s. ,,
Ethyl Phthalate ..	.. 3s. 3d. ,,
Eugenol	.. 10s. 6d. ,,
Geraniol (Palmarosa)	.. 35s. ,,
Geraniol	.. 11s.—18s. 6d. per lb.
Heliotropine ..	.. 7s. per lb.
Iso Eugenol ..	.. 15s. 9d. ,,
Linalol ex Bois de Rose ..	26s. ,,
Linalyl Acetate ..	.. 26s. ,,
Methyl Anthranilate	.. 9s. 6d. ,,
Methyl Benzoate	.. 6s. ,,
Musk Ambrette ..	.. 45s. ,,
Musk Xylol ..	.. 16s. 6d. ,,
Nerolin	.. 4s. 9d. ,,
Phenyl Ethyl Acetate	.. 12s. 6d. ,,
Phenyl Ethyl Alcohol	.. 16s. ,,
Rhodinol	.. 57s. 6d. ,,
Safrol	.. 1s. 10d. ,,
Terpineol	.. 2s. 4d. ,,
Vanillin	.. 24s.—24s. 9d. per lb. Price reduced. Demand steady.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 15s. 6d. per lb.
Anise Oil	.. 2s. 8d. per lb.
Bergamot Oil ..	.. 19s. 6d. per lb.
Bourbon Geranium Oil ..	36s. 6d. ,,
Camphor Oil ..	.. 75s. per cwt.
Cananga Oil Java	.. 10s. 6d. per lb.
Cinnamon Oil, Leaf	.. 6½d. per oz.

Cassia Oil, 80/85%	.. 8s. 9d. per lb.
Citronella Oil—	
Java 85/90% ..	.. 6s. per lb.
Ceylon	.. 3s. 9d. per lb.
Clove Oil	.. 7s. per lb.
Eucalyptus Oil 70/75% ..	2s. per lb.
Lavender Oil—	
French 38/40% Esters	29s. per lb.
Lemon Oil ..	.. 3s. per lb. Cheaper.
Lemongrass Oil	. 3d. per oz.
Orange Oil, Sweet	.. 13s. 3d. per lb.
Otto of Rose Oil—	
Bulgarian ..	.. 30s. per oz. Dearer.
Anatolian ..	.. 26s. per oz. Dearer.
Palma Rosa Oil ..	.. 19s. per lb.
Peppermint Oil—	
Wayne County	.. 20s. 9d. per lb.
Japanese ..	.. 14s. 3d. per lb.
Petitgrain Oil ..	.. 9s. 6d. per lb. Cheaper.
Sandal Wood Oil—	
Mysore	.. 26s. 6d. per lb.
Australian ..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Sept. 9 h, they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on July 24th.

I.—Applications

Boldy. Drying-machine. 16,054. July 4.

Cuylits. Process of preparing sintered materials. 15,951. July 2.

Koppers Coke Oven Co. Ltd. Apparatus for distilling mixtures of liquids. 15,801. July 1. (Ger., 5.7.23.)

Lockhart. Hydraulic separators etc. 15,832. July 1.

Marks (Darco Sales Corporation). Drying, burning, or revivifying material. 15,710. June 30.

Moll. Regenerative furnaces. 15,721. June 30.

Rigby. Drying apparatus. 15,791. July 1.

I.—Complete Specifications Accepted

1950 (1923). Flint. Evaporator apparatus. (217,945.)

7899 (1923). Dumont. *See* VII.

15,235 (1923). Jones. Automatic control of temperature in evaporating, drying, etc. (218,086.)

16,214 (1923). Mycock. Autoclaves, kiers, etc. (218,098.)

28,018 (1923). Lacy. Frame for use in solvent recovery by distillation. after extraction. (218,178.)

II.—Applications

Barrs. Briquetting material. 15,937. July 2.

Heath. Catalysts and production of liquid fuel. 15,764. July 1.

Josue. Fuel briquette. 15.725. June 30.

Marks (Darco Sales Corporation). 15,710. *See* I.

Tapping. Binder for briquetting fuels etc. 16,094. July 4.

Violini. Fuel briquette. 15,725. June 30.

Wallace. Production of decolorizing carbons. 15,955. July 2.

II.—Complete Specifications Accepted

35,023 (1922). Dederich (Ditmar). Treatment of hydrocarbons, particularly crude petroleum. (191,037.)

7865 (1923). Ashley, and Aldridge and Rankin, Ltd. Apparatus for making coal-gas. (217,969.)

8738 (1923). Tully. Manufacture of gas. (217,998.)

11,526 (1923). South Metropolitan Gas Co., Evans, and Stanier. Treating gases for removing carbon disulphide. (218,053.)

13,221 (1923). Praceiq. Preparation of pulverulent fuels for converting their ashes into hydraulic cements. (218,075.)

III.—Application

Coke and Maxted. 15,669. *See* XX.

III.—Complete Specifications Accepted

35,023 (1922). Dederich (Ditmar). *See* II.

10,003 (1923). Tyrer. Manufacture of phenol and phenolic bodies. (218,034.)

IV.—Applications

Farbenfabriken vorm. F. Bayer und Co. Manufacture of azo-dyestuffs. 16,138. July 4. (Ger., 18.7.23.)

Ransford (Cassella und Co). Manufacture of azotriphenylmethane dyes. 15,812. July 1.

V.—Application

Paschke, and Verein. Glanzstoff-Fabr. Method of recovering acetic acid from acetic solutions of acetyl cellulose. 16,021. July 3.

V.—Complete Specifications Accepted

8238 (1923). Cole Treating silk. (207,145.)

8994 (1923). Colas, and L'Alpha Soc. Anon. Treating liquor accruing from the lixiviation of vegetable matter. (200,482.)

1566 (1924). Chem. Fabr Griesheim-Elektron, and Wiss. Obtaining fibres from plants of the agave and yucca etc. (218,215.)

VI.—Application

Geigy Soc. Anon. Dyeing or printing textile fabrics etc. 15,993 July 3. (Ger., 23.7.23.)

VI.—Complete Specification Accepted

7933 (1923). Russell and Broomfield Filling, or dyeing and filling, of textile fabrics. (217,973.)

VII.—Applications

Casale. Catalytic synthesis of ammonia. 15,688. June 30

Crotogino, and Salzbergwerk Neu-Stassfurt. Process for recovery of salts. 16,024. July 3.

Dowson and Mason Gas Plant Co., Ltd. 15,979. *See* IX.

Paschke, and Verein. Glanzstoff-Fabr. 16,021. *See* V.

Rhenania Verein Chemischer Fabriken Akt.-Ges. Process of dissolving rocks etc. 15,846. July 1. (Ger., 10.7.23.)

VII.—Complete Specifications Accepted

7899 (1923). Dumont. Lime-kilns and other vertical kilns. (217,970.)

8204 (1923). Gjersoe. Producing metal oxides etc. (217,976.)

8576 (1923). Stewart, and Laporte, Ltd Manufacture of barium peroxide. (217,988.)

18,552 (1923). Shimadzu. Manufacture of lead suboxide intermingled with metallic lead powder. (218,119.)

VIII.—Complete Specification Accepted

19,071 (1923). Ohlsen. Producing impermeable strong and acid-proof tubes, bricks, etc. (218,127.)

IX.—Application

Dowson and Mason Gas Plant Co., Ltd., Maltby, and Paton. Gas-fired lime kilns. 15,979. July 3

IX.—Complete Specifications Accepted

7899 (1923). Dumont. *See* VII.

13,221 (1923). Praceiq. *See* II.

X.—Applications

Aarts. Extraction of metals from their oxides etc. 15,826. July 1. (Belgium, 28.7.23.)

Bosch. Blast furnaces, cupolas, etc. 15,924. July 2.

Bullen and Chopra. Manufacture of steels. 16,040. July 3.

Deutsch Luxemburgische Bergwerks- und Hutten Akt.-Ges. Hard alloy. 15,797. July 1. (Ger., 16.7.23.)

Fitzgerald. Means for recovoring gold etc. from diluto solutions. 15,772. July 1.
Holzapfel. Protection of metals by coating. 15,836. July 1.
Jascourt, Pattison, Rose, and Seal Co. Removal of rust and scale from metals. 15,692. June 30.
Marks (Glockenstahlwerke Akt.-Ges. Vorm. R. Lindenberg). Steel alloys. 15,708. June 30.
Marks (American Manganese Steel Co.). Heat treatment of manganese steel. 16,031. July 3.
Rhenania Verein. Chemischer Fabriken Akt.-Ges. 15,846. *See* VII.
Schaap. Heat treatment of iron. 15,823. July 1.
Vereinigte Aluminium-Werke Akt.-Ges. Aluminium alloys. 16,147. July 4. (Ger., 16.8.23.)

X.—Complete Specifications Accepted

1926 (1923). Loftus. Metallurgical furnaces. (217,943.)
4814 (1923). Berlin. Producing ferro-chrome and other ferrous alloys. (201,520.)
5705 (1923). Berlin. Producing rustless iron and steel. (202,952.)
7447 (1923). Thompson (Commercial Steel Co.). Steel. (217,963.)
8602 (1923). Marks (Kemet Laboratories, Inc.). Alloys. (217,991.)
8993 (1923.) Minerals Separation, Ltd. (Minerals Separation North American Corporation, Ltd.). Froth-flotation concentration of ores etc. (218,012.)

XI—Application

Prytherch. High-temperature resistance furnace. 16,079. July 4.

XII.—Applications

Fairweather (Kutsit Soap Co.). Soap compounds. 16,206. July 5.
Lever Bros., Ltd., and Tainsh. Manufacture of soap products etc. 15,815. July 1.
Taylor. Manufacture of margarine etc. 16,166. July 5

XII.—Complete Specification Accepted

22,447 (1923). Walton, and Tokalan, Ltd. Manufacture of oleo stearate of glyceryl. (218,154.)

XIII.—Applications

Baggaley. Sympathetic inks. 15,864. July 2.
Goldschmidt, Prill, and Wohl. Purification of pine tars and resin oils. 15,647. June 30. (Dantzig. 19.2.24.)
Witt. Preparation of a washable paint etc. 16,137. July 4. (Fr., 6.7.23.)

XIII.—Complete Specifications Accepted

5708 (1923). Armour. Purifying crude turpentine oils. (194,286.)
11,558 (1923). Bau. Synthetic resin. (218,054.)

XVI.—Application

Taylor. Treatment of soil. 16,047. July 4.

XVII.—Complete Specification Accepted

9004 (1923). Imray (Soc. of Chemical Industry in Basle). *See* XX.

XVIII.—Applications

Distilleries des Deux-Sevres (*formerly* Soc. Ricard, Allenet, et Cie.). Manufacture of absolute alcohol. 15,946. July 2. (Belgium, 6.7.23.)
Kahn. Manufacture and extraction of nitrogenous products from yeast etc. 16,139. July 4. (Fr., 7.7.23.)

XIX.—Applications

Aten and Lulofs. Pasteurising or sterilising liquids. 16,150. July 4.
Dixon. Purification of water etc. 15,717. July 1.
Kahn. Manufacture and extraction of nitrogenous products etc. from fish etc. 16,140. July 4. (Fr., 7.7.23.)
Taylor. 16,166. *See* XII.

XX.—Applications

Coke and Maxted. Oxidation of aromatic hydrocarbons. 15,669. June 30.
Distilleries des Deux-Sevres (*formerly* Soc. Ricard, Allenet, et Cie.). 15,946. *See* XVIII.
Dreyfus. Manufacture of aliphatic compounds. 15,936. July 2.

XX.—Complete Specifications Accepted

9004 (1923). Imray (Soc. of Chemical Industry in Basle). Manufacture of soluble acid calcium salts of inosite-phosphoric acid. (218,014.)
31,879 (1923). Wibaut. Manufacture of alkyl halides. (209,722.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number: *Argentina:* Steel, (A.X./1120); *Belgium:* Chemical products, ores, (48); *British India:* Steel, (East Indian Railway Co., 73-76, King William Street, London, E.C. 4); *Canada:* Hardware, (39); Cutlery, leather, (41); Brass, hardware, (42 and 43); *Chile*: Glass, (77); Iron wire, (78); Wallpaper, varnish, (79); *Cuba:* Artificial silks, (80); *Denmark:* Iron and steel, (52); *Italy:* Copra, (54); *Mexico:* Steel, (81); *Netherlands:* Sugar, (58); Chemicals, (62); *Poland:* Rubber tyres, (B.X./1064); *Rumania:* Asbestos, (65); *South Africa:* Steel, (A.X./1102); Hides, (B.X./1075); *United States:* Rubber, (73); Steel, (A.X./1098); China clay, (B.X./1074); *Uruguay:* Steel, (A.X./1121).

Metallurgical and Mining Notes from Canada

The ground has been broken for the erection of the first unit of the Dominion Alloy Steel Company at Sarnia, Ont., This portion of the plant will cost $1,500,000. The ultimate plans call for a $3,000,000 equipment.

The Carbon and Alloy Steel Company is opening a plant at Montrose, Ont. Mr. Wiles, of the firm of Carlisle and Wiles, Sheffield, Eng., has arrived to take charge.

The Canadian National Railway has placed an order for 56,000 tons of 85 and 100 pound steel rails with the British Empire Steel Corporation, Sydney, N.S., and 40,000 tons of similar rails with the Algoma Steel Co., Sault Ste Marie, Ont. This will represent between 350—400 miles of railway track. The same railway has placed orders for 20 very large locomotives with the Canadian Locomotive Co., Ltd., Kingston, Ont., and 30 powerful freight locomotives in Montreal.

The surplus zinc concentrates of the Sullivan Mine, southern British Columbia, are now being shipped to Antwerp for treatment. It is anticipated that over 100,000 t. will be exported during the year.

Much British capital is now invested in the gold and silver mines of North Ontario, and practically controls seven or eight properties.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

VOL. 43 NEW SERIES | LONDON, JULY 25, 1924 | NO. 30

EDITORIAL

THIS week we are honoured by being allowed to publish the Annual Reports of two important organisations which have made *Chemistry and Industry* their official Journal. With the Association of British Chemical Manufacturers the Society has long had a close, though an informal, connexion and at the present time the General Manager of the Association is the President of the Society, so that it will be safe to presume that co-operation between these two bodies will be easily maintained. The Association has been of great help to the Journal in many ways, and we are glad to acknowledge with perfect sincerity the consideration and friendly assistance always given, and we believe gladly given, whenever these were desired. In the work of co-ordinating the chemical activities of the country the Association must necessarily play a dominant part; the Society of Chemical Industry has made its main function the publication of information of value or of interest to applied chemists and others engaged in the chemical industry of the country. It will be seen from the Annual Report of the Association how many and how varied are the problems of chemical manufacturers which are common to the industry as a whole and can be conveniently solved in common. Our new President a few years ago gave up to party what was meant for mankind; this did not narrow his view of life nor was his political career so prolonged as to mould him in a definite crystalline form whose sharp edges and angular points hinder his utility in positions where some elasticity and power of accommodation are necessary. He becomes our President at a time of singular interest and some difficulty, but he has some unusual advantages in addition to his own abilities. He has the advantage of speaking at any time, subject of course to the views of his two Councils, for two closely allied organisations whose ultimate aims are identical, the furtherance of the interests of industrial chemistry. He has the further advantage of being able at any moment to secure the help of a very large number of chemists, using the word in a very wide sense indeed, who in the past have profited by his advice and encouragement and will in the future not be unmindful of this fact. It would be futile and indiscreet to set out the advantages which he possesses in an unusual quantity of common sense and so on; those who know him are well aware of these, and probably he knows himself sufficiently for this purpose.

* * *

The Institution of Chemical Engineers is a body of recent growth and its formation was regarded by many chemists as a rather unnecessary development. Both the Chemical Engineering Group and the Institution of Chemical Engineers have ideas and aspirations which are apt to conflict with the traditions and past history of chemical societies. The chemical engineers have been regarded as unorthodox in the worst sense of the word: but the chemical engineers are engineers with a chemical trend, and with chemical knowledge, not chemists. They have a different way of looking at the problems; some say they have brains of a different constitution or complexion. Whatever may be the truth about these matters the fact remains that chemical engineering is already an extremely complicated and important industry and will steadily become so to an even greater degree. It appears to us that it is to the advantage of engineers and of chemists that they shall work harmoniously together in promoting civilisation in the world. It is really of more importance that they should work together than that they should work harmoniously. A few discords make an agreeable feature in modern music, and many a happy family is enlivened by a few domestic jars. Not that there is any discordant element about the relations between chemical engineers and the Society of Chemical Industry or this *Journal*. Many important papers on chemical engineering have already been published in our columns, and if we can continue to receive such articles in the future the value of the *Journal* will increase greatly. Several of the papers of the Institution of Chemical Engineers have been of exceptional merit, well written, accurate and comprehen-

sive. The Institution has published some Transactions which have already become indispensable to industrial chemists, and the Society of Chemical Industry is extremely proud that the Institution is willing that a number of the Transactions should be published in these columns in pursuance of the arrangement mentioned in the Institution's Report. We look forward with considerable confidence to printing some of these in the course of the next few weeks, and are sure that the circulation of proofs of them beforehand will create considerable interest.

* * *

It has been widely proclaimed in the daily press that mercury has been partially converted into gold by a distinguished German man of science. No student of modern chemistry can now regard this feat as impossible; the conversion of one element into another is hourly taking place in many parts of the world and the artificial disintegration of elements has already been accomplished by certain physicists. Nevertheless, considerable caution or scepticism is still necessary when such startling phenomena as the artificial production of gold are announced. It is not that this cannot be done; surely within the next twenty years it will be done; it is merely that the operation will at first be extremely difficult, so difficult that its effect on the future supply of the noble metals need not disturb the present generation. The daily papers have within the last few days provided us with another announcement almost equally sensational and probably equally controversial. We allude to the letters to the *Daily Mail* by Sir William Pope and Professor Dixon, both of Cambridge, on the properties of a much advertised preparation known as Yadil. It is unfortunately difficult to make scientific tests of medicines. A few days ago an acquaintance of ours was afflicted with pains, a high temperature and other infallible symptoms of disease. After a couple of days in bed he recovered and was in normal health again, without the aid of any medicine. Had he taken a few cubic centimetres of Y's infallible cure or a limited number of X's all-healing pills, who can say he would not have equally recovered? In such a case the credulous would have ascribed the recovery to the drugs. But we cannot conveniently find two human beings with similar symptoms, similar powers of resistance, similar inherited tendencies and similar determinations to recover and treat one with the drug and leave the other to the care of Nature. The history of magic, astrology, spiritualism and some other occult studies shows how many possible causes may explain a particular fact and how illogical are the mental processes of those who are deeply imbued by a belief in the universal efficacy of a change in the moon, in telepathy, in talismans or in a dilute solution of simple organic compounds associated with a smell resembling that of garlic. Those who believe that the day they give a garden party is always wet, that it is unlucky to go to sea on a Friday or to go to the Court of Appeal with a decision of Mr. Justice A in their favour, can find plenty of evidence to support them. We are all credulous, even editors.

THE THEORY OF CO-ORDINATION AND THE LEWIS-LANGMUIR STRUCTURE OF THE ATOM

By C. J. BROCKMAN

(Contribution from the Chemical Laboratory of the University of Georgia)

The theoretical background of Werner's theory of co-ordination is practically the same to-day as it was when it was first announced. It has been shown that "anions such as chlorine can combine with metallic cations (Cr, Pt, Co, Cu, etc.) in two essentially different ways; they may be either in the inner sphere, attached by 'co-ordinative valencies,' or in the outer sphere of the molecule, attached by the ordinary type of bond." [1]

To explain complex compounds, Werner has postulated the "co-ordination number," which is the number of atoms or radicals in the first or inner zone.[2]

Beyond this and a host of experimental data there is very little theory concerning co-ordination compounds. T. M. Lowry[3] has developed some valuable ideas with reference to the Lewis-Langmuir structure. The Bohr theory of atomic structure has been correlated with co-ordination by N. V. Sidgwick.[4]

Several assumptions of the octet theory will be taken as the starting point, namely:—

1. Positive valence is determined by the number of electrons which an atom gives up.

2. Negative valence is determined by the number of electrons which an atom takes up.

3. Covalence is determined by the number of electrons which an atom shares with its neighbours.

4. Chemical combination is due to a "natural urge" which causes the atoms to take on or lose electrons so that the stable groupings of 2, 8, 18 or 32 electrons may be formed.

Lowry builds his theory on these four postulates and the following statement: "If one atom shares two electrons with another but contributes both electrons to the common stock instead of only one, it acquires a positive charge, whilst its neighbour (which has acquired a half-share in two electrons not originally belonging to it) becomes negatively charged." He then goes on to show that in platinic chloride the outer shell of 32 electrons is completed by drawing in six doublets from six chlorine ions. These six doublets are held in common by the platinum atom and the chlorine atoms and each element can claim an equal share in them. That is the platinum atom gains six electrons and each chlorine ion loses

(1) Nernst, "Theoretical Chemistry" 1923 edition, p. 413, Macmillan.

(2) Werner, "New Ideas on Inorganic Chemistry," 1911 edition, p. 47 *et. seq.* Longmans.

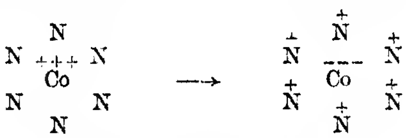
(3) T. M. Lowry, *Chemistry and Industry*, Vol. 42 (1923), pages 316, 412, 462, 623 especially, together with other papers in the same journal.

(4) N. V. Sidgwick, *J. Chem. Soc.*, 123, 725 (1923); *Chemistry and Industry*, 42, 901 and 1203 (1923).

one, that is, the platinum atom is in the bivalent ion

$PtCl_6$ and the ion contains six neutral chlorine atoms held by covalencies, whilst the double negative charge is held by the platinum.

Lowry, furthermore, assumes that in the cobalt ammines each molecule of ammonia that is co-ordinated therefore acquires a positive charge like that of an ammonium ion, whilst the cobalt atom gains one electron. The effect is first to neutralise and then reverse the charge on the metal. Thus in the hexammines the charge on the cobalt is changed from Co^{+++} to Co^{---}, as follows :—



(The H atoms of the ammonia groups are omitted for the sake of simplicity.)

The theory now suggested differs from that of Lowry in that the co-ordination of the ammonia groups does not change the charge on the platinum ion. The accumulation of evidence points to this fact as a general rule, and that the third assumption above should be broadened to include the fact that a molecule may contribute a pair of electrons to the common stock to be shared by two atoms with the formation of a covalent bond. It will also be shown that when an anion is co-ordinated it contributes two electrons if monovalent, four if divalent etc. to the common stock to be shared by both atoms and so becomes covalently bound to the central atom ; in being so bound a monovalent ion reduces the positive charge on the central ion by one, while a divalent ion reduces the charge by two units.

Complexes Containing Platinum

The platinum atom having 24 electrons in its outer shell gives one electron to each of 4 chlorine atoms forming the compound $PtCl_4$, in which the platinum ion has 20 electrons in its outer shell and carries a positive charge of 4. The urge to complete the outer shell of the platinum ion to 32 electrons (that is the configuration of the outer shell of the next higher inert gas niton) is sufficiently strong to cause $6NH_3$ groups to be absorbed by the ion. Each NH_3 group contributes a pair of electrons (making 12 in all) to the outer shell of the platinum ion, so bringing the total number of electrons to 32. The compound so formed is well known as hexammine-platé chloride[5] $[Pt6NH_3]Cl_4$, in which there are 5 ions—namely, one $[\overset{++++}{Pt6NH_3}]$, and 4 chloridions.

If only 5 NH_3 groups are co-ordinated by the platinum ion the other two electrons needed to complete the shell of 32 are supplied by a chloridion. That is 5 NH_3, and one chlorine atom are co-ordinated ; but in co-ordinating the chlorine ion the platinum ion receives one electron which it originally gave to the chlorine to form the chloridion, together with another electron which it did not previously give to the chlorine atom ; the net result is that the positive charge on the platinum ion is reduced by one unit forming the complex compound chloro-pentammine-platé chloride $\left[Pt^{Cl}_{5NH_3}\right]Cl_3$, in which only three chloridions are known to be present.

In the compound dichloro-tetrammine-platé chloride $\left[Pt^{2Cl}_{4NH_3}\right]Cl_2$ the platinum ion receives 8 electrons from $4NH_3$ groups and 4 more from 2 chloridions, and completes its shell of 32 electrons. The co-ordination of the 2 chloridions decreases the positive charge of the central ion from 4 to 2, so that only half of the chlorine in the compound is present as chloridions.

This scheme may be followed through to the compound tetrachloro-diammine-platinum $\left[Pt^{2NH_3}_{4Cl}\right]$ which is a non-electrolyte. The four positive charges on the platinum ion have been entirely neutralised by the 4 negative charges in the co-ordination of the 4 chloridions. To complete its shell of 32 electrons the platinum ion in potassium pentachloro-ammine platéate $\left[Pt^{NH_3}_{5Cl}\right]K$ receives 2 electrons from the NH_3 group and 10 from the chloridions, together with 5 negative charges which not only neutralise the 4 positive charges on the platinum ion, but leave an excess of one negative charge on the platinum. It is this one negative charge which accommodates the potassium ion.

If no ammonia molecules are available for co-ordination as is the case when platinic chloride is treated with a solution of potassium chloride, the platinum ion co-ordinates 6 chloridions to complete its shell of 32 electrons but also receives 6 negative charges which leave the platinum ion with an excess of two negative charges so that the two potassium ions can be accommodated to form potassium hexachloro-platéate (potassium chloroplatinate) $[Pt4Cl]K_2$.

The fact that the halogen atoms inside the brackets are co-ordinatively attached to the platinum atom is proven by the fact that they cannot be present as halogen ions since they are not precipitated by the addition of silver nitrate

One co-ordinated ammonia molecule may be replaced by a pyridine molecule as in $\left[Pt^{Py}_{5Cl}\right]K$. Two monovalent acid radicals may be replaced by one divalent radical as the carbonate or sulphate radical. This means that a divalent anion on co-ordination brings with it 4 electrons and two negative charges, as in $\left[Pt^{SO_4}_{4NH_3}\right]K_2$.

The platinous ion can also form complex compounds, but in this case the outer shell contains 30 instead of 32 electrons. Starting with platinous chloride in which the platinum ion has 22 electrons in its outer shell, the co-ordination of ammonia leads to the compound $[Pt4NH_3]Cl_2$ in which the charge

(5) See "Inorganic Complex Compounds," Schwarz-Bass, p. 25, Wiley, 1923.

on the platinum ion remains unchanged at 2. If only three ammonia molecules are co-ordinated the compound is $\left[Pt\genfrac{}{}{0pt}{}{Cl}{3NH_3}\right]Cl$ and the platinum ion has lost one positive charge by the co-ordination of one chloridion. Similarly we have the compounds

$$\left[Pt\genfrac{}{}{0pt}{}{2Cl}{2NH_3}\right] \;;\; \left[Pt\genfrac{}{}{0pt}{}{3Cl}{NH_3}\right]K \;;\; \left[Pt4Cl\right]K_2.$$

In any of the above compounds the chlorine as an ion or in the co-ordinated condition may be replaced by another member of the halogen family, by the cyanide or the thiocyanate group; two halogen atoms may be replaced by one divalent acid group.

Complexes Containing Cobalt

Much has been reported on the cobalt ammines, so that many of the series of these compounds are complete. The cobalt atom has 9 electrons in its outer shell, and responds to the urge to complete this shell to 18 electrons, which is the stable configuration of the next higher inert gas, krypton. The cobalt ammine-nitrites will be taken as typical examples. In cobalt nitrite the cobalt atom in becoming an ion gives three electrons, one to each nitro group, which leaves the cobalt ion with 6 electrons in its outer shell. The stable configuration of 18 is obtained by co-ordinating $6NH_3$ molecules to form hexammine-cobalti nitrite $[Co6NH_3](NO_2)_3$. Each NH_3 denotes a doublet toward the completion of the shell of 18 electrons and shares them with the cobalt ion. As the charge is not changed by this co-ordination, the cobalt ion still retains its positive charge of three.

If only $5NH_3$ groups are co-ordinated the shell of 18 electrons is obtained by co-ordinating one nitrite ion which loses its property as an ion, and so decreases the charge on the cobalt ion from three to two, forming nitro-pentammino-cobalti nitrite. By a similar process the following cobalti nitrites may be formulated —

$$\left[Co\genfrac{}{}{0pt}{}{NO_2}{5NH_3}\right](NO_2)_2 \;;\; \left[Co\genfrac{}{}{0pt}{}{2NO_2}{4NH_3}\right]NO_2 \;;\; \left[Co\genfrac{}{}{0pt}{}{3NO_2}{3NH_3}\right] \;;$$

$$\left[Co\genfrac{}{}{0pt}{}{4NO_2}{2NH_3}\right]K \;;\; \left[Co\genfrac{}{}{0pt}{}{5NO_2}{NH_3}\right]K_2 \;;\; \left[Co\,6NO_2\right]K_3$$

In the above compounds the NH_3 molecule may be replaced by a water molecule forming the following compounds :—

$$\left[Co\genfrac{}{}{0pt}{}{2H_2O}{4NH_3}\right]Cl_3 \;; \qquad \left[\begin{matrix} & 2Cl \\ Co & H_2O \\ & 3NH_3\end{matrix}\right]Cl \;;$$

$$\left[\begin{matrix} Cl \\ Co\,H_2O \\ 4NH_3\end{matrix}\right]Cl_2 \;; \qquad \left[\begin{matrix} Cl & & 2H_2O \\ & Co & \\ Br & & 4NH_3\end{matrix}\right]Br$$

in which the halogen atoms are interchangeable with each other and with the nitro group. Also two monovalent atoms may be replaced by a divalent acid radical as the C_2O_4, CO_3 or ethylendiamine groups to form compounds as

$$\left[\begin{matrix} Br & N_2O \\ & Co\,NH_3 \\ Br & en\end{matrix}\right]Br \;; \qquad \left[\begin{matrix} 2NH_3 \\ Co\,C_2O_4 \\ 2NO_2\end{matrix}\right]R \;;$$

$$\left[Co\genfrac{}{}{0pt}{}{C_2O_4}{4NH_3}\right]X \;; \qquad \left[Co\genfrac{}{}{0pt}{}{CO_3}{4NH_3}\right]X.$$

Then, too, one NH_3 molecule may be replaced by a salt molecule or even an acid molecule as in

$$\left[\begin{matrix} & AgCNS \\ Co & \\ & 5NH_3\end{matrix}\right](NO_3)_3 \;; \qquad \left[\begin{matrix} & KNO_3 \\ Co & NO_2 \\ & 4NH_3\end{matrix}\right](NH_3)_2 \;;$$

$$\left[\begin{matrix} HCl \\ Co\ en_2 \\ Cl\end{matrix}\right]Cl_2 \;; \qquad \left[\begin{matrix} & AgCNS \\ Co & NO_2 \\ & 4NH_3\end{matrix}\right]\genfrac{}{}{0pt}{}{Cl}{NO_3} \;;$$

$$\left[\begin{matrix} AgCl \\ Co\ Cl \\ 4NH_3\end{matrix}\right]SO_4 \;; \qquad \left[\begin{matrix} & AgCl \\ & Cl \\ Co & H_2O \\ & 3NH_3\end{matrix}\right]SO_4.$$

The compound $K_4Co(CN)_6$ formulated on the above system as $[Co6CN]K_4$ is a cobaltous compound, in which the cobalt ion starts with 7 electrons in the outer shell, and adds 12 more from 6 cyanogen groups, making a shell of 19 electrons which configuration is unstable. The result is that the compound breaks down to $K_3Co(CN)_6$ according to the equation :—

$$2K_4Co(CN)_6 + 2HCl \longrightarrow 2K_3Co(CN)_6 + 2KCl + H_2.$$

This latter compound $[Co6CN]K_3$ is stablo, being the well-known potassium cobalti nitrite in which the cobaltic ion with 6 electrons in its outer shell adds 12 more, making the stable group of 18. Under ordinary conditions the salts of trivalent cobalt are unstable, but in complex compounds the trivalent cobalt compounds are the more stable, which substantiated the theory set forth above.

Complexes Containing Chromium

The chromium complexes follow the rules set out above except that in building up the outer shell of electrons the stable configuration of 18 is never attained; the process of co-ordination stops when the number of electrons in the outer shell reached 15. The following compounds bear out this fact. In hexammine-chromi thiocyanate the chromium ion has three electrons in the outer shell, and receives 12 more from the $6NH_3$ groups co-ordinated, bringing the total to 15. If a smaller number of NH_3 groups are co-ordinated a corresponding number of SCN groups are co-ordinated, as described above, so that the complexes of this series will be :—

$$[Cr\,6NH_3](SCN)_3 \;;\; \left[Cr\genfrac{}{}{0pt}{}{SCN}{5NH_3}\right](SCN)_2 \;;$$

$$\left[Cr\genfrac{}{}{0pt}{}{2SCN}{4NH_3}\right]SCN \;;\; \left[Cr\genfrac{}{}{0pt}{}{3SCN}{3NH_3}\right] \;;\; \left[Cr\genfrac{}{}{0pt}{}{4SCN}{2NH_3}\right]R \;;$$

$$\left[Cr\genfrac{}{}{0pt}{}{5SCN}{NH_3}\right]R_2 \;; \qquad [Cr6SCN]R_3.$$

The aquo-ammine chromi chlorides are well known, and their ionisation has been studied. All these compounds conform to the same scheme as do the thiocyanates. The aquo ammine chlorides of chromium are more stable than those of cobalt, and all but one of the series are known. They are rather sensitive to heat, for example $\left[Cr\genfrac{}{}{0pt}{}{H_2O}{5NH_3}\right]Cl_3$ loses its molecule of water when heated, with the result that one chloridion is co-ordinated, leaving only two chloridions in the complex $\left[Cr\genfrac{}{}{0pt}{}{Cl}{5NH_3}\right]Cl_2$.

Complexes Containing Iron

The ferric compounds are, as a rule, more stable than the ferrous compounds, but not always, which fact may be interpreted as follows: The co-ordinatively saturated atom of iron which has an outer shell of electrons approaching nearest to the stable krypton grouping of 18 electrons will form the most stable complex compound. Experimental data substantiate this fact. $K_4Fe(CN)_6$ is more stable than $K_3Fe(CN)_6$. In the former the iron atom is in the bivalent state, and so starts from 6 electrons in its outer shell, adds 12 more to make 18 in all; in the ferricyanide the iron being in the ferric state starts from 5 electrons, and by adding 12 more makes a shell of 17.

On the other hand, when iron is combined with three molecules of α-dipyridyl or 3 molecules of σ-phenanthroline trivalent, iron is only retained by very cautious work. An analysis of the electronic condition of these complexes shows that in the ferric state the 5 electrons in the outer shell receive 12 more (4 from each of three α-dipyridyl molecules etc.), making a shell of 17, while in the ferrous ion the 6 electrons add 12 more to make a shell of 18, the more stable grouping.

This analysis shows that a smaller number of electrons than is required to complete the next higher stable grouping is tolerated in the case of platinous compounds with good stability, also in some iron complexes, but a shortage seems to be preferred in the case of chromium complexes. But under no conditions is a stable compound formed when the number of electrons exceeds the stable grouping as in the case of the potassium cobaltous cyanide $K_4Co(CN)_6$.

Summary

1. The formation of co-ordinated complex compounds is explained as the result of a natural desire on the part of a metallic ion to complete its outer shell of electrons to that stable grouping assigned by the Lewis-Langmuir theory to the next higher inert gas.

2. By a sharing of electrons the co-ordinated atoms or ions lose their ionogenic properties and become covalently bound to the central atom.

Athens, Georgia, U.S.A.

THE WRITINGS OF GEBER

By Prof. J. R. PARTINGTON, M.B.E., D.Sc.

In the *Chemiker Zeitung* of June 28 Dr. Darmstaedter, of Munich, has a few remarks on "Geber Manuscripts" which are of interest. It will be remembered that I have consistently maintained that the reproduction of what this or that authority says on the matter, which is a method sometimes pursued, is of no value, and that further progess can only be made by the discovery of further unpublished material. This seems to be accepted by Darmstaedter, who has been looking into some of the *Latin* MSS. of Geber. As is usual with German scholars, he omits any mention of the English MSS., some of which are the oldest known. He states that the Paris BN 6514, which contains two copies of the *Summa*, and dates approximately to 1300, shows no appreciable difference from the printed texts. This was stated by Hoefer in 1842 (Histoire de la Chimie, 1842, Vol. I., p. 310), and by Berthelot (Chimie des Anciens, Vol. I., p. 344); I have confirmed it by inspection of the MSS. in question, and have also found that the text in BN 7156, of about the same date, is practically identical with that of BN 6514. This fact is not mentioned by Darmstaedter; Hoefer also refers to BN 6679, which I have not examined. The first statement of Darmstaedter is, therefore, common knowledge to all who have looked into this question and is far from new.

Darmstaedter next refers to a Bologna codex, Lat. 448 (756), early fifteenth century. This is a late MS., its date being approximately that of the earliest MSS. of the British Museum, to which I shall refer in a moment. This contains also the "Book on Furnaces of Geber," which usually accompanies the printed text of the *Summa*. The point to which Darmstaedter draws attention is that the explicit of the MS. states that it was translated in Anno Arabicum 1420 by Rodgerum Hyspalensem. He points out that 1420 leads to the date 1720, since the 7 is really a 4 (a well-known fact to those who have looked at early MSS.!), and since this would lead to an impossible date A.D., he assumes it to be 720, giving 1340 A.D.

He then remarks that Rodger Hispalensis (Rodger of Seville) is named as the translator of the "Book of Furnaces" in the Nurnburg text of 1541 and that of 1545. In the latter, which is the only one of the two I possess, the title reads: Gebri Arabis Philosophi solertissimi. Rerumque naturalium peritissimi, Liber Fornacum ad exercendam χημείαν pertinentium Interprete Rodogero Hispalensi (p. 184). The text of the 1541 edition is identical, as I satisfied myself some time ago. The Greek title is not without interest; the preface to the whole book is by Chrysogonus Polydorus, who mentions the statement of Suidas as to the origin of Chemistry, which he quotes in the original Greek, but says nothing of the Alexandrian alchemical MSS. of Zosimus, etc. I have found nothing in this preface which would give any hint as to the source of the MSS., but the treatise of Roger Bacon, and the *Correctorium* of Richard of England, also printed in the collection, make it not improbable that it was English.

The part played by Rodger of Seville is, of course, known to all who have looked into this matter. In the *Bibliotheque des Philosophes Chimiques, ou Recueil des Ouvres des auteurs les plus approuvez qui ont écrit de la pierre philosophale*, published in two volumes in Paris in 1672 and 1678, respectively, this name occurs. The first volume has the title: *Tome premier . . . par le Sieur S.D.E.M. a Paris chez Charles Angot, rue Saint Jacques au Lyon d'or M.DC.LXXII.* The translation of Geber is not in this, but in the second volume: *Tome Second qui contient cinq traitez . . . une Preface sur l' obscurité*

des Philosophes, et sur les Traitez de ce Tome, & leurs Auteurs . . . par le Sieur S. Docteur en Medicine . . . M.DC.LXXVIII. Both are by the same publisher. This *Sieur S.D.E.M.* is usually regarded as William Salmon, who published an English translation of Geber in 1692; in this reference is made to "the Author's House, at the Blue Balcony, by the Ditch-Side, near Holbourne Bridge, London." The second edition of the French work appeared in three volumes in 1741 and a fourth volume in 1754, enlarged by J. M(augin) D(e) R(ichebourg), with fatuous notes by the Abbe Lenglet du Fresnoy; the text of Geber's Summa is in volume 1. The French translations in the two editions are quite different, and Hoefer is in error in saying that the translation is that of the "Vatican edition" of the Latin text. The published Latin texts differ rather considerably, and may be divided roughly into two groups, represented by the Nurnburg text of 1541, referred to above, and the Rome text, published by Silber in c. 1530. Darmstaedter (Geber, p. 11), gives 1510–1520 as the date of this Vatican edition, which is clearly impossible since Pope Clement the Seventh is mentioned in it, and his dates are 1523–34 (Creighton, *History of the Papacy*, 1897, vol 6, pp. 203, 274, 341; during his pontificate the Vatican Library was considerably extended). I have had for some time notes of the principal variations, and it may save the time of Dr. Darmstaedter and others who appear to be going over the same ground, if I publish these elsewhere in the near future.

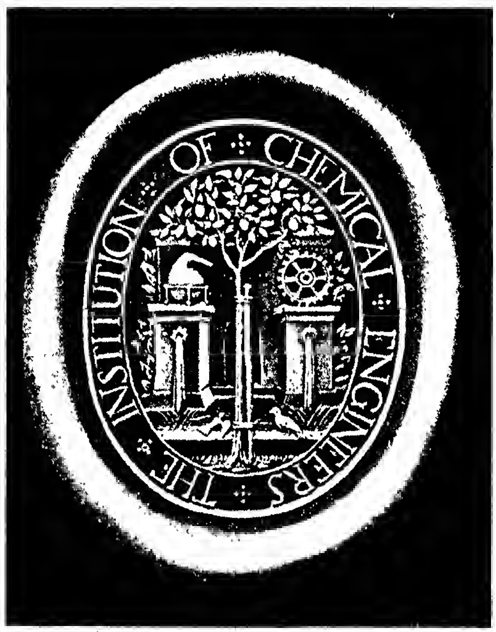
In the 1678 edition of the *Bibliotheque des Philosophes Chimiques* (which I do not think need be by Salmon), on the (unpaged) folio ã vi of the preface, the editor says: "Il n'y a pas aussi a douter qu'il ne l'ait écrit en Arabe, puisque mesme lá Livre qu'il a fait des Fourneaux a esté traduit d'Arabe en Latin par Roger de Seville." The editor of this edition also gives a useful list of variant readings of different editions of the printed text, which will be of use to those who have not made lists of their own. He refers to an edition published at Lyons in octavo, "dont le premiere feuille estoit déchirée." No edition of Lyons is known to me; perhaps the editor has mistaken Horn's edition of 1668, published at Leyden (Lugduni Batavorum) for one of Lyons (Lugduni), although he mentions this separately, and it is in 18mo, not 8vo.

Darmstaedter states that the Bolognese MS. proves that the "Book of Furnaces" existed, and was ascribed to Geber, at a date nearly as early as that of the earliest known copies of the "Summa."

I have been unable to find any particulars of Roger of Seville, but he is probably well known to Oriental scholars.

The MSS. of Geber in the British Museum which I have looked at are of no particular interest. The earliest of them is of the fifteenth century. Arundel 164, later fifteenth century, on paper, is fairly clear but much contracted. It begins "Totam nostram scientiam quae ex libris antiq. abbreviavimus" (fol. 131 vo), and ends "haec dicta sufficiant" (fol. 192 ro). It may be noted in passing that many MSS. have dictis instead of libris, and a fair idea of the contents may be got from these opening words. BN 7156 and 6514 have libris. Future students of Arundel 164 may be saved trouble if they note that on fol. 155 Geber's treatise breaks off suddenly at the end of Cap. lxxxvi. in the 1545 printed text, and Expositio Hermetis follows, which in turn is followed on fol. 157 ro by "Incipit liber divinitatis de origine lapidis," the Summa beginning again only on fol. 187 ro, and proceeding normally to fol. 192 ro. Arundel 164 contains several interesting treatises on alchemy, notably Albertus Magnus de Alchymia. Sloane 1091, of the fifteenth century, is less easy to read than Arundel 164, but its text of Geber is normal. It contains some English treatises, notably the letter of Raymund Lully to King Robert (fol. 97 ro.). Other MSS. are later than the printed texts. The Spanish MS. (Egerton) is quite recent, but may, of course, be a copy of an older MS. Sloane 1754, fifteenth century, contains several alchemical tracts, including the dialogue of Avicenna known as *de Anima* (fol. 50 vo), Liber Archillei physicus de corporibus et spiritibus (fol. 84 ro), Liber perfecti magisterii (fol. 95), Liber Rasis de 12 aq. precioss., etc. On fol. 136 is a sort of dictionary, including Arabic words ("Zarnet O=O arsenicum auripigmenti").

THE NEW SEAL OF THE INSTITUTION OF CHEMICAL ENGINEERS



INSTITUTION OF CHEMICAL ENGINEERS

Annual Report of the Council, July, 1924

1. Introductory

The Council has pleasure in submitting to the Corporate Members of the Institution an account of the work accomplished during the past year. The record is one of continued progress, which it is hoped will give the same satisfaction to the general body of members as to the Council.

2. Committees

At the first meeting of the Council held on Wednesday, July 4th, 1923, it was decided that four Committees should be created, namely:—

(*a*) General Purposes and Finance Committee.
(*b*) Education Committee.
(*c*) Publication Committee.
(*d*) Nomination Committee.

In view of the importance of the work of these Committees it was decided to enlist the co-operation of members of the Institution who were not members of Council. The Education Committee was also fortunate in having the assistance of a number of correspondents in different parts of the Empire. To all of these gentlemen the Council expresses its sincere thanks for the valuable services so generously and unselfishly given.

The Committees were constituted as follows:—

General Purposes and Finance Committee

Sir Arthur Duckham, K.C.B. (*chairman*), W. J. U. Woolcock (*vice-chairman*), J. Arthur Reavell, Jas. MacGregor, J. W. Hinchley, F. H. Rogers, C. S. Garland, H. Talbot, E. L. Randall.

Education Committee

C. S. Garland (*chairman*), Sir Alexander Gibb, G.B.E., C.B., Sir Frederic L. Nathan, K.B.E., W. Newton Drew, R. G. Browning, F. H. Rogers, J. W. Hinchley, W. J. Gee, E. W. Smith, F. R. Tunks, F. A. Greene.

Corresponding Members

Jas. MacLeod (Dunbartonshire), W. A. Fraymouth (Bhopal, Central India), W. G. Weaver (Cape Town), K. B. Quinan (South Africa), J. A. Wilkinson (Johannesburg), N. E. Rambush (Stockton-on-Tees), J. H. Young (Glasgow), A. Cottrell (Edinburgh).

Publication Committee

Wm. MacNab (*chairman*), J. W. Hinchley, C. S. Garland, A. R. Warnes, A. L. Booth, A. Baker, H. J. Pooley, M. W. Travers, E. A. Alliott, S. G. M. Ure, M. B. Donald.

Nomination Committee

J. Arthur Reavell (*chairman*), H. Talbot, W. B. Davidson, Sir Alexander Gibb, G.B.E., C.B., J. W. Hinchley, C. S. Garland, E. W. Smith, W. P. Joshua, C. J. Goodwin, F. A. Greene, E. A. Alliott.

3. Meetings

Since the last Annual Meeting the Council has held TEN Meetings, while the Committees have held meetings as follows:—

	Meetings.
General Purposes and Finance Committee	6
Education Committee	9
Publication Committee	7
Nomination Committee	6

4. Seal

The seal of the Institution, with the emblematic watering of the Tree of Knowledge from the Fountains of Chemistry and Engineering, is due to the happy inspiration of Mrs. J. W. Hinchley, who designed it, and to whom the Council feels itself greatly indebted.

The execution of the design by Mr. Cecil Thomas and the use of a new process by which this seal is affixed in gutta-percha to the certificate has produced a result of which the Council considers members may be justly proud.

Sir Arthur Duckham presented the Seal to the Institution as an enduring memento of his Presidency.

5. Official Journal

During the provisional life of the Institution, the question of the Journal *Chemistry and Industry* becoming the official organ of the Institution had been raised, and Mr. J. Arthur Reavell had agreed to negotiate with the Society of Chemical Industry on this subject. Subsequently a deputation, consisting of Mr. Reavell, Mr. Garland and the Honorary Secretary, met the Editor of *Chemistry and Industry* and a scheme approved by that deputation was accepted by the Council. The scheme included —

(*a*) A statement on the cover of the Journal that it was the official organ of the Institution of Chemical Engineers.

(*b*) That the Journal will print papers read before the Institution.

(*c*) That the Journal, by arrangement, will print "slip" proofs of papers read under the auspices of the Institution and hold sufficient copies to be included in the Annual Volume of Transactions. The cost of "setting-up" such papers will be borne by the Society of Chemical Industry, but the cost of printing and circulating "slip" proofs and printing additional copies for inclusion in its Annual Volume will be borne by the Institution.

It was understood that the Editor of *Chemistry and Industry* had the right to refuse matter which in his opinion would not be suitable for his Journal. In such case, "slip" proofs and printing for the Annual

Volume of Proceedings of the Institution will be carried out by the printers at the expense of the Institution.

6. British Empire Exhibition

The Institution has given active support to the British Empire Exhibition at Wembley. The Honorary Secretary was elected to represent the Institution on the Committee of the Chemical Section, and a sum of £25 was contributed to the cost. Mr. S. G. M. Ure carried out the work of planning the chemical engineering exhibit. This exhibit has attracted widespread attention, and the Council feels amply repaid for the efforts put forward.

7. Ramsay Memorial Laboratory

The raising of a fund for the establishment and equipment of a Chemical Engineering Laboratory in memory of Sir William Ramsay at University College, London, gave the Institution an opportunity of doing a definite practical work in the interests of chemical engineering education, and an appeal for funds resulted in the sum of £121 being handed over to the Ramsay Memorial Fund.

Mr. J. A. Reavell represents the Institution on the Chemical Engineering Committee of the Ramsay Memorial Laboratory, and the Council has great satisfaction in recording the establishment of this further school of Chemical Engineering in London.

8. American Institute of Chemical Engineers

The exchange of publications between the Institution and the American Institute of Chemical Engineers was agreed to and copies of the Transactions for 1921-22 of the American Institute of Chemical Engineers have been sent to our members.

9. Education Committee

During the year the Education Committee has been engaged upon a Memorandum on "The Training of a Chemical Engineer," and in draft form this is now being submitted to the heads of all the principal industrial firms of the country, with a view to obtaining opinions and criticisms, so that a final draft may be produced for approval by the Council prior to submission to the educational authorities for action.

The Council has prepared for the Department of Technology of the City and Guilds of London Institute a syllabus for examinations in Chemical Engineering which it is hoped will be held annually.

On the election of Professor E. C. Williams, first Ramsay Professor of Chemical Engineering, as a member of the Institution, he was co-opted as a member of the Education Committee.

10. Death of Mr. A. C. Flint

The Council reports, with the very greatest regret, the death on January, 1924, of Mr. A. C. Flint after an operation. The Council expressed their deep sorrow and sympathy with Mrs. Flint, and placed on record their great appreciation of his services to the Institution.

The Council also desires to record the very valuable services rendered by Mrs. Talbot, who voluntarily carried out the duties of assistant secretary for three months.

In conjunction with the Chemical Engineering Group the new assistant secretary was appointed after advertisement of the post and a careful and searching analysis of the replies. A joint Sub-Committee of the Institution and the Chemical Engineering Group finally considered the applications and interviewed candidates, Mr. Cecil J. T. Mackie, the selected candidate, taking up his duties as assistant secretary at the beginning of June.

11. Resignation of Dr. Charles Carpenter as Vice-President of the Institution

Dr. Charles Carpenter tendered his resignation as Vice-President of the Institution in February, 1924, considerations of health compelling him to withdraw from practically all his public work.

The Council accepted this resignation with very great regret and conveyed to Dr. Carpenter its sympathy and appreciation of the reasons which compelled him to resign.

12. Ordinary Meetings

During the year on account of the difficulties encountered by a new Institution, few meetings have been held, the work of the Institution being mainly that of its Committees.

The undermentioned papers were read and aroused considerable interest at well-attended meetings of the Institution :—

June 8th, 1923.—Mr. T. C. Finlayson on "Industrial Oxygen."

November 14, 1923.—Mr. M. B. Donald, on (1) "A Study of the Absorption Tower," by M. B. Donald and C. W. Tyson. (2) "A Study of the Conditions of Constant Rate of Flow in Filter Presses," by M. B. Donald and R. D. Hunneman.

February 18th, 1924.—Mr. D. M. Newitt on "The Transport, Storage and Distribution of Hydrochloric Acid."

13. Balance-Sheet

The Balance-sheet for the accounting period, January 1st, 1923, to December 31st, 1923, is submitted herewith.

At the termination of the preceding accounting period there was a considerable contingent credit amounting to £766 4s. 6d. in respect of called and uncalled Guarantees.

In the Balance-sheet for the accountancy period under review, the Revenue Account shows that the receipts from income have amounted to £1372 8s. 2d., whilst the Expenditure has been £1201 15s. 10d., leaving a sum of £170 12s. 4d. to carry forward to the year 1924. Whilst the expenditure shown comprises to a small extent items of a non-recurring character, in relation to purchases and printing necessary in the starting of the Institution, these are offset by the fact that the entrance fees on the income side of the account are, for the members already enrolled, a non-recurring item. Life membership composition fees, however, have been capitalised, and the amount now standing to the credit of that item has been invested in War stock.

14. Membership

The following gentlemen have been elected Honorary Members of the Institution during the past year.

M. Paul Kestner (France).
Principe Gionori Conti (Italy).
Dr. R. F. Ruttan (Canada).
Professor W. K. Lewis (United States).
Professor F. G. Donnan, F.R.S.

On June 1st, 1924, the membership of the Institution was as follows :—

Honorary Members, 6 ; Members 119 ; Associate-members, 76 ; Graduates, 17 ; Students, 3 ; Total, 221.

The interest in the Institution continues to be maintained, and applications for membership have been received from all parts of the world.

On behalf of the Council,

F. H. Rogers
J. W. Hinchley

REVENUE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1923

EXPENDITURE

	£ s. d.	£ s. d.
To Rent, Lighting, Heating, etc.		230 8 4
„ Printing, Stationery and Advertising		328 15 10
„ Postages and Telegrams ..		54 9 6
„ Telephones		17 15 10
„ Salaries and Clerical Assistance		359 5 0
„ Reporters' Fees		13 2 10
„ Bank Charges		8 11 6
„ Travelling Expenses		8 2 9
„ Accountancy and Audit ..		31 10 0
„ Annual Dinner Expenses ..	42 4 9	
Less Receipts .. .	23 16 9	
		18 8 0
„ Miscellaneous Expenses ..	.. ..	51 4 3
„ Repairs and Renewals ..	.. ..	8 13 0
„ Depreciation written off Office Furniture	.. ..	36 9 0
„ Legal Expenses re Lease ..	.. ..	10 0 0
„ Donation to British Empire Exhibition	.. ..	25 0 0
„ Surplus carried to Balance Sheet..	.. ..	170 12 4
		£1372 8 2

INCOME

	£ s. d.	£ s. d.
By Entrance Fees –		
94 Members	493 10 0	
61 Associate Members ..	192 3 0	
15 Graduates	15 15 0	
		701 8 0
„ Subscriptions—		
94 Members	440 9 6	
61 Associate Members ..	151 4 0	
15 Graduates	17 17 0	
		609 10 6
„ Donations	.. ..	3 3 0
„ Rents Receivable	.. ..	58 6 8
		£1372 8 2

BALANCE SHEET AS AT 31st DECEMBER, 1923

LIABILITIES

	£ s. d.	£ s. d.
Sundry Creditors		121 11 1
Life Compositions Account—		
Surplus for the year		94 7 0
Revenue Account—		
Balance as at 1st January, 1923 (taking into account Donations outstanding)	573 12 10	
Add : Surplus for the year ..	170 12 4	
		744 5 2
		£960 3 3

ASSETS

	£ s. d.	£ s. d.
Office Furniture—		
Balance as at 1st January, 1923	45 0 0	
Additions	137 5 4	
	182 5 4	
Less : Depreciation written off @ 20% p.a.	36 9 0	
		145 16 4
Guarantees Outstanding—		
As per Balance Sheet, 31st December, 1922..	766 4 6	
Less : Amount received to date	184 5 0	
		581 19 6
Rents Receivable—		
Chemical Engineering Group ..		29 3 4
Cash at Bankers and in Hand—		
Deposit Account	0 15 2	
Life Compositions Account ..	94 7 0	
Current Account	102 18 10	
Cash in Hand	5 3 1	
		203 4 1
		£960 3 3

On behalf of the Council—
ARTHUR DUCKHAM, *President.*
C. S. GARLAND.
F. H. ROGERS, *Hon. Treasurer.*

REPORT OF THE AUDITORS TO THE MEMBERS OF THE INSTITUTION OF CHEMICAL ENGINEERS

We have audited the foregoing Balance Sheet dated the 31st December, 1923, and have obtained all the information and explanations we have required. In our opinion, the Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Institute's affairs, according to the best of our information and the explanations given to us, and as shewn by the books of the Institution.

HUGHES & ALLEN,
Incorporated Accountants

67, Basinghall Street, London, E.C. 2. 12th February, 1924

SOCIETY OF CHEMICAL INDUSTRY
ANNUAL MEETING

Last week considerations of space prevented the insertion of some notes on the later items in the Liverpool programme. It must not be supposed that these were not as well organised and as interesting as the earlier items, and the delay in giving some account of them was, in the circumstances, unavoidable.

The United Alkali Co., Ltd., welcomed the Society at its Widnes works. Sir Max Muspratt, Bart., and other directors of the company, with an efficient staff of guides, showed the visitors round and explained the nature of the operations. The manufacture of ammonia from crude liquors and its oxidation to nitric acid interested them exceedingly, and it was striking to see the contrast between this modern development and the old, and yet successful, manufacture of bleaching powder. The great range of this company's operations is well known, and the skill shown in the manufacture of chlorine derivatives of organic bases is almost equally obvious. All those who visited this works were very grateful to the United Alkali Company for the hospitality and attention showed to them.

On the next day, July 10, a visit was paid to Port Sunlight. Time did not permit a tour round the whole town, but enough was seen to make us all wish to visit it some time in a leisurely manner. The magnificent hall in which we were entertained to dinner is spacious and interesting; the Hon. W. Hulme Lever acted as the principal host, Lord Leverhulme being obliged to return to London. Many of the members of the Society were much disappointed by the shortness of the day, twenty-four hours with a necessary deduction for sleep and meals, are inadequate for a place like Port Sunlight. One ought to spend a quiet six or eight hours looking at the pictures alone: they are a wonderful collection. Somehow or other means must be found on some future occasion for a more worthy inspection of them.

The visit to Lake Vyrnwy and the water supply of Liverpool was a fitting conclusion to the meeting. The mountains of Wales introduced a change of atmosphere which was mentally refreshing, although the actual temperature was almost tropical.

Next year the meeting will be at Leeds: in subsequent years no doubt other big cities will be visited. Liverpool will for long be an outstanding meeting; its huge numbers and the wonderful organisation of the various functions made it a striking success. It must be a great advantage to a city to have a happy Lord Mayor! Happiness is infectious, and at Liverpool we all caught some slight measure of the abnormal geniality characteristic of its Lord Mayor. It will never be possible to eclipse the Liverpool meeting, but in other ways and for other reasons the future meetings will also attain great success. Some cities and towns will strike different chords; in its way Liverpool was unique; other meetings will be unique in other ways, and we look forward to a long succession of pleasant meetings each with a charm of its own.

THE "RUTHS" STEAM ACCUMULATOR

(From a Correspondent)

One of the most remarkable developments in connexion with steam and power practice, of very particular interest to the chemical and allied industries, is the "Ruths" steam accumulator, the invention of Dr. Johannes Ruth, of Stockholm. The first patents were taken out in 1913, 165 patents being held by the end of 1921 whilst 214 further applications are pending, distributed amongst every civilized country. Also, we are given to understand over 150 installations are already at work on the Continent, and it will be remembered that Dr. Ruths delivered a paper on the subject at the recent World Power Conference at Wembley. The principle of accumulating or storing exhaust steam to a partial extent has, of course, already been used for many years past, such as for example without the use of water by merely passing it into an empty boiler or container, for immediate use to a low pressure steam turbine in the case of non-condensing colliery winding or rolling mill engines. Also, the principle of blowing exhaust steam into water in a container and re-evaporating the water has long been known to engineers and physicists, as in the Rateau accumulator and Druitt Halpin's feed water accumulator.

But Dr. Ruths set himself to use the principle of the accumulation of steam in water on the entirely different and much more important lines, of an essential part of the steam boiler plant so as to revolutionise the generation of steam in the boiler. He has been engaged for many years on research work concerning the intricate theoretical problems of the storage of steam in heated water, for details of which the original literature must be consulted. It is claimed that as a result of these investigations complete practical success has now been attained, and we are informed that accumulators with a storage capacity, which must be very large if success is to be obtained, of 25,000—70,000 lb. of steam are already in operation.

The general advantage from the point of view of the average chemical works, for example, is the extremely important one that the boiler plant can be kept running at a steady steam output and pressure all the time, whilst the steam is stored into the accumulator and delivered to the works exactly as required. Take, for example, a works with 5 Lancashire boilers. If the demand for steam was absolutely steady, say, at the rate of 22,500 lb. per hour, then 3 boilers would do, and they could always be run at the highest efficiency with a steady fuel feed and draught conditions and exactly the right size of feed water economisers and superheaters. In practice, especially in a chemical works, the demand fluctuates over wide limits, say, 15,000—37,500 lb. per hour, consequently 5 boilers have to be kept in operation instead of 3, in spite of the fact for the greater part of the time 2 or 3 boilers would do the work. This means a heavy drop in the efficiency of the steam generation for various reasons, including much greater radiation loss, and increased capital cost. The Ruths accumulator is essentially an apparatus which is added

to the boiler plant in such a way that in the above case the 3 boilers only can operate continuously at 22,500 lb. steam output, storing the excess in the accumulator which supplies automatically to the works any desired amount, even outside the range of 15,000—37,500 lb. per hour, without affecting the steam generation plant. That is to say the accumulator plays the same part in the equipment of the boiler plant as the flywheel in the steam or other engine, acting as a reservoir of energy.

The accumulator consists essentially of a large cylindrical container, generally horizontal, with hemispherical ends very like in appearance to the old "egg-ended" externally fired steam boiler, but of much greater size, built up of steel plates, which is almost full of water, to 90·95 per cent. of the total capacity, and covered with insulating material.

The steam from the boilers is admitted through a main provided with two non-return valves and this pipe passes along inside the accumulator almost the full length. To this steam main, which is under the surface of the water, is attached a considerable number, a typical installation being 16, of branch pipes leading downwards into wide mouth distribution nozzles which go almost to the bottom of the water. That is to say, the steam from the boiler is split up amongst a large number of nozzles and is mixed very rapidly and intimately with the water content of the accumulator. The steam passes out through a delivery pipe, and the whole is arranged to be perfectly automatic, any desired amount of steam passing out with a steady inlet from the boiler.

The principle of the steam accumulator would also appear to foreshadow a radical alteration in the design of the steam boiler. The ordinary "Lancashire" boiler, for example, in which by far the greater amount of steam in Great Britain is produced, acts first as a steam generator, that is an appliance in which liquid (water) is converted into a gas (steam). But it also acts in the very important capacity of a steam accumulator, a large reserve of steam always being stored above the water space, and one of the practical advantages of the cylindrical boiler as against the water tube type is this large reserve capacity, especially when the steam demand fluctuates as in most chemical works. Water-tube boilers have much less steam reserve, although they make up for this by increased rate of evaporation, but every steam boiler of ordinary design acts in a dual capacity, as a generator and an accumulator. The perfection of the separate steam accumulator means that we can now make the boiler for its true function only of a steam generator, that is merely a series of tubes with little or no steam space, and small water content, whilst all the steam is stored in the accumulator. Also the latter can be at lower pressure than the generator, so that for example a coil of pipes can be used for the latter at very great pressure, the steam passing through a reducing valve into the accumulator at a reasonable working pressure. A special form of accumulator can also be supplied to deliver superheated steam, which really consists of two containers on the regenerative principle on what may be termed one accumulator for superheated steam, and the other for latent heat.

THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS

ANNUAL REPORT

For the Year ending May 31st, 1924

(Slightly Abridged)

The Council has pleasure in presenting the Eighth Annual Report. The membership of the Association has increased from 135 to 152. In addition there are 11 Affiliated Associations, the same number as last year. The following have filled the respective offices during the year: President, Mr. R. G. Perry. Vice-Presidents, Sir John Brunner, Bart.; Dr. Charles Carpenter, C.B.E., M.Inst.C.E. Chairman, Sir Max Muspratt, Bart.: Vice-Chairman, Sir William Pearce; Treasurer, Mr. C. A. Hill, B.Sc., F.I.C. During the year there has been no change in the constitution of the Council. The Council records with satisfaction that the following members of the Council have been elected as Members of Parliament: Sir William Alexander, K.B.E., C.B., C.M.G., D.S.O., M.P.: Sir John Brunner, Bart, M.P.: and Dr. G. C. Clayton, C.B.E., F.I.C., M.P. The Council also desires to report that the General Manager, with their approval, has accepted nomination as President of the Society of Chemical Industry for the forthcoming year. In view of the visit of the Colonial Premiers to this country during the year, your Council thought it desirable to extend an invitation to them to be the guests of the Association with a view to discussing matters of mutual interest, and to visit representative works. Unfortunately, however, the Premiers, whilst anxious to accept the invitation, found it impossible to fit it in with their other arrangements.

British Empire Exhibition, 1924

The Council has organised what is believed to be the finest chemical exhibit which has ever been shown at any exhibition. The Chemical Hall at Wembley occupies 40,000 square feet, and is the largest section in the Palace of Industry. The aim which the Council had before it was to show to the world the present position of the industry and the progress recently made in the science of chemistry, such progress being the best guarantee for the stability of the industry. To this end, in addition to the industrial exhibit, and with the cordial co-operation of the Scientific Societies, the Council organised the Scientific Section, which has attracted such favourable notice. The Joint Scientific Committee, of which Dr. Levinstein acted as chairman, in addition to preparing the scientific exhibits, set up a Publications Committee, which took the responsibility of preparing literature to accompany the scientific exhibits. Of this committee Dr. E. F. Armstrong was chairman and also editor of the main publication, "Chemistry in the XX Century," a work which has achieved instantaneous success, and bids fair to carry all over the world the lesson which the Scientific Exhibit can best convey to those who visit it. In addition, a series of eight pamphlets on chemical subjects has been published, written in simple language for the general reader, and already

a large number of these have been sold to the public. The Council feels that members of the Association will desire to join them in offering hearty congratulations and grateful thanks to all who have co-operated in this successful enterprise. It is too early to attempt to estimate the total value of the Exhibition to the industry, but the Council is confident that the arrangements which it has made will be approved by the members and will be of lasting benefit in the improved status of Chemical Industry among other British industries.

Films for Chemical Industry

In furtherance of its policy of keeping the British Chemical Industry before the public, the Council has had prepared two films representing the manufacture and use of heavy chemicals and coal tar products respectively. The films will be exhibited throughout the country at public cinemas, and it is thought that by this means the public will be educated as to the importance of the chemical industry in national life.

Broadcasting

The general public have been further enlightened as to the importance of the industry through the medium of wireless telephony. On the 19 September, 1923, the General Manager spoke on the importance of "Applied Chemistry in Modern Life."

Market Reports

As announced last year, the system of contributing weekly Market Reports to *Chemistry & Industry*, the official organ of the Association, has been in operation throughout the year with marked appreciation and success. The Report is also made use of in other technical journals. The Council feels, however, that it is desirable that a larger number of members should contribute information for use in the compilation of these Reports, and has issued an appeal to all members inviting their co-operation. As in previous years, articles are being constantly written by the staff to the technical press with a view to keeping the industry well before the public.

Statistics

The arrangement with the Customs Authorities, announced last year, whereby statistics of imports of dutiable articles included in the Schedule to the Safeguarding of Industries Act are received monthly by the Association, has been in operation throughout the year, and in view of the utility of these statistics and the appreciation which has been expressed by the members the Council has decided to continue the arrangement throughout the forthcoming year.

Dyestuffs

The Council has been in frequent communication with the Board of Trade on the position brought about by the proposed agreement between the British Dyestuffs Corporation and the Interessen Gemeinschaft and other allied matters. The business of the Council is to develop chemical industry in this country and to safeguard the interests of all its members. It has endeavoured to do this in all the advice which it has given to the Government. At the time of preparing this Report it appears unlikely that the agreement will be ratified until the dyestuffs branch of chemical industry has been reorganised. In such a reorganisation the Council believes the members would desire it to take part, and the Council is willing at all times to give any possible assistance. The importation of certain British dyestuffs into Italy has been the subject of negotiations between the Governments of the two countries. An agreement has now been made to permit of the importation of British vat and gallocyanine dyes into Italy free of duty provided they are accompanied by a certificate of origin signed by the General Manager of the Association. The Council considered the proposal to establish a British textile school in China, and on the recommendation of Group IX appointed Mr. S. Whetmore of the British Dyestuffs Corporation to represent the Group on the General Committee.

Safeguarding of Industries Act

During the year only three appeals have been heard by the Referee under this Act. In the Rochelle Salt case the Referee held that Rochelle Salt was rightly included in the list as a fine chemical. Formaldehyde was removed from the list, but sodium formaldehyde sulphoxylate and zinc formaldehyde sulphoxylate were held to be rightly included on the ground they were synthetic organic chemicals.

Alcohol

It was announced at the last Annual Meeting that a number of concessions had been made by the Commissioners of Customs and Excise regarding the use of alcohol in chemical manufacture, and a memorandum on the general position was sent to all members in September last. At the request of the Commissioners the Council has since submitted a list of ethyl compounds in the manufacture of which the use of pure alcohol, denatured with 2 per cent. pure methyl alcohol, would be preferable to industrial spirit, and has suggested a conference between the Government chemists and representatives of the Association to discuss the evidence in support of the manufacturers' claim.

Translation of British Pharmacopœia into Chinese

The work of translating the British Pharmacopœia into Chinese is actively proceeding in Shanghai, and your Council is keeping in close touch with the progress being made. Criticisms and suggestions which have been made by the Council on the recommendation of Group VI have been adopted by the Translation Committee almost in their entirety.

Parliamentary Matters

Your Council has carefully watched legislation in so far as it affects chemical industry. Legislation with regard to Smoke Abatement, introduced into the House of Lords last year, has not become law owing to the change of Government, but it is anticipated that the question will again be raised, and any future developments will be carefully watched.

The Petroleum Bill, 1923, which had been introduced into the House of Lords to amend the Acts

of 1871 and 1879, was dropped by the Committee appointed to examine it.

It is anticipated that a Consolidated Factories Bill will be introduced shortly, and the Council is watching this matter.

Preservatives and Colouring Matters in Food

The Minister of Health has appointed a Committee to investigate the use of Preservatives and Colouring Matters in food, and your Council arranged for evidence to be given on behalf of the particular firms concerned.

Pitch, Standard Test for

In view of the varieties of the methods in use for testing Pitch, a desire was expressed that a standard method of testing Pitch which would be acceptable both to the producer and the user should be established. A Sub-Committee has been investigating the matter, but their labours are not yet complete.

Cresylic Creosote, Standard Test for

Difficulties having arisen between the producers and users of Cresylic Creosote as to the method of testing to be adopted for determining the quantity of Tar Acids present, a Sub-Committee was appointed to consider the matter. A method of testing has been adopted by the Association and submitted to the British Engineering Standards Association for adoption as the British Standard. The subject is at present being considered by that body.

Patent Law

The question of International Patent law has been a subject which has engaged the attention of your Council The necessity of having some central organisation to watch the interests of British manufacturers has resulted in the formation of the Trade Marks, Patents and Designs Federation, to which your Association has become affiliated. The Patents Committee has had several lengthy meetings to consider the International Industrial Property Convention of 1883, which regulates international relations in industrial property matters, and which is due to be revised at an official Conference to be held either this year or next. Representatives have also attended Conferences of the Federation on the same subject.

Rating of Machinery

The law relating to the Rating of Machinery in England differs from that in operation in Scotland, and an attempt was made in the last Parliament to unify the system, but, unfortunately, the Bill was not passed into law. A Departmental Committee has been set up to consider the question of the principle of the Rating of Machinery, and your Council, through the Federation of British Industries, has suggested that the basis for valuation of industry should be the structure of works plus the first motive power.

Census of Production

Members will be aware that a Census of Production is to be made on account of the current year. The President of the Association (Mr. R. G. Perry) has received and accepted an invitation from the President of the Board of Trade to serve on the Committee which has been appointed to deal with this subject.

Contracts

The unsatisfactory features of the Forms of Contracts issued by the Official and Public Bodies have been considered and representation made to the Federation of British Industries on the subject. As a result the Forms of Contract with Government Departments have been amended, but so far as Municipal Contracts are concerned the difficulties which members of the Association have experienced were not shared by those of other organisations, and in the circumstances it is felt that no useful action can be taken.

Unfair Competition

The question of Unfair Competition has been a subject which had engaged the attention of Trade organisations generally, and your Council is represented on a Committee set up by the Federation of British Industries to consider the subject and to draw up recommendations to the Government with a view to their being considered by Experts of the Economic Committee of the League of Nations at their meeting in Geneva. Sir H. Llewellyn Smith, Economic Advisor to the Government, has drawn up a Memorandum embodying the revised text of draft Articles of Convention on Unfair Competition, and these have been considered by the Committee referred to, and amended suggestions put forward in the interests of British manufacturers

Chemical Plant

Co-operation with the British Chemical Plant Manufacturers' Association has continued throughout the year, and as a result of representations made to your Council by the Plant Manufacturers, members have been asked as far as possible to place their orders for Chemical Plant with those firms who are members of the British Chemical Plant Manufacturers' Association.

Chemical Engineering, University College, London

Your Council received a request from University College, London, to appoint a representative on the Sub-Committee for Chemical Engineering, and is pleased to be able to report that Sir John Brunner, Bart., has agreed to represent the Association on that Sub-Committee.

Transport

The Transport Department has continued the policy of settlement by negotiation which has worked very satisfactorily. In August last a general reduction in railway rates was obtained to a level of 50 per cent. over the rates in operation on January 14, 1920, plus certain flat rate additions. The proposals of the Railway Companies as to the terms under which merchandise, other than dangerous goods,

would be accepted for conveyance at Owner's Risk, have been dealt with, and as the result of meetings with the railway companies only two or three points were left over for determination by the Railway Rates Tribunal. The conditions of Carriage for Damageable Goods, Merchandise by Passenger Train and Coal, Coke and Patent Fuel have also been settled. During last summer the railway companies submitted their proposed schedules of standard charges to the Rates Tribunal. Objection has been taken to the charges on the ground that they are too high. The subject will be discussed later with the Railway Companies, and if agreement cannot be reached the Tribunal will be asked to adjudicate. The Tribunal has commenced a public enquiry into the question of the net revenue of the railway companies, as provided for in Section 58 of the Railways Act, 1921. In order that Traders' interests may be safeguarded, an appeal for funds was made by the Traders' Co-ordinating Committee, and members of the Association have contributed an amount over £900.

The question of the retention of exceptional rates under Section 36 of the Railways Act has formed the subject of negotiations with the railway companies, with the result that a scheme has been drawn up which obviates the necessity for members giving particulars of each rate they require to be retained. The railways are taking a record of the rates actually used during a period of two years from January 1, 1924, and, subject to the provisions of the Act, all rates used during the two years, with a few minor exceptions, will be retained for use after the appointed day.

The liability of owners of private wagons to third parties for damage arising by reason of defects in such wagons has received careful attention. Counsel's opinion was obtained, and the view expressed that the railway companies were responsible to third parties if negligence could be proved against them. In some cases it would be difficult to say which party would be liable, and enquiries were therefore made to see if the risk could be covered by insurance. Your Council is pleased to be able to report that a policy has been arranged at the rate of 9d. per wagon per annum (minimum premium 20s. per annum), provided all wagons owned are insured. The amount covered is £10,000, including costs for any one accident, and £20,000, including costs in any one year. The charges made at the various ports throughout the kingdom have received the attention of your Council, and it is pleased to report that substantial modifications have been secured. Complaints of delay in the transit of tank wagons have been taken up with the railway companies concerned, and it is hoped that more satisfactory arrangements will be made by the railways to give generally better facilities for the transport of tank wagons. In addition to the foregoing matters, assistance has been given to various members in connexion with questions of rates, classification and sidings, which in many cases have resulted in concessions being obtained.

MAX MUSPRATT

FORTHCOMING EVENTS

Sept. 4 and 5. IRON AND STEEL INSTITUTE, Autumn Meeting at British Empire Exhibition, at 10.30 a.m. each day. (1) "Changes of Volume of Steels During Heat Treatment," by L. Aitchison and G. R. Woodvine. (2) "Investigations on the Herbert Pendulum Hardness Tester," by C. Benedicks and V. Christiansen. (3) "Effect of Changes in Total Carbon and in the Condition of Carbides on the Specific Resistance and on some Magnetic Properties of Steel," by E. D. Campbell and G. W. Whitney. (4) "Pickling: The Action of Acid on Iron and Steel, and the Diffusion of Hydrogen Through the Metal," by C. A. Edwards. (5) "Examination of Iron from Konarak," by J. N. Friend and W. E. Thorneycroft. (6) "On the Nature of High-Speed Steel," by M. A. Grossman and E. C. Bain. (7) "Improvements in the Brinell Test on Hardened Steel, including a New Method for Producing Hard Steel Balls," by A. Hultgren. (8) "Present Position of the Theories of the Hardening of Steel," by W. Rosenhain. (9) "Effect of Free Surfaces on the Plastic Deformation of Certain Metals," by F. C. Thompson and W. E. W. Millington.

Sept. 8 to 11. INSTITUTE OF METALS, Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at the British Empire Exhibition. On September 10 further papers will be presented for discussion, the afternoon being devoted to visits to works. A reception will be held in the evening at the National Physical Laboratory, Teddington. A detailed programme will be issued in August.

Sept. 15. BRITISH EMPIRE EXHIBITION, Conferences of Engineering Societies, to be held in Conference Hall No. 4, at 10.30 a.m. Short papers on various Engineering Subjects will be read and discussed. Further information and tickets may be obtained from the Secretary, Society of Engineers, 17, Victoria Street, Westminster, S.W. 1.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL AUTUMN DINNER

The Annual Autumn Dinner of the Society will be held in London on Friday, November 14, 1924.

The place and hour of meeting will be intimated later along with other details.

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The eighth volume of these Reports is now ready. The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members, post free in each case.

A Member of the Society may purchase a set of Vols. II to VIII inclusive at the reduced price of £2 2s. 6d., and a Non-Member can procure a set at

CORRESPONDENCE

"A POINT OF ORDER"

Sir,—Professor Lowry's letter in your issue of July 11 raises the question whether the signs — and + should be used in any sense but that denoting "a deficit or a surplus of one electron."

I submit that historically the first use of these as electrical signs was to indicate the *kind* of electrification, and this therefore has priority over the quantitative application. It seems to me undesirable to restrict the significance of the older signs, and the onus of finding satisfactory new signs with a quantitative meaning such as Professor Lowry requires for his electro-covalent double bond rests with him. The dot and dash, already appropriated by physical chemists as appendages to ions, would probably serve his purpose.

As to the pairing of signs, it may be pointed out that in my original paper on the "Latent Polarities of Atoms" it was made quite clear, I believe, that the + and — signs were to be understood as being paired in a neutral molecule, one pair for each pair of mutually attached atoms between which a real or latent polarity distinction could be demonstrated. Thus tests for the polarities of atoms in vinyl ether lead to two separate expressions:

$$CH_2{=}CH{-}O\,Et \text{ and } CH_2{=}CH{-}O\,Et$$

and Professor Lowry now takes exception to such combined expressions as

$$CH_2{=}CH{-}O\,Et$$

which is simply an abbreviation for the more awkward forms,

$$CH_2{=}CH{-}O\,Et \quad \text{or} \quad CH_2{=}CH{-}O\,Et$$

No single alternative is free from objections; but the first, interpreted sympathetically, need give rise to no real confusion, and is to be preferred until a much better one has been invented.

Professor Lowry also discusses the phenyl group, of which a good deal has been heard lately. Kermack and Robinson (*Trans.*, 1922, **121**, 431) suggested that the benzene ring may functionate as a resonator rather than (I suppose) as a true key polarising group. Researches at Manchester tend to confirm this or what may in reality amount to the same thing in the long run—to show that the feeble electro-chemical character of this group renders its action wholly subservient to what Dr. Flürscheim has termed its "quantitative" effect or factor. This factor is manifested by the great strength of the bond by which it attaches itself to any atom and a consequent "weakening" and "tightening" alternately of the succeeding bonds and free or residual affinities. How, in spite of the apparently non-polar character of such disturbances, the apparently inconsistent behaviour of styrene, for example, towards polar reagents can be reduced to order, without the introduction of any new assumption, will shortly be demonstrated elsewhere.

In the hope of partially dispelling certain prevalent misunderstandings, may I be allowed to add the following remarks. The principle of induced alternate polarities does not supersede the three great factors in organic chemistry so ingeniously manipulated by Flürscheim in his classical papers, but claims recognition as a fourth factor (overlooked by Flürscheim in his calculations), and one as well worthy of consideration as the other three, often assuming the leading role. Next, it is not, as Professor Ingold erroneously assumes (*Trans.*, 1922, **125**, 93), a part of the disputed principle that when tervalent nitrogen and divalent carbon act in opposition the oxygen is invariably the key atom. The original statement (*Mem. Manchester Lit. and Phil. Soc.*, 1920, **64**, iii, 1) ran as follows—"Where they are in competition the influence of the oxygen *usually* appears greater than that of the nitrogen." (The italics are new.)

Lastly, it is no part of the principle that the piling up of homogeneously arranged key atoms necessarily enhances the effects initiated by one key atom. This fact was obvious from the beginning, and the carbonyl groups and the α-hydrogen atoms of carboxylic acids are incomparably less reactive than the corresponding aldehydes or ketones in spite of the additional oxygen atoms homogeneously arranged. As systems strive towards homogeneous arrangements, so minima of potential energy occur with complete "homogeneity" as with complete symmetry; maxima of potential energy are to be expected with some degree of heterogeneity.

Organic chemists will quickly recognise that the polar additive reactions of carbonyl in the complex

CH_3

$\quad\!\!>C{=}O$ are most in evidence, *not* when A is

A

an atom or group such as —Cl, —OH, —O Et, or —NH_2, tending to enhance the necessary induced positive character of the carbon atom, but when A is —H or —CO.X, which function in the opposite way from the carbonyl oxygen which confers on the carbon atom its distinctive character.—I am, Sir, etc.,

ARTHUR LAPWORTH

The University, Manchester
July 14, 1924

Sir,—In a recent letter entitled "A Point of Order" (this vol. p. 723) Professor Lowry protests against the practice of using plus and minus signs "in such a way that ions and molecules are not distinguished from one another." In the same letter Professor Lowry refers to me in a way which might suggest that I am an upholder of the custom of which he disapproves. I may, therefore, perhaps be allowed to make my position clear, and to say that, on the contrary, I entirely agree with him in his condemnation of the practice. The misunderstanding which led Professor Lowry to quote certain polar formulæ which I wrote at the Chemical Society is a very curious one, for it will be evident to anyone who reads the report of that discussion* (this vol.

* Despite some obvious misprints, *e.g.*, "a key position" for "key-positive,"

p. 665) that I was using the language employed by the principal advocates of the polarity theory merely for the purpose of showing to what fallacious results a fallacious theory can lead, and not in the least because I, myself, believed a word of it!

Every student of Organic Chemistry is aware that carbon valencies possess some attribute (of quality, or of amount) which can *alternate* along a chain. All are aware of the existance of an influence which manifests itself near certain groups, and may aptly be termed a "*polar*" influence. My own study of the numerous facts, and many discussions with my friends and co-workers, have, however, convinced me that the combination of these two ideas into a "theory of alternate polarities" (whether a general theory, or one relating to double bonds alone) is wrong. It is, I believe, a false combination of correct ideas, and, despite all the attractions of its simplicity, it is not, nor will any so elementary a generalisation turn out to be, the true solution of our difficulties.—I am, Sir, etc.,

CHRISTOPHER INGOLD

THE USE OF ALUMINIUM

Sir,—Answering the inquiry of Mr. Joseph Barnes on page 667 of your issue of June 27, as to how the idea originated that food cooked in aluminium is injurious to health, it should be remembered that the aluminium used in making pots and the like may in some cases contain metals other than aluminium, *e.g.* zinc or copper, added mainly to make the alloy work right. If zinc or copper dissolve off, there may be trouble, but the greatest care must be exercised in finding the facts in any particular case, for the illness reported may of course have quite other causes.—Yours, etc.,

JEROME ALEXANDER

July 11, 1924

SAFEGUARDING OF INDUSTRIES

Sir,—I have read with interest Sir William Pope's letter in your issue of the 13th ult., commenting on mine of May 2. As we have had each the opportunity of stating our views, I have no doubt Sir William will agree that no good purpose will be served by a lengthened correspondence, and that it will be sufficient to leave the issues raised to the consideration of your readers.—I am, Sir, etc.,

WM. E. KAY

PERSONAL AND OTHER ITEMS

The death has occurred of Dr. N. Lorenz, who will be remembered as the originator of a method of estimating nitrogen.

Dr. M. Benjamin, the editor of the publications of the U.S. National Museum, and an original member of the Society of Chemical Industry, has been made a knight of the Order of the Crown by the King of Italy, in recognition of his attainments in Science.

The German Dyestuffs Industry

According to a report by the U.S. Department of Commerce, the Italian dye market is practically under German control, and if the "cartel" and the British Dyestuffs Corporation complete an agreement, German interest in British dye markets will be important. The possibility of an agreement between Swiss dye interests and the "cartel" is discussed, and it is suggested that France can maintain "only a limited independence" of the "cartel," which appears to have been at work in Russia. Expansion of the "cartel" is limited, however, by the natural resources of Germany and costs must grow the more dependent Germany becomes on imported raw materials. The industry tends toward self-sufficiency, controlling power, mines and a states up to finished products. At present acti work is being carried out to find new applicati — (*Oil, Paint and Drug Rep., June* 30, 1924.)

COMPANY NEWS

MOND NICKEL CO., LTD.

Presiding at the tenth annual general meeti the Right Hon. Sir Alfred Mond referred to the death of Sir Edmund Walker, the late presider n the Bank of Commerce of Canada, who had r sented the firm in Canada for a great many and to the death of Mr. F. J. Bloomer, the manager at Clydach, who was connected with company since its first inception. A profit and lo account was published, for the first time, which showed a balance of profit of £276,457. Additions had been made during the year to mines and other properties in Canada of £104,926, which, except for £13,000 transferred from suspense account, represented expenditure during the year in Canada on construction at the Coniston Smelter, enlarged by the addition of a third unit, now in operation, and on special development work at one of the mines. The amount of £79,863 had been written off from special depreciation reserve, in respect of the value of the Canadian properties, leaving a net addition to the same of £25,062. Additions made to properties in the United Kingdom amounted to £224,712, which included £136,075 transferred from suspense account. The sum of £106,292 had been written off the property at Clydach. A balance still remained which would be allocated in due course.

The credit balance on profit and loss for the year was £276,457, £31,317 less than in the previous year, due to the low prices prevailing for the main products—nickel and copper sulphate—during the greater part of the year, the price now obtained for these being below pre-war value, although the costs of production were above the pre-war level. The same occurred with regard to copper, the prices being unduly depressed on account of close competition. The exchange fluctuations in the main export markets—France and Italy—made business very difficult. There was an increase of 47 per cent. in the tonnage of nickel sold. The use of nickel in non-ferrous alloys was continuing, and some of the big countries had substituted nickel coins for paper notes and silver coins of small denomination. The use of nickel was

rapidly growing, especially in America, and the company had established considerable works there and also associated itself with a concern which was beginning to market nickel utensils on a considerable scale. This company, being in its initial stages, was not producing anything towards the dividend of the company, but progress was being made, and it was hoped that in time it will be a valuable concern.

A good deal of the prejudice which existed in the past, and of the difficulties put in the way of the use of nickel owing to insufficient technical research, was being overcome by the company, which controlled production in all its stages.

Messrs. Henry Wiggins and Co. this year declared a dividend of 10 per cent. on the ordinary shares, free of tax, over a period of nine months, as against 4 per cent. over twelve months for the previous year. This concern was becoming a valuable asset to the Mond Nickel Co.

The accounts were passed and the following dividends were declared :—To the holders of the 500,000 cumulative preference shares and the 2,000,000 non-cumulative preference shares of £1 each, numbered 1 to 2,500,000 inclusive, in the capital of the company, a dividend of 7 per cent. per annum for the year ended April 30, 1924, including the interim dividend paid on March 3, 1924, and subject to the deduction of income-tax. To the holders of the 900,000 ordinary shares of £1 each, numbered 1 to 900,000 inclusive, a dividend of 2s 6d. per share, subject to deduction of income-tax, and including the interim dividend paid on March 3, 1924. On the motion of the Chairman, seconded by Mr. Robert Mond, J.P., the retiring directors (Dr. C. V. Corless, Viscount Erleigh, Sir Robert Hadfield, Bt., and Mr. Robert Mathias) were re-elected

REPORT

Annual Report of H.M. Chief Inspector of Factories and Workshops for the Year 1923. Pp 129. Cmd. 2165. H.M. Stationery Office, 1924. Price 3s.

The raw silk industry is in a very bad state owing to foreign competition and also to the rapid growth in the manufacture of artificial silk ; an artificial silk factory has been extended in Coventry and another large works has been opened in the Wigan district.

With trade in such an unsettled condition, new developments have been less numerous than usual in the Midlands. Perhaps the most striking are : the development of large electrical power stations ; also the introduction of the "Schoop" process of metal coating by a finely-divided spray of molten metal ; the manufacture of synthetic ammonia and nitrates ; new operations for purifying lead by a wet chemical process ; an electrolytic process for the manufacture of carbonate of lead, and the further development of the internal combustion marine engine. Production in the manufacture of stainless steel and rustless iron has made rapid strides, and many new developments are recorded.

The initial difficulties met with in the administration of the celluloid code are being gradually overcome, but some cases, particularly those relating to inward opening doors and the means of escape in the tenement factories in Sheffield, have not yet been satisfactorily settled. Many interests are involved and consequently the work is slow, but steady progress is being made to ensure compliance with the requirements. Trade depression and financial stringency have prevented more rapid progress.

Chemical Works.—Substantial compliance with the requirements of the Regulations has been secured without resort to a single prosecution. Mr. Brothers (Warrington), in whose district there are a large number of important works, reports that the manufacture of salt cake has now become almost a mere minor product. One case of arseniuretted hydrogen poisoning arose from the solution of zinc residue in sulphuric acid, with the escape of fumes into the workroom. Suppression of dust is the chief difficulty where certain materials are conveyed long distances, and economical forms of mechanical conveyance do not lend themselves readily to enclosure ; success has not yet been attained. No difficulty has been experienced in securing efficient illumination ; in fact there is rarely any deficiency found. As regards inflammable dust, it has been found necessary to have double air-tight glass covers for incandescent electric lamps about coal grinding plants for furnace firing by dust. Improved methods of dealing with dust are discussed at length.

The liability to an escape of a dangerous gas or fume which calls for the provision of respirators, etc., exists in 27 of the chemical works. In 19 of these 27 factories apparatus is kept of the definitely safe type where only outside air is breathed, but in many of these 19 works it is desired to retain the right to use an apparatus of the Tower or the Army Box Absorber or the self-contained Mines Rescue types. The monthly examination is regularly and methodically performed. There have been cases of gassing in chemical works during the year due to carbon monoxide, sulphur dioxide and to chlorine, but in no case was it due to a failure to observe the regulations. Certain types of self-contained breathing apparatus have been approved for use in mines by the Mines Department of the Board of Trade and, upon application being made for their use in chemical works, approval will be given. The precautions against inadvertent production of arseniuretted hydrogen are generally well observed, and wooden buckets and spades, copper or lead scoops and ladles are generally used for this purpose. In sulphate of ammonia plants a copper scoop is usually used. The provision of drenching water and eye wash bottles has been found with but few exceptions to be satisfactory.

Many applications for exemption were received from gas undertakings in respect of sulphate of ammonia and tar-dehydrating plants. Agreement has been come to with the National Gas Council as to the exemption to be given for sulphate of ammonia plants but not for tar plants. The danger of epitheliomatous ulceration from tar exists even in small works, and it is not desirable to give exemption from the necessity to provide suitable bath and washing accommodation. Eighteen certificates have been

granted during the year, mainly to permit the use of public baths instead of providing bath accommodation at the works.

The use of the plastic form of rubber mixed with lead oxide is increasing. By its use exemption from the requirements to provide exhaust ventilation and to have periodical medical examination of the workers follows automatically. The chief development that has been noted is the use of rubber solutions in the manufacture of *crêpe* soled tennis and similar shoes, which bring these works within the scope of the regulations. The trade has readily complied with the requirements, and the danger has been guarded against from the outset. The demand for this rubber solution has led to an extension in its manufacture. It is generally made in mechanical mixers, from which the danger of escaping fumes is limited and can be adequately met by maintaining a suitable ventilation.

The advantage of good natural lighting in works has also been realised, and a new method giving a good illumination towards the centre of wide buildings depends on light refraction. The idea appears to be to throw the light horizontally across the room, no matter in what direction it may fall upon the outside of the windows, by means of "prismatic glass," the surface of which, instead of being smooth, is ridged vertically at angles of 30° or 45° or 60°, whichever is preferred.

Exceptions to the general compliance with Statutory Welfare Orders are to be found in chrome dyeing, glass-bottle making, and in a less degree glass-bevelling. The bi-weekly inspection of fingers is difficult to observe in the large dyeworks by reason of the refusal of some of the operatives to submit to examination. The bi-weekly examination of the fingers has not only resulted in the discovery of septic wounds due to causes other than chrome, but has had the intended effect of eliminating men susceptible to chrome eczema and chrome ulceration from rooms in which chrome is used. In one factory where three chrome cases due to fluoride of chrome, which is not within the scope of the Order, had occurred in the printing of wool, the occupier consented to carry out the whole of the provisions of the Order in relation to this process.

Medical inspection inquiries among others, related to special incidence of lead poisoning in shipbreaking and in the manufacture of electric accumulators; visits to certain centres in Germany to see the effect on horsehair of low-pressure steam disinfection as a means of protection against anthrax; incidence of epitheliomatous ulceration among mule spinners from mineral oil and in the manufacture of arsenic compounds; the following up of the first definitely recorded cases in this country of manganese poisoning. Reference is also made in some detail to fatal poisoning from arseniuretted hydrogen gas, from fumes from melted cadmium, and from benzol; and to effects on health from new developments in the use of organic chlorine solvents, such as trichlorethylene, in affixing *crêpe* soles in the boot trade. The following is a table showing the number of cases of poisoning due to lead, phosphorus, arsenic and mercury, toxic jaundice, epitheliomatous and chrome ulceration and anthrax:—

Disease and industries	1923	1922	1921
Lead poisoning	337 (25)	247 (26)	230 (23)
1. Smelting of metals ..	19 (2)	9 (2)	25 (4)
2. Plumbing and soldering	8 (1)	8	7
2a Shipbreaking	38	17	7
3. Printing	6 (1)	11	12 (1)
4 File cutting	—	—	—
5. Tinning	2	2	1
6 Other contact with molten lead	12 (1)	15	7 (1)
7. White and red lead ..	37	22 (2)	17 (1)
8. Pottery	44 (11)	42 (17)	35 (11)
9. Vitreous enamelling ..	5	3	8
10. Electric accumulators .	95 (2)	32	35
11. Paints and colours ..	11 (1)	14 (1)	13 (1)
12. Indiarubber . ..	5	3	4 (1)
13. Coachbuilding	13 (3)	15 (1)	20 (1)
14. Shipbuilding	8 (1)	12 (1)	4 (1)
15. Paints used in other industries	21	23 (2)	12
16. Other industries ..	13 (2)	19	23 (1)
Phosphorus poisoning ..	—		—
Arsenic poisoning	—	—	1
Mercurial poisoning	4	6 (1)	—
Toxic jaundice	7 (2)	3	1 (1)
Epitheliomatous ulceration ..	58 (4)	32 (3)	32 (2)
Chrome ulceration	58	42	29
Anthrax—	46 (5)	45 (5)	25 (6)
1. Wool	14 (1)	19 (3)	11 (3)
2. Horsehair	9 (2)	9 (1)	4 (1)
3. Handling of hides and skins	22 (1)	16 (1)	8 (1)
4. Other industries ..	1 (1)	1	2 (1)

N.B.—The principal numbers relate to cases, figures in brackets to deaths. Fatal cases not reported in previous years are included as both cases and deaths.

Two cases (one of them fatal) from arseniuretted hydrogen occurred in a dross refining foundry, as a result of a thunderstorm. An alloy of arsenic is present in the dross, capable of giving off comparatively large quantities of arseniuretted hydrogen under the action of cold water. It is known that a compound of aluminium with arsenic readily evolves arsine on treatment with water.

Anthrax.—The figures for wool show the effect of the station for disinfection at Liverpool, only one case having been reported from Bradford. Of the 14 cases, East Indian Wool was present in the wool handled in at least nine. Anxiety exists in the trade as to the risk of anthrax from horsehair, especially that from Russia and Siberia, as out of 18 cases since January 1, 1922, 11 (three fatal) were due to this material. As the plant of the Wool Disinfecting Station at Liverpool cannot deal with tail hair, the question was raised whether the method of steam disinfection of foreign horsehair and bristles required under the German regulations since 1899 could not be adopted.

Four cases of chrome ulceration occurred in a paper mill to persons employed in producing chromate of lead, by double decomposition, the solution of chromate being poured into the beaters containing the half-stuff from whence it passed to the paper machine, producing a yellow-tinted paper. The workers had to feel with their fingers the condition of the "half-stuff" to ascertain when it was fit to be discharged to the mill, and the wearing of gloves for this was impracticable. Since the outbreak, the firm has supplied good washing accom-

modation and first-aid requisites, and has arranged for regular inspection of the fingers. No further cases have been reported.

Inquiry has been made into outbreaks of dermatitis arising from many substances used in industry. The cases may be classified as follows:—Dyes and intermediates 24; alkalis, caustics, acids, 15; turpentine, 14; volatile liquids, spirit polishes, etc., 11; flour, sugar, etc., 9; wood dusts, 6; lime and calcium compounds, 3; miscellaneous, 13; non-industrial, 5. In an inquiry into the prevalence of dermatitis among fur dyers using para- or meta-phenylenediamene, the number of cases found was small, considering the irritative effect of this dye on the skin.

Three non-fatal cases (two of them rescuers) of unconsciousness produced by trichlorethylene occurred in the painting of a brewing vat with a preparation of enamel. No instructions had been given on the label on the container of the enamel, except that when it was used in vats there should be free ventilation. A special cautionary notice is now issued with the enamel.

No definite poisoning from amyl acetate has been observed, although its use has considerably increased. Unless localised exhaust ventilation or good general ventilation is maintained, the workers suffer from headache, drowsiness and throat irritation, particularly when first commencing work. No permanent injury to health results from inhalation of this fume.

The use of solvent recovery plants in the india-rubber industry appears to be increasing owing to the greater efficiency of modern methods of recovery. In some cases 70 per cent. of the solvent spirit is said to be recovered. In the processes of spreading, calendering, and "frictioning," in which a rubber dough, heavily charged with naphtha or similar spirit, is used, there is always a danger that the electrostatic charges created on the surface of the fabric may give rise to sparks and ignite the vapour from the spirit, thus causing a fire or an explosion. This danger is well recognised in the indiarubber trade, and has doubtless hindered the introduction and development of solvent-recovery plants. The use of flue gas has proved successful in preventing fire in solvent-recovery plant.

The possibility of an explosion occurring through the ignition of a cloud of fine dust of any combustible material does not appear to be sufficiently realised by many occupiers and managers of factories. In some cases where the risk is known, the precautions taken to avoid or to minimise it are very inadequate. The majority of explosions due to this cause were due to dusts of carbonaceous materials, *e.g.*, vegetable products, coal, dye substances, naphthalene, ebonite, pitch; but some explosions have been due to sulphur dust, and in previous years explosions from aluminium and magnesium powders have been reported. The manufacture and use of these metallic powders have decreased since the war and additional precautions have been taken by the firms concerned so as to reduce the risk of explosion; no explosion of metallic powders has occurred during the past two years,

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	.. £45 per ton.
Powder ..	.. £47 per ton.
Acid Hydrochloric	.. 3s. 9d.–6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	.. £21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric ..	.. Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali..	.. £6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	.. Spot £11 d/d.: Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	.. £7 per ton, packages extra.
Borax, Commercial—	
Crystal	.. £25 per ton.
Powder ..	.. £26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	.. £5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial ..	.. 3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised ..	.. 4s. 2d.–4s. 6d.
Potash Caustic ..	.. £30–£33 per ton.
Potass. Bichromate	.. 5¾d. per lb.
Potass. Chlorate..	.. 3d.—4d. per lb.
Salammoniac ..	.. £32 per ton d/d.
Salt Cake.. ..	.. £3 10s. per ton d/d.
Soda Caustic, solid	.. Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals ..	.. £5 5s.–£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	.. £24 per ton.
Sod. Bicarbonate	.. £10 10s. per ton, carr. paid.
Sod. Bichromate..	.. 4½d. per lb.
Sod. Bisulphite Powder 60/62%.. ..	.. £18–£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate ..	.. 3d. per lb.
Sod. Nitrate refd. 96%	.. £13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	.. £9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	.. 5¾d.—1s. 4d. per lb., according to quality.
Crimson ..	.. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	**1s. 1d. per lb.**

Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	7d. per lb. ex wharf. Dearer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	45s per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 6d. per lb.
Vermilion, pale or deep	4s. 10d. per lb
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton. Fair demand.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall. 60% O.P. Market dull.
Solvent	5s. 6d. per gall. 40% O.P. Fairly good demand.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£46 per ton.

TAR PRODUCTS

Prices in this section show some irregularity according to district. In the North East counties, for instance, anthracene, oil, solvent naphtha and naphthalenes are cheaper than in Lancashire or London. On the other hand, crude carbolic and creosote are dearer.

Acid Carbolic—	
Crystals	6½d.—6¾d. per lb. Fair inquiry.
Crude 60's	1s. 9d.—2s. per gall., according to district. Still quiet but slightly firmer.
Acid Cresylic, 97/99	2s 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—1s. 11d. per gall. Steady demand.
Dark	1s. 10d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	8½d.—9½d. per gall. Quiet.
Unstrained	7½d.—8½d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d. per gall.
Pure	1s. 8d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	9d.—9½d. per gall. Few inquiries.
Middle Oil / Heavy Oil / Standard Specification	5½d.—6d. per gall in Lancashire; 7d.—8d. per gall. in Yorkshire.
Naphtha—	
Solvent 90/160	1s. 1d.—1s. 4d. per gall. according to district. Rather better inquiry.
Solvent 90/190	1s. 1d.—1s. 4d. Fair business passing.
Naphthalene Crude—	
Drained Creosote Salts	£4—£6 10s. Quiet.
Whizzed or hot pressed	£9 per ton. Little business.
Naphthalene—	
Crystals and Flaked	£13—£17 per ton in Yorkshire and London respectively. Market quiet.
Pitch, medium soft	52s. 6d.—60s. per ton f.a.s. for next season. Frequent inquiries.
Pyridine—90/160	19s.—20s. per gall. Market less firm.
Heavy	12s.—12s. 6d. Little business.

INTERMEDIATES AND DYES

There has been a fair demand for dyestuffs during the past week. Prices remain constant. A number of intermediate products have been reduced in price.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 7d. per lb.
Acid H	4s. per lb 100% basis d/d.
Acid Naphthionic	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1d. per lb. Improved demand.
Acid Sulphanilic	9¼d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8¼d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 1d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4½d. per lb. Demand steady.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	2s. 3d.—2s. 11d. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£85 per ton.
Diethylaniline	4s 7d. per lb. d/d, packages extra, returnable.
Dimethylaniline	2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. per lb. d/d
Monochlorbenzol	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 3½d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works

o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis
m-Phenylene Diamine	4s. per lb. d/d.
p-Phenylene Diamine	10s. 3d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 3d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 6d. per lb. naked at works.
m-Toluylene Diamine	4s. 3d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P	£45 per ton.
Acid, Acetyl Salicylic	3s. 3d. per lb. Very heavy demand. Price firm.
Acid, Benzoic B.P.	3s. 6d. per lb. Larger supplies available.
Acid, Boric B.P.	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6½d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal.
Acid, Pyrogallic, Cryst.	7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic	1s. 6d.—1s. 8d. per lb. Low prices have stimulated more inquiry.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d.—1s. 2d. per lb. less 5%.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 3d. per lb. for quantity. Demand slow. Prices shaded to secure large orders.
Amidopyrin	13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. per lb. Quiet market.
Benzonaphthol	5s. 3d. per lb. Small inquiry.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Prices vary. Local stocks are being cleared and forward prices are higher. There are rumours of a coming shortage and higher prices in Germany. Average spot values:—
	Ammonium 1s. per lb.
	Potassium 10d. per lb.
	Sodium 11d. per lb.
Calcium Lactate	Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate	4s per lb. Very firm and scarce.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Formaldehyde	£55 per ton, *ex* works. English make in casks. About 8s. per cwt. extra for carboys.
Glycerophosphates—	Fair business passing
Calcium, soluble and citrate free	7s. per lb.
Iron	8s. 9d. per lb.
Magnesium	9s. per lb.
Potassium, 50%	3s. 6d. per lb.
Sodium, 50%	2s. 6d. „
Guaiacol Carbonate	10s. 6d.—11s. 3d. per lb.
Hexamine	3s. 6d. per lb. for English make. Market steady.
Homatropine Hydrobromide	30s. per oz.
Hydrastine hydrochlor	English make offered at 120s. per oz.
Hypophosphites—	
Calcium	3s. 6d. per lb., for 28-lb. lots.
Potassium	4s. 1d. per lb.
Sodium	4s. „
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 2d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	52s. 6d. per lb. Weaker.
Synthetic	26s.—31s. per lb., according to quantity. English make. Strong demand.
Mercurials	Market firm and more active.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. „
White precip.	4s. 7d.—4s. 8d. „
Calomel	3s. 11d.—4s. „
Methyl Salicylate	2s.—2s. 3d. per lb.
Methyl Sulphonal	26s. per lb.
Metol	11s. per lb. British make.
Paraformaldehyde	3s. per lb. Ample supplies.
Paraldehyde	1s. 6d. per lb. in free bottles and cases.
Phenacetin	6s.—6s. 3d per lb. Price and demand steady.
Phenazone	7s. 3d.—7s. 6d. per lb. A shade firmer. Forward prices higher.
Phenolphthalein	6s. 6d. per lb. Dealers appear anxious to sell.
Potass. Bitartrate— 99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 10d—2s. 2d. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues heavy.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate	7d.—7½d. per lb. Keen competition keeps price low
Quinine Sulphate	2s. 3d. per oz., in 100 oz. tins. Very heavy demand.
Resorcin	5s. 6d.—5s. 9d. per lb. Firmer Scarce.
Saccharin	63s. per lb., in 50-lb. lots.
Salol	3s. 6d.—3s. 11d. per lb.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 6d. per lb. Ample supplies B.P. quality available.
Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity. Firm in common with other citrates.

Sod. Hyposulphite—Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside ..	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt) ..	.. 75s.—82s. 6d. per cwt., according to quantity. Steady market, good demand.
Sod. Salicylate ..	.. Market more active. Powder 2s. 2d.—2s. 4d. per lb. Crystal at 2s. 4d.—2s. 6d. per lb. Flake 2s. 9d. per lb.
Sod. Sulphide—Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol	.. 18s. per lb. Very scarce indeed. Still rising. Forward quotations 22s. per lb.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.	
Aubepine ..	.. 15s. 3d.	.. Advanced.
Amyl Acetate ..	.. 2s. 9d.	,,
Amyl Butyrate ..	.. 6s. 9d.	,,
Amyl Salicylate ..	.. 3s. 3d.	,,
Anethol (M.P. 21/22° C.)	4s. 6d.	,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 10½d.	,,
Benzyl Alcohol free from Chlorine ..	.. 2s. 10½d.	,,
Benzaldehyde free from Chlorine ..	.. 3s. 6d.	,,
Benzyl Benzoate	.. 3s. 6d.	,,
Cinnamic Aldehyde Natural ..	.. 15s. 6d.	,,
Coumarin ..	.. 20s.	,,
Citronellol ..	.. 16s.	.. Advanced.
Citral	.. 10s.	,,
Ethyl Cinnamate	13s. 6d.	.. Cheaper.
Ethyl Phthalate ..	.. 3s. 3d.	,,
Eugenol	.. 11s.	.. Advanced
Geraniol (Palmarosa)	.. 35s.	,,
Geraniol	.. 11s.—18s. 6d. per lb.	
Heliotropine ..	. 7s. 9d.	,. Advanced.
Iso Eugenol ..	.. 15s. 9d.	,,
Linalol ex Bois de Rose ..	26s.	,,
Linalyl Acetate ..	.. 26s.	,,
Methyl Anthranilate	.. 9s. 6d.	,,
Methyl Benzoate	.. 6s.	,,
Musk Ambrette ..	.. 45s.	..
Musk Xylol ..	.. 15s.	.. Cheaper.
Nerolin	.. 4s. 9d.	,,
Phenyl Ethyl Acetate	.. 15s.	., Advanced.
Phenyl Ethyl Alcohol	.. 16s.	,,
Rhodinol	.. 57s. 6d.	,,
Safrol	.. 1s. 10d.	,,
Terpineol	.. 2s. 4d.	,,
Vanillin	.. 25s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 15s. 6d. per lb.	
Anise Oil	.. 2s. 8d. per lb.	
Bergamot Oil ..	.. 19s. 6d. per lb.	
Bourbon Geranium Oil ..	36s. 6d. ,,	
Camphor Oil ..	.. 75s. per cwt.	
Cananga Oil Java	.. 10s. 6d. per lb.	
Cinnamon Oil, Leaf	.. 6½d. per oz.	
Cassia Oil, 80/85%	.. 8s. 9d. per lb.	
Citronella Oil—Java 85/90% ..	. 5s. 9d. per lb.	Cheaper.
Ceylon .. .	. 3s. 7½d. per lb.	Cheaper
Clove Oil	.. 7s. per lb.	
Eucalyptus Oil 70/75% ..	2s. per lb.	
Lavender Oil—French 38/40% Esters	29s. per lb.	
Lemon Oil ..	.. 3s. per lb.	
Lemongrass Oil	.. 3d. per oz.	
Orange Oil, Sweet	.. 13s. 3d. per lb.	
Otto of Rose Oil—Bulgarian ..	.. 30s. per oz.	
Anatolian .	. 26s. per oz.	
Palma Rosa Oil ..	.. 19s. per lb.	
Peppermint Oil—Wayne County	.. 20s. 9d. per lb.	
Japanese ..	.. 14s. 3d. per lb.	
Petitgrain Oil	.. 9s. 6d. per lb.	
Sandal Wood Oil—Mysore	.. 26s. 6d. per lb.	
Australian ..	.. 21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before Sept. 1, 1924; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on July 31.

I.—Applications

Deckers. Preventing formation of and removing boiler scale. 16,430. July 9.

Felten und Guilleaume Carlswerk Akt.-Ges. Acid proof coating for metallic vessels. 16,510. July 9. (Ger., 12.2.24.)

Gill and John. Drying apparatus. 16,529. July 9.

Kempter. Crushing and kneading mills. 16,333. July 8.

Kuntz. Rotary driers. 16,308. July 7.

Metropolitan-Vickers Electrical Co., Ltd. Means for obtaining inert atmospheres. 16,596. July 10. (U.S., 20.7.23.)

Naamlooze Vennootschap Utrechtsche Fabriek van Centrale Verwarming and Constructiewerken voorheen H. Zimmermann & Co., and Zimmermann. Drying. 16,631. July 10.

I.—Complete Specifications Accepted

3197 (1923). Woodall, Duckham, and Jones (1920), Ltd., and Duckham. Annular furnaces or kilns. (218,343.)

6251 (1923). South Metropolitan Gas Co., Woodall, Duckham, and Jones (1920), Ltd., and Hatfield. Electrostatic separation of particles. (218,354.)

13,762 (1923). Keene. Filtering-apparatus. (218,117.)

15,141, 26,042, 26,043, and 27,226 (1923). Fink. Separating liquids. (218,462.)

16,010 (1923). Aktiebolaget Separator. Centrifugal separators. (202,616.)

21,303 (1923). Appareils et Evaporateurs Kestner. Crystallisation processes. (214,572.)

29,784 (1923). Appareils et Evaporateurs Kestner. Vertical evaporators. (218,556.)

30,589 (1923). Greaves. Apparatus for washing granular material. (218,561.)

II.—Applications

Duffield. Apparatus for producing gas from powdered carbonaceous matter. 16,598. July 10.

Heyl. Distillation and utilisation of oil shale etc. 16,285. July 7.

Klotzer. Method of recovering combustible gases from fuel. 16,480. July 9.

Marks (Kohlenscheidungs Ges.). Rotary drums for distillation of coal etc. 16,708. July 11.

Marks (Kohlenscheidungs Ges.). Production of fuel from semi-coke. 16,709. July 11.

Niece. Apparatus for treating hydrocarbons 16,726. July 11.

Techno-Chemical Laboratories, Ltd., and Testrup. Treatment of peat. 16,793. July 12.

II.—Complete Specifications Accepted

359 (1923). Jackson (Koppers Co.). Coking retort ovens. (218,339.)

9491 (1923). Martel. Agglomeration of fuel (218,391.)

11,786 (1923). British Thomson-Houston Co. (General Electric Co.). Filaments for electric incandescent lamps. (218,430.)

19,824 (1923). Humphreys and Glasgow, Ltd. (Rasby). Carbonisation of bituminous coal and like material. (218,512.)

5770 (1924). Simon. Combustion of readily combustible waste and residues (218,598)

III.—Application

Pease and Partners, Ltd., and Robinson. Recovery of pyridine etc. from by-products. 16,283. July 7.

III.—Complete Specification Accepted

29,314 (1923). Weil, and Chemische Fabrick in Billwarder vorm. Hell u. Sthamer Akt.-Ges. Obtaining pure anthracene and carbazole from crude anthracene. (210,742.)

IV.—Applications

Farbwerke vorm. Meister, Lucius, und Bruning. Manufacture of dyestuffs 16,407. July 8. (Ger., 23.7.23.)

Morton Sundour Fabrics, Ltd., Wylam, and Jones Dyes and dyeing. 16,805. July 12.

Soc. of Chemical Industry in Basle. 16,406 *See* XX.

IV.—Complete Specifications Accepted

15,644 (1923). Pereira. *See* XX

27,233 (1923). Ransford (Cassella und Co. Ges.). Production of acridinium compounds. (218,542.)

31,359 (1923) Bloxam (Chem. Fabr. Griesheim-Elektron). Manufacture of azo dyestuffs. (218,568.)

V.—Applications

Akt.-Ges. fur Anilin-Fabrikation. Manufacture of viscose silk. 16,512. July 9. (Ger., 8.8.23.)

Akt.-Ges. fur Anilin-Fabrikation. Manufacture of viscose silk. 16,741 July 11. (Ger, 20.8.23.)

Akt.-Ges. fur Anilin-Fabrikation. Manufacture of viscose products. 16,742. July 11. (Ger., 22.8.23.)

Granton. Utilisation of waste material from de-inking of paper. 16,626. July 10.

V.—Complete Specifications Accepted

9284 (1923). Colas, Colas, and L'Alfa, Soc. Anon. Treating liquor from the lixiviation of vegetable matter. (218,385.)

10,477 (1923) Walker. Nitration of cellulose (218,411.)

VI.—Applications

Bailey and Gee. Machines for treating fabrics with liquids. 16,542. July 10.

Germann. Dyeing and simultaneously water-proofing etc material. 16,555. July 10.

Johnson (Smith, Drum and Co.). Dyeing etc. machines. 16,371, 16,372, and 16,373. July 8.

Morton Sundour Fabrics, Ltd. 16,805. *See* IV.

VII.—Applications

Legeler. Production of carbon disulphide. 16,704. July 11.

Spence, and Spence and Sons, Ltd. Production of ferric sulphate 16,342. July 8.

VII.—Complete Specifications Accepted

3292 (1923). Worsley. Production and use of hyposulphurous acid. (218,347.)

9075 (1923). Ewan. Manufacture of sodium. (218,373.)

27,977 (1923). Harr. *See* VIII.

30,872, and 30,873 (1923). Ewan. Manufacture of alkali metals. (218,563.)

32,200 (1923). Dorr Co. Manufacture of whiting. (212,877.)

9621 and 9622 (1924) Ewan Manufacture of sodium or potassium. (218,606.)

VIII.—Applications

Donald. Manufacture of bricks and pottery. 16,568. July 10.

Refractories Process Corporation. Processes for manufacturing high refractories. 16,497. July 9. (U.S., 14.8.23.)

Wade (Dixon Co.). Plate-glass annealing-leers. 16,325. July 7.

VIII.—Complete Specifications Accepted

18,438 (1923). Siemen. Manufacture of fire-proof bricks. (218,495.)

27,977 (1923). Harr. Manufacture of sintered magnesite and magnesite bricks. (207,172.)

IX.—Application

Collins and Gollop. Cement. 16,111 July 9.

IX.—Complete Specification Accepted

29,773 (1923). Lyon. Artificial seasoning of wood. (208,522.)

X.—Applications

Brookfield. Cupolas etc 16,696. July 11

Cachemaille (Westinghouse Lamp Co.) Extraction of metals from compounds. 16,275, 16,278. July 7

Folkerts. Steel conversion 16,584. July 10.

Hannay. Treatment of stibnite etc. 16,672. July 11.

Minerals Separation, Ltd., and Lavers. Concentration of ores. 16,787. July 12

Naamlooze Vennootschap Philips' Gloeilampenfabrieken. Separation of hafnium and zirconium 16,788. July 12. (Denmark, 13.7 23.)

Refractories Process Corporation. Metallurgical furnace roof. 16,498. July 9. (U S, 14.8.23)

X.—Complete Specification Accepted

2878 (1924). Fox. Treating the surface of bronze, brass, and like metals. (218,591.)

XI.—Applications

Cachemaille (Westinghouse Lamp Co) Manufacture of electron-emitting material etc 16,273 July 7

Cachemaille (Westinghouse Lamp Co). Cathodes for vacuum electric devices. 16,274. July 7.

Cachemaille (Westinghouse Lamp Co.). Activated material for electron emission. 16,276. July 7

Nordiske Fabriker De-No-Fa Aktieselskap. Electrolytic decomposition apparatus. 16,521. July 9. (Norway, 29 8.23.)

XI.—Complete Specifications Accepted

6251 (1923) South Metropolitan Gas Co., Woodall, Duckham and Jones (1920), Ltd, and Hatfield. *See* I.

29,097 (1923). Correra Electrolytic tanks (207,199)

32,215 (1923). Elektro Osmose Akt. Ges. (Graf. Schwerin Ges.). *See* XII.

388 (1924). Elektro-Osmose Akt.-Ges. (Graf. Schwerin Ges.). *See* XV.

XII.—Applications

Plauson, and Plauson's (Parent Co), Ltd. Production etc. of sulphur soaps. 16,647. July 11.

Schneler. Presses for expressing oil from seeds etc. 16,643. July 11.

XII.—Complete Specifications Accepted

15 394 (1923). MacIlwaine. Preservation and preparation of copra. (218,465.)

32,215 (1923). Elektro-Osmose Akt.-Ges. (Graf. Schwerin Ges.) Electro-osmotic purification of glycerin. (214,576.)

XIV.—Application

Plauson, and Plauson's (Parent Co.). Materials for use in rubber mixings etc. 16,422. July 9.

XIV.—Complete Specifications Accepted

8745 (1923). Feldenheimer and Plowman. Manufacture of rubber compositions. (218,364.)

9269 (1923). Naugatuck Chemical Co. *See* XX.

27,759 (1923) General Rubber Co. Concentrating latex etc. (218,544.)

XV.—Complete Specification Accepted

388 (1924). Elektro-Osmose Akt.-Ges. (Graf. Schwerin Ges.). Process for the electro-osmotic purification of glue or gelatin. (214,579.)

XVII.—Application

Urban. Purification of sugar solutions. 16,525. July 9.

XIX.—Application

Brashier. Manufacture of volatile solid insecticides etc. 16,630. July 10.

XIX.—Complete Specification Accepted

9808 (1923). O'Shaughnessy. Treatment of sewage liquor etc. (218,399.)

XX.—Applications

Akt.-Ges. fur Anilin-Fabrikation. Manufacture of vanillin. 16,634. July 10. (Ger., 28.7.23.)

Burdick. Process of making olefin oxides. 16,507. July 9.

Pease and Partners, Ltd., and Robinson. 16,283. *See* III.

Soc. of Chemical Industry in Basle. Manufacture of acylated diamines. 16,406. July 8. (Switz., 17.7.23.)

XX.—Complete Specifications Accepted

9369 (1923) Naugatuck Chemical Co. Processes for the manufacture of diphenylguanidine. (199,354.)

14,486 (1923). Green, Oxley, and British Dyestuffs Corporation, Ltd. Separating alkylamines from ammonia and other gases (218,458.)

15,644 (1923). Perera. Process of manufacturing amino-perylene-quinones. (199,721.)

28,190 (1923). Austerweil and Peufaillit. Process for the production of *p*.-cymene from monocyclic terpenes. (206,848.)

XXI.—Application

Kovasznay and Tolnay. Photographic plates. 16,309. July 7.

XXIII.—Complete Specification Accepted

7380 (1924). Optische Anstalt C. P. Goerz Akt.-Ges. Refractometers. (213,286.)

GENERAL NOTES

Official Trade Intelligence

The Department of the Overseas Trade Development and Intelligence, 35, Old Queen Street, London, S.W. 1), has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting specific reference number: *Australia:* Brass tubes (82); Hardware, aluminium, enamelled ware, (83); *Austria:* Leather (B.X./1079); *British East Africa:* Water piping (84); *British India:* Steel (The Director General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); *Canada:* Steel, iron, hardware (87); Leather, china and hollowware (89); *Germany:* Shellac, copra (94); *Malta:* Soap (90); *New Zealand:* Hardware (91); *Norway:* Leather goods (95); *Siam:* Steel (A.X./1149); *South Africa:* Brassware, paint, oil, builders' hardware (92); Steel, iron (C.X./1067); Brass piping, copper sheet, (A.X./1151); *Spain:* Hardware (97); *United States:* Scientific instruments (101); Steel (A.X./1144); Steel tubing and piping (C.X./1070); *Uruguay:* White varnished porcelain insulators (B.X./1093).

Chemical Industry in Czechoslovakia

According to the report of the Association of Czechoslovak Chemical Industries, the position of the large chemical works in Czechoslovakia during 1923 was more favourable than in 1922. Imports of raw materials, and the output and export of heavy chemicals increased to a large extent. The larger demand for phosphatic acid and nitrogenous fertilisers increased unemployment, and although chemical factories in general were really not much busier than in 1922, confidence in the future has been restored, and a steady development of the industry may be expected. Conditions in the petroleum industry continued unfavourable, and the dyeing industry generally did not derive the same benefit as other branches of the chemical industry from the temporary slump in German production. The pharmaceutical industry, however, did well in the home market, whilst the starch industry also had a good year, the export trade developing. A smaller consumption characterised the varnish industry, and there was a reduced output of mineral oil. Other branches of industry included lubricating oils, coal-tar, boot polishes, candles and soap. The perfumery industry recovered from its heavy losses to some extent, and employment in the rubber industry was decidedly better in 1923 than in the previous year, whilst a better market was also found for grinding and polishing materials later in the year.

Polish Output of Potash

The total production of potassium salts in Poland during 1923 amounted to 61,503 metric t. as compared with 46,082 t. in 1922, an increase of 38 per cent. over that of 1922 and a much larger gain over previous years. There was a slight decrease in the production of sylvinite during 1923, but the production of kainite considerably exceeded that of 1922, the figures being: Sylvinite, 39,375 t. (43,562 t. in 1922) and Kainite, 22,128 t. (2520 t. in 1922). Deposits at Drohobycz and Stanislawow were worked in 1923, the latter employing 405 out of a total of 559 workmen engaged in the industry.

PUBLICATIONS RECEIVED

Carbonisation of Seaweed as a Preliminary to the Extraction of Iodine and Potassium Salts. By J. G. King, B.Sc., A.R.T.C., F.I.C. Department of Scientific and Industrial Research, Fuel Research Board Technical Paper No. 9. Pp. 16. H.M. Stationery Office, 1924. Price 6d.

The Journal of the Institute of Metals. Vol. xxxi. Edited by G. Shaw Scott, M.Sc. No. 1. Pp. xi+680. London: The Institute of Metals, 1924.

Report on the Economical and Commercial Conditions in Turkey, April, 1924. By Colonel H. Woods, O.B.E. Department of Overseas Trade. Pp. 52. H.M. Stationery Office, 1924. Price 1s. 6d.

Report of the Department of Industries, Madras, for the year ended March 31, 1923. Pp. iv+86. Madras: Government Press, 1924.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

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EDITORIAL

DURING this week the first Empire Mining and Metallurgical Congress is being held at the British Empire Exhibition. The main object of the Congress—to take stock of Empire mineral resources and to discuss measures for their development and utilisation—is one that will appeal to all our readers. The time between the opening of the Congress and our going to press is too short, even were sufficient space available, to give an account of it, but we are told that the successful opening meeting was attended by a representative gathering, including delegates from the United States present as guests. On Wednesday the Congress listened to the "May Lecture" of the Institute of Metals delivered by Dr F. W. Aston—a summary of the lecture will be found on another page of this issue—and papers are to be read by nearly all the well-known workers connected with metalliferous and coal mining, safety problems in mining, the transport, production and refining of petroleum, and ferrous and non-ferrous metallurgy. Nature, as Lord Long pointed out in his opening address, has been prodigal in her gifts of minerals to the various lands which constitute the British Empire. But let the visitor to the Exhibition obtain the excellent handbook, "Minerals of the Empire" at the stand of the Imperial Mineral Resources Bureau, and he will see how the output from the Empire compares with that of the rest of the world. Asbestos, china clay, chrome ore, diamonds, gold, mica, nickel, the output of all these represents over half the world's production, but the figures for bauxite, copper, graphite, iron ore, and petroleum show a proportion of under one-tenth, although the proportions for important products such as manganese, coal, tin, lead and zinc are much higher. This is not a reason for despondency, however, as production does not imply a measure of the reserves, and estimates of reserves are always conservative. Each time a survey of England's reserves of coal has been made the estimated reserves have grown, and so it will probably be with other minerals, particularly as so small an area of our vast Empire has yet been surveyed minutely. By the time this journal is published, the Congress will be practically over, and one hopes for very beneficial results. Valuable as the effect will undoubtedly be, development will ultimately depend on the attitude of the financier and the facilities for transport, but that is hardly within the scope of a scientific congress.

* * *

The review which we publish this week by G. T. M. of "Chemistry in the XXth Century" directs attention to a remarkable achievement. The review mentions in detail the contents of the book and praises with faint damns—if that is the correct quotation—the scientific treatment of the subjects. The really notable fact about the matter is that a large, handsome and well-printed book can be made of the present state of certain chapters of chemistry with special reference to the work of British chemists, and that so much is left over for future publications. We can hardly recollect any chemical book we have read which presents so many topics to excite our curiosity and compel us to learn more. The cause of this is obvious: there is a story in each chapter, a design, a plot. There is hardly a page in the book which does not reveal a search for some explanation of fundamental importance; we are continually left stranded on the border which lies between the well-surveyed land and the mysterious ocean of ignorance. This provides a sense of fascination, and we see more clearly what perhaps many of our readers never forget, the underlying purpose stimulating the collection and dissemination of myriads of details. Mr. Samuel Weller said that the great art of letter-writing was to end so that the reader wanted more. The President of the Society of Chemical Industry will long feel a just pride in this book.

THE MANUFACTURE AND USES OF GLYCERINE

Glycerine was discovered by Scheele in 1779, and although Chevreul showed, some forty years later, that it was an invariable constituent of fats and oils, and was produced when they were saponified, it was not until the 'fifties of the nineteenth century that commercial quantities were demanded. About that time Prices Candle Co. was selling a good commercial glycerine, but it was not until the late 'seventies, when the usefulness of nitroglycerine—discovered in 1863 by Nobel began to be appreciated, that really large amounts of glycerine were in demand From that date the application of glycerine in many industries has steadily increased

Glycerine is one of the few really pure industrial products, ranking with sugar and liquid ammonia. The so-called "C P" variety contains essentially nothing but glycerine and, say, 1 per cent. of pure water When it is remembered that it often originates in the lyes of the soap maker, which contain in addition salt, sodium sulphate, carbonate, hydroxide, acetate, butyrate, caproate, salts of iron, calcium and arsenic, and various sulphur compounds, and that volatile fatty acids are formed when the salts are acidified, some idea may be gained of the difficulties besetting the refiner. In the distillation, too, volatile fatty acids, ammonia and amines and trimethylene glycol must not be allowed to contaminate the distillate, nor must albuminoid or resinous matters or polymerised glycerine be permitted to be carried out of the still The production of a pure product from such a source reflects the greatest credit upon British chemical plant manufacturers, inventors and technical chemists.

Sources and Manufacture of Crude Glycerine

The principal source of crude glycerine is found in the lyes from soap and candle making Natural and hydrogenated fats and oils, consisting chiefly of mixed glycerides, are saponified by means of caustic alkalis, whereupon a soap is produced and glycerine remains in the lyes separated from the curd formed on the addition of common salt to the soap kettle after boiling. The lyes also contain the impurities noted above Treatment with lime, aluminium or ferric salts forms a precipitate of the corresponding metallic soaps and the higher fatty acids which entangles much of the resinous and albuminoid matter present in the lyes After filtration and neutralisation, the treated lyes are concentrated This operation is usually conducted in special vacuum evaporators, and concentration is taken past the salt point without breaking the continuity of operations, a high vacuum process and special designs of plant preventing the deposition of salt upon the evaporator surfaces. The salt is washed and returned to the soap-making process. The concentration is carried on until a "soap lye crude" glycerine, containing about 80 per cent. of glycerine, 10 per cent of salts and 10 per cent. of water is obtained. This is a yellowish viscous liquid, without unpleasant taste but still containing organic impurities. Methods of testing for alkali, fatty acid salts, total ash, and organic residue have been standardised by agreement (the Internation[al] Standard Methods "I. S. M." pamphlet, 1911 and all crude glycerines are bought and sold—at an rate in this country upon contracts embodyin[g] penalties and allowances, the whole resting upo[n] the results of analyses carried out by standardise[d] methods. The methods have recently been care fully revised and improved.

Saponification Crude

Perhaps the best type of crude glycerine is tha[t] obtained from the autoclave saponification process of fat splitting, employed, say, in the candle industry a mixture of fats and water being converted under pressure, usually in the presence of catalysts such as lime, zinc and zinc oxide, or magnesia, into fatty acids and glycerine. The lyes or sweet water are fairly pure, and after acidification and, if desired, treatment with aluminium or iron salts, as in the case of soap lyes, they are concentrated until a crude product containing from 85 up to 90 per cent. of glycerine is obtained. Relatively little ash is found in this type of crude glycerine, whilst the organic matter is normally fairly low as compared with soap lye crude.

The glycerine solutions resulting from the splitting of fats, oils and greases by means of the Twitchell reagent are worked up broadly in a similar manner, the acid present being first neutralised and a purification (precipitation) treatment being applied if desired. The crude glycerine obtained is often of lower quality than that from the autoclave process not necessarily because the process is inherently faulty, but because low-grade fats and greases are often used in this splitting process. The ash content and organic residue are relatively high, and the crude glycerine has an unpleasant taste.

Two sources of glycerine which are of relatively smaller importance are found in the so-called fermentation crudes and distillation crudes. Fats and oils may be split by means of the enzyme contained in castor seeds, but the glycerine liquors often contain large quantities of albuminous matter, and are difficult to separate from the fatty acids produced and difficult to refine. Although the fermentation splitting process has been very considerably improved, it is applied only to a limited extent. Effective separation from fatty acids and emulsified organic matter must be attained before concentration to crude glycerine is attempted.

Crude distillation glycerine is so called because the fatty acids resulting from the hydrolysis of fats by means of sulphuric acid must be distilled before employment in the candle industry. On account of the relatively large quantities of sulphuric acid in the sweet water, the crude glycerine obtained upon evaporation contains considerable ash—in the form of calcium sulphate, when lime has been used to neutralise the acid whilst the organic residue is also rather high. Trouble is often experienced in the evaporation of the neutralised sweet water by reason of the separation of calcium sulphate on the heating surfaces.

By careful manipulation in the working up of any form of glycerine solutions (particularly those

rom the first three processes noted) a good crude product containing upwards of 80 per cent. of glycerine can be obtained, and it is often possible to apply a good crude directly, or after decolorising treatment, in industry. By far the most common practice, however, is to distil the crude product in vacuo, superheated steam being used in order to help to carry over the glycerine. By careful distillation, followed in certain cases by redistillation, it is possible to win glycerine of the highest purity, provided that effective purification has been achieved in the production of the crude glycerine. Mineral salts, albuminous and resinous impurities, volatile fatty acids, and ammonia and amines remain in the crude to a greater or less extent, but the salts and high boiling materials are retained in the still together with polyglycerols—present or produced during distillation—whilst the volatile bases and acids passing over with the steam and glycerine vapours are kept out of the glycerine by fractional condensation.

Distillation

Many types of still have been designed since the time of the old fire-heated apparatus, and refinements have resulted not only in the possibility of obtaining regularly a high quality of glycerine, but also in the reduction of the costs of the process. In general terms, the process consists in heating the crude glycerine by means of closed steam coils in a suitable still, fitted with baffling devices to prevent the spraying of even the smallest trace of the still contents over into the condensers where, of course, it would contaminate the condensed glycerine. Superheated steam, preferably generated from distilled water, is blown into the charge in the still, whereupon, under the conditions of high vacuum prevailing, the glycerine is vaporised and carried in the steam current to a series of condensers. The primary cooling is so arranged as to condense glycerine at such a temperature as to allow the steam to pass without condensation, so that the product from the primary condensers is essentially glycerine. Further condensation leads to progressively "weaker" glycerines, until finally the so-called sweet water, containing a recoverable amount of glycerine is condensed. According to the quality of glycerine demanded (*v. infra*) the condensates are directly marketed, concentrated in vacuo to a higher glycerine content, or redistilled. For the highest grades—chemically pure glycerine perfect decolorisation is effected by means of a highly efficient decolorising carbon, and, in addition, special processes for the total removal of arsenic are worked.

A brief description of a more complex distillation system which is continuous in operation, economical in fuel consumption and capable of yielding high-grade products may be given as an illustration of the improved practice which now obtains in British glycerine refineries.

A single current of steam is used to distil the glycerine from a number of stills, the glycerine being injected into the steam current so that the hydrostatic head of quantities of glycerine in a series of several stills is eliminated. The steam is generated in a multiple effect evaporator, containing the sweet water produced in the final condensation, and mixes with the injected glycerine in the tubes of the stills after suitable superheating. Glycerine is vaporised under the 28 in. vacuum prevailing and passes with the steam to a condenser, surrounded by water boiling under reduced pressure at 175° F., and is condensed, giving up its heat to the boiling water and thus furnishing steam which may be utilised in the process. The uncondensed steam passes to the second still, where the operations are repeated until after a series of stills has been worked, the steam is condensed with the small remaining amount of glycerine vapour to form sweet water. The mixture of salts, polyglycerols, etc., which remains in the still of whatsoever type used may be treated for the recovery of any glycerine contained, or it may be directly employed for some industrial purposes.

Types of Glycerine Produced

Two general types of glycerine are ordinarily produced by the distiller, namely, dynamite glycerine and "C. P." glycerine. Slight variations from the specifications fulfilled by these two types are made to suit various consumers, who may desire a pure glycerine but do not require a product containing a maximum 1·5 per cent. of water. In other cases, the so-called industrial white glycerine may satisfy when the slightly coloured dynamite glycerine is unsatisfactory, but where the complete and absolute purity of the "C. P." product is not essential.

Nobel's specification for dynamite glycerine demands a glycerine which is neutral to litmus, of light colour and affording no unpleasant smell when heated to 100° C. It shall contain a minimum of 98·5 per cent. of glycerine when tested by the acetin method (I. S. M. procedure), and possess a specific gravity of 1·262 at 15·5° C. The percentage of chlorides, reckoned as NaCl shall not exceed 0·01 per cent., nor shall the total ash exceed 0·05 per cent. When 10 c.c. each of 10 per cent. solutions of the glycerine under test, ammonia and silver nitrate are mixed, heated to 60° and then kept in the dark for ten minutes, there shall be no apparent reduction of the silver salt, as evidenced by a darkening. This test indicates the absence of formic acid, acrolein, etc., which might cause undesirable rise of temperature in the nitrating operations to which the glycerine is to be subjected, and the test is of great importance. The saponification equivalent of the glycerine shall not exceed 0·1 per cent. calculated to Na_2O.

Chemically pure or C. P. glycerine passes the rigid specification of the British Pharmacopœia, which calls for a clear colourless liquid of no odour, showing no reaction for ammonium, chlorides or sulphates. It must not contain lead, iron and copper, whilst the arsenic limit is set at 4 parts per million. Tests must reveal the absence of fatty acids, and the silver nitrate test must show the absence of formic acid and acrolein.

Properties and Uses of Glycerine

The chemical and physical characteristics of glycerine permit its wide application. Thus, the reactivity of the hydroxyl groups enables various esters of value to be readily produced. In addition, it possesses antiseptic and preservative properties and is an excellent emollient for the skin. It mixes with alcohol and water in all proportions and dissolves many drugs and chemicals to a greater extent than does water. It is odourless, but easily and pleasantly perfumed when desired, whilst its sweet, agreeable taste renders it useful, especially in view of its solvent action, in medicinal preparations. It is a good excipient for various materials. It is very hygroscopic and its solutions in water possess a low freezing point. Its viscous character makes it a good lubricant.

Nitroglycerine.—One of the largest applications of glycerine is in the manufacture of the ester, nitroglycerine, which is an essential component of dynamite, blasting gelatine and cordite. Glycerine is therefore a basic chemical both in peace and war. A perfectly pure, colourless glycerine is not required for nitration, but certain easily oxidised impurities must be absent. The specification given above for dynamite glycerine is more than fulfilled by British manufacturers.

Nitration is effected by means of a mixture of nitric and sulphuric acids, the product being washed free of acid. The extreme care which is necessary in manufacture and the technical details essential to the production of a standard material cannot be indicated in this article, and it must suffice to state that the industry is highly efficient.

Small quantities of nitroglycerine are used in medicine.

Glycerine Acetates—Acetins.—Glycerine is readily converted into its acetic esters, the acetins, by heating with acetic anhydride and potassium bisulphate.

Commercial acetin usually consists of a mixture of the di- and tri-acetins, that is, glycerine in which two or three of the hydroxyl groups have been replaced by the acetyl radical. The monoacetin, obtained with the aid of acetic acid, is also somewhat in demand. The acetins are chiefly employed as an adjunct in calico printing.

Glycerine Arsenite.—Arsenious oxide behaves as an acid when heated with glycerine at about 250° C., for glycerine arsenite is obtained. It decomposes above 250°. This compound is also employed in calico printing.

The Chlorhydrins.—The chlorhydrins are esters of glycerine and hydrochloric acid, whilst epichlorhydrin is formed by the esterification of one hydroxyl group and the removal of one molecule of water from the other two hydroxyl groups of the glycerine molecule. The chlorhydrins and epichlorhydrin possess some importance as solvents, especially for hard resins, such as copal, which often dissolve in the cold.

Glycerophosphoric Acid.—The monophosphoric ester of glycerine is prepared by heating a suitable mixture of the trihydric alcohol and the acid to about 105°, above which temperature the di-ester is formed in addition. It is a colourless, odourless liquid, usually met with in aqueous solution, which is decomposed upon heating. Its salts are far more important and find extensive application in medicine, for instance, as nerve tonics. Calcium glycerophosphate and iron glycerophosphate are often combined with other medicinals, such as nux vomica (strychnine) as well as emulsified with cod liver oil, petroleum, etc.

In the human system, glycerophosphoric acid occurs in the lecithin of brain and nerve tissue.

For the preparation of glycerophosphates pure glycerine must obviously be used, the above esters, used in industry, being made from dynamite glycerine or industrial glycerine.

Medicinal Preparations.—A glance through the British Pharmaceutical Codex reveals the scores of medicinal preparations into which glycerine enters. The reason for its value may be one of many. In some cases it is used merely as a convenient excipient. In others it is a useful solvent, and permits a greater penetration into the cell than does water, for instance. Again, its agreeable taste conceals the bitter or nauseous taste of certain drugs and medicines.

Glycerine, taken internally, is demulcent, antiseptic and somewhat nutritious. It was used to some extent, particularly before the introduction of saccharin, for sweetening the food for diabetic persons. On account of its soothing effect it is employed in many cough medicines and, associated with gelatin, in the preparation of pastilles.

Glycerine of boric acid or a simple solution of boric acid in aqueous glycerine, is a useful throat antiseptic.

The preservative action of glycerine is made use of in preparing compositions containing digestive ferments. Thus, glycerine of pepsin is made by acting upon pepsin with aqueous glycerine in the presence of hydrochloric acid, allowing the mass to stand for a week and filtering. The preparation made up in standard strengths is a valuable digestive.

There are scores of preparations of similar nature to those indicated above, which have been arbitrarily selected as types demonstrating the use of glycerine for some specific property it possesses.

One final instance of its antiseptic and preservative action is of interest. Glycerinated calf lymph is considered the safest medium for vaccination. In this preparation the glycerine destroys all non-spore-bearing extraneous organisms.

Toilet Preparations.—In the realm of toilet preparations, glycerine finds hundreds of applications, its use depending upon its emollient and antiseptic action. In skin preparations it is associated with water, fats or oils, gelatin, agar-agar, Irish moss, starch, to form skin washes, pomades, salves, jellies, creams, and so forth.

Glycerine is a component of tooth pastes and general dentifrices, hair washes and hair dyes, nail polishes, hair oils and shampoo preparations, pomade hongroise, "make-up" and other preparations.

Glycerine has also a healing action upon broken skin, chapped hands, and so forth, being employed, diluted with water, perfume solutions, and oil.

Transparent Toilet Soaps.—Glycerine is, of course, present in "cold process" soaps, but it is also actually added to some varieties of transparent toilet soaps.

Beer and Wine.—The preservative action of glycerine is also made use of in the brewery, the beers, in addition, being stated to be improved of taste. Wines acquire body and flavour with the addition of glycerine, it is claimed, although in these latter instances it is not clear that any extensive application of glycerine is in evidence. Indeed, it may here be noted that many of the "uses of glycerine" set out in literature are suggestions only, or applications which have long since been discarded. The information has been studiously copied however, and the sixty uses presented in a pamphlet in the late seventies appear with monotonous regularity.

Glycerine as a Lubricant.—Glycerine is, of course, much more expensive than ordinary lubricants, but there are instances where it can profitably be employed. In delicate machinery lubricated with glycerine, no sticky or hard frozen products of oxidation or cooling interfere with good working. Apparatus which is to come into contact with foodstuffs may very well be lubricated with glycerine, for obvious reasons. The use of glycerine alone or in aqueous solution has also been suggested for liquid air and refrigerating apparatus. In the former case, its use is scarcely to be recommended.

Anti-Freeze Compositions.—Glycerine and its aqueous solutions possess a low freezing temperature. Plain solutions or special preparations are used in gas meters to a limited extent, and in motor car radiators, quick-firing guns, and hydraulic testing gear. Anti-dimming compositions also contain glycerine.

Tobacco is sometimes treated with glycerine solution, the hygroscopic properties of the glycerine being utilised in keeping the tobacco moist. The use of glycerine here could be considerably increased with advantage, although cheaper substances are available. Glycerine possesses an advantage over all, as it inhibits fermentation and mould growth and acts as a general preservative and as an aid to the development of flavour.

Foodstuffs such as jams, fruits, etc., are preserved better in the presence of glycerine, the use of which for this purpose is increasing, as glycerine has no harmful effect upon the human system.

Inks and Duplicating Compositions contain glycerine. In this field—the production of copying inks, lithographic inks, duplicating compositions, special papers for receiving impressions, printer's roller compositions—there are scores of formulæ, and glycerine is almost an invariable constituent. It is known that the well known manufacturers have their own formulæ which have only been arrived at through long experience and experiment, and which represent the last word in this field. These manufacturers use glycerine in their products.

It is, therefore, unnecessary to burden this article with uninteresting formulæ, as these, in any case, would not represent the best practice, which is kept a profound secret.

General.—Glycerine is used in the textile industry to a certain degree in finishing operations, improving the appearance and feel of the products. In the softening of chamois and other leathers and as a polishing agent in compositions, it is employed in the tannery, whilst it is a good preservative for pelts which are not intended to be subjected to the ordinary processes of preservation.

In preserving anatomical specimens it has advantages over alcohol. Its capacity for attracting and retaining moisture is made use of in keeping modelling clays and plasters in the moist condition. It is useful in removing coffee and other stains from textiles, many colouring matters being soluble in glycerine. Simple rubbing with a glycerine impregnated cloth with subsequent treatment with spirit or soap and water is very efficacious in many instances. It has been found the best material over which to store hydrogen, as foreign gases, such as nitrogen, diffuse at a minimum rate into the pure hydrogen. It is suggested as a component of rust-resisting compositions and for purifying domestic coal gas from sulphurous impurities. The latter application, although successful in the laboratory, has not been developed in any large degree in practice.

It is employed in the preparation of photographic emulsions, although the exact manner of its use is a well-kept secret.

THE TRAINING OF CHEMISTS IN BACTERIOLOGY

By Dr. DAVID ELLIS

Those of us whose duty it is to give instruction to chemists in the science of bacteriology are aware that there is a quickening of interest in the subject which is an agreeable change when we reflect on the general apathy which distinguishes the chemists of even a decade ago. Formerly the visitors who trod the corridors which gave access to the bacteriological laboratories of the Royal Technical College of Glasgow unconsciously trod lightly lest they should awaken the sleepers, which they felt were reposing in the laboratories. Nowadays, whilst it is not exactly necessary yet to compel intending workers to line up in a queue so as to make their entrance in an orderly manner, it is necessary to make provision for a large inflow of students. The budding chemist of to-day feels, and feels rightly, that a study of bacteriology is an essential part of the equipment of the modern chemist who is going to offer his services to one or other of the many branches of industrial concerns. Such being the case, it behoves us to examine the whole matter in the light of the conditions which now hold in the industrial world. Also, it is necessary to ascertain how far the educational equipment of the chemist is adequate to meet the demands that will be made upon him. The latter appears to the writer to be the more important of the two and will be dealt with first. The fact is, that we are at the parting of the ways. The only standard up to the present which is able

to serve as a guide to the chemist is the training in bacteriology which is served up to the medical student during his University career. It is probably true that the medical man has so many subjects to study that it is not possible to do many of them thoroughly. At any rate, his study of bacteriology is largely confined to the study of a few empirical facts, all severely utilitarian, and all solely concerned with pathogenic organisms. All this may be quite correct if the general practitioner, bacteriologically considered, is to be trained to be a mere machine to supply data to the bacteriological specialist who will then conduct the investigation. A medical student, after he has stained according to Gram, may not feel that he is ready to sit for his examination, but he does feel that he has broken the back of his work. He is tested by his capacity to perform certain mechanical operations, and to identify certain pathogenic organisms in artificial cultures. The object in making these statements is not to deride this course or even to question its wisdom. But when it is automatically assumed that the same kind of training is adequate for the industrial chemist, the matter wears a different aspect. It would be easy enough to put a chemist through a parallel course to make him sufficiently expert at staining operations to cause his friends to exclaim at his cleverness. He could also be taught to make beautiful media for the cultivation of bacteria, and sterilise so well that not a microbe would dare to approach his apparatus. Alas, one could call in an intelligent porter and make him equally expert. As a matter of fact in many laboratories there are laboratory attendants who do this kind of thing much better usually than their superiors. And yet these excellent attendants cannot be dubbed bacteriologists. What makes the bacteriologist is the mental power of co-ordinating these facts in the light of all the other facts that are known from former experience. In short, the bacteriologist must have a scheme of the bacteriological world in his head, and he must be able to place the ascertained facts in their correct relation to this world. A laboratory attendant can never do this: a medical practitioner is somewhat better off because his general training is partly biological. But, in general, he is little better off unless he brings to bear his biological training. Almost unconsciously a course of bacteriological training is judged by a medical man by the standard which holds in a medical laboratory. A very good instance of such a standard was a criticism by a medical reviewer of one of the writer's books that a certain organism used by the writer for instructional purposes "was not much used in the laboratory nowadays." Let the educationist consider the exact import of this silly criticism, and he will see the trend of the reviewer's thoughts. Obviously the reviewer regarded the training of the bacteriologist just as an old-fashioned baker regards the training of his apprentice, the aim being to secure a mechanical deftness in the carrying out of certain bakery operations. It seems to the writer that this mischievous conception must be combated at all costs. It is being combated even in the so-called mechanical trades, and "it is a bit hard," as Mr. Ukridge would say, that such an eminently scientific person as a chemist should be gradually inveigled into an atmosphere in regard to bacteriological matters that is fraught with danger, because of all professions that of a chemist is the one in which it is necessary that he should be freed from the trammels of empirical lore.

It is necessary next to enter upon an aspect of the chemist's training, to which very few chemists have given any thought. It is agreed by most that some study of the microscope should be given to the budding chemist. But note this very essential point. In chemistry, physics and mathematics his training proceeds in one unbroken line from his early schooldays until he finally qualifies at the University or else develops his faculties in the laboratories of an analytical chemist. The point is that the line of his development is unbroken, and thereby he becomes a professional chemist and markedly different from the less fortunate amateur. But does the same hold in respect to the training of the chemist in bacteriological work or in that part of his work where the use of the microscope is involved? That which is held to be of the utmost importance in respect to his training in chemistry, physics and mathematics is held to be unnecessary when the chemist has to deal with objects of microscopic dimensions or when he has to deal with the facts of biological life. The chemist, in spite of his excellent training in the three subjects mentioned, is the most amateurish of persons the moment he begins to handle the microscope, and when he tries his hand at deciphering the facts of life that are presented to him when he examines micro-organisms under the microscope. It is not the chemist who is to blame, it is his education that is at fault. He does not know how to observe, the facts of developmental life history are a closed book to him. His senses record certain impressions; they result in vague perceptions but never in clearly defined conceptions. Does any chemist think that a series of observations in biology that correspond to sets of observations or experiments in chemistry that would only be given to chemists in their fourth year of training, can be accomplished in their first biological year? That is what it amounts to when chemists in their fourth year or at the close of their career in college take out a course in bacteriology without the slightest training in biology. It cannot be done. The result is that when the voice of the tempter becomes insistent, the training of the chemist in bacteriology is apt to degenerate into an attempt to become mechanical experts at certain standardised mechanical operations. That is what the training in bacteriology usually amounts to in the medical student's career, and he is somewhat better off than the chemist, because whilst it cannot be said that he has had a bite at biology, he has had a lick at it. The chemist sees the futility of this kind of procedure in the realm of chemistry. It would be quite feasible to train a laboratory attendant to perform fairly complex operations in chemistry and become quite expert at them—in fact, attendants often perform experiments at the lecture table better than the lecturing professor. But suppose

he chemist were judged by this mechanical skill, e would be the first, and rightly so, to cry out. hat, however, is precisely what the study of bacteriology will amount to in the hands of chemists, nless they can free themselves from the procedure vogue in medical laboratories. Let them face the ct that they must either obtain a preliminary training in certain aspects of biology or else give up the udy of bacteriology except as a pastime. One feels nclined to retort as did Huxley when he was worried by a divine who "put his foot into it every time he opened his month." The retort was: "Go and dissect a frog." So one would say to the chemist: "Go and get a biological training, no matter what the means by which this training is obtained." Of course one does not expect the chemists to go hand-in-hand gathering flowers and trying to find out the technical names for a lot of plants and animals. Old time botany consisted largely in learning the technical names of plants. All this is a thing of the past. Behind all this rubbishy learning of names are vast biological truths corresponding to, say, the laws of chemical union or the principles of osmosis. It is of the utmost importance that some of these biological truths should be known before the student tackles the science of bacteriology. It must be considered that if a course of bacteriology were instituted at a biological centre, it would be given only during the concluding part of the period of training on account of its difficult nature. Why, then, should the chemist be expected to plunge into a course of bacteriology without the slightest preparation in biology to fit him for the task? The result, of course, is that, as already stated, a number of empirical facts are gleaned, and there the matter rests. Again, superficially considered, a training in examining things under the microscope does not appear necessary. A person with good eyes can see just the same as any other person who has equal powers of vision. Every biologist knows the fallacy which is here involved. It confuses sensation with perception. The sensations of both are the same, but oh! how different their perceptions! Books have been written to enable the chemist to identify various objects under the microscope, but very few without a biological training can do more than just identify the grosser objects with something that they have seen depicted in the book. And when attempts are made with very tiny objects like yeasts and bacteria, very disappointing results are obtained. It may well be stated that the industrial chemist has too much on his hands already, and has no time to devote to the study of biology as a preparatory course for the study of bacteriology. In that case the subject should be left alone. Quite apart from the subject of bacteriology it must, however, be confessed that it is hardly to be expected that a modern chemist should forego the powers that the microscope puts into his hands. Even if he means to devote himself to the metallurgical side, for example, in which living organisms play no part, he still needs the training in microscopy.

The final conclusion which the above remarks lead to is this, that a course in microscopy exemplifying the main biological truths, and giving the chemist an insight into the developmental factor in the lives of animals and plants, should precede the study of bacteriology. The specific proposals as to the line which such a course should take and the manner in which it should lead to a second course embracing the study of bacteria, yeasts and moulds will be given in a subsequent article. Finally, the mode in which the bacteriology course should proceed so as to be of most use to the chemist in his subsequent life work will be delineated.

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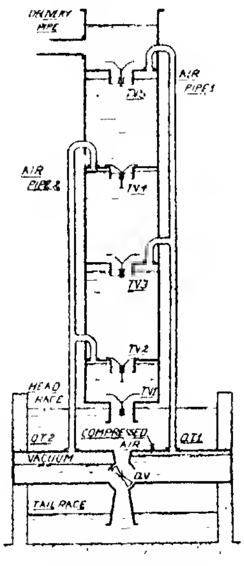
CHEMICAL ENGINEERING AT THE BRITISH EMPIRE EXHIBITION

By Prof. J. W. HINCHLEY

The nine and a-half acres of machinery in the Palace of Engineering alone provide so many exhibits of great importance to the chemical engineer and factory manager that it is difficult to know where to begin. Some of the oldest engineering devices, which are almost forgotten to-day, and the latest inventions for the same purpose are to be seen. The



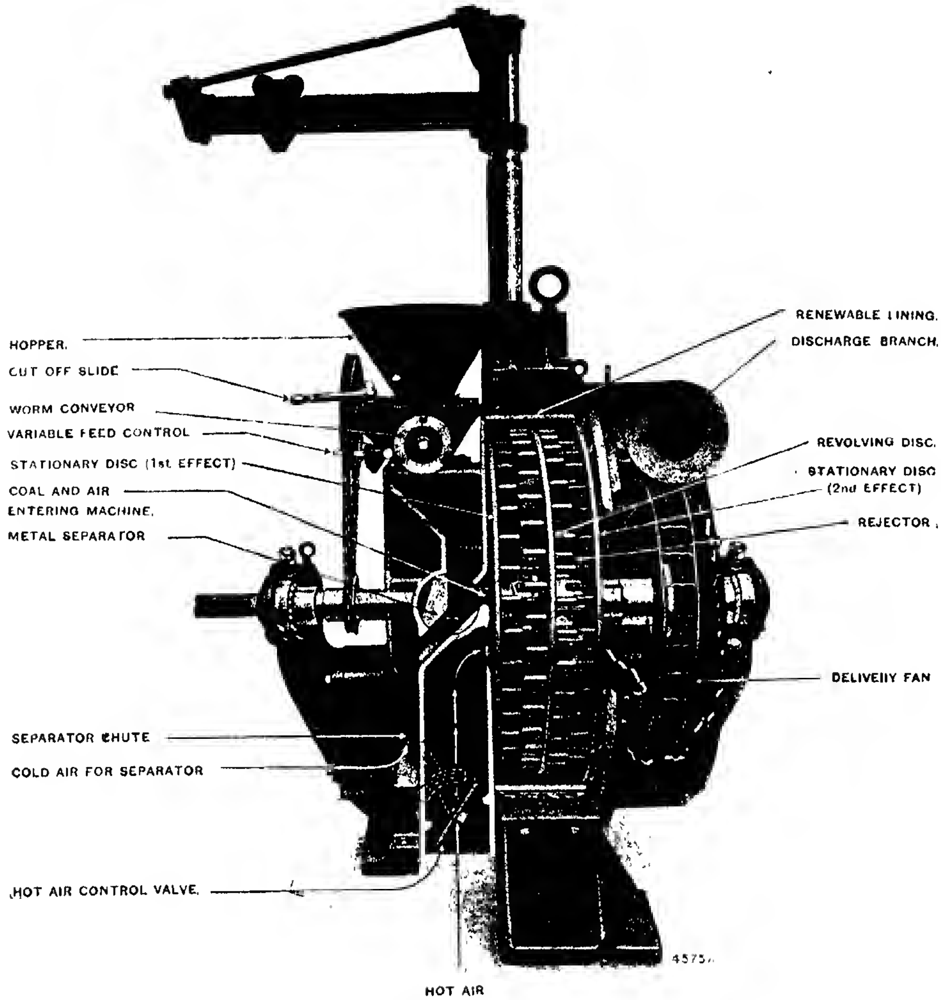
The Hydrautomat

FIG. 1

old-fashioned but really useful hydraulic ram, which may be seen on the stand of Sir W. H. Bailey and Co., has its modern equivalent in the apparatus, (Fig. 1) shown by Hydrautomat, Ltd. It is a pumping device which will work for an unlimited time without expense. A small difference of level may be utilised to raise water to any height by making it produce, in the first instance, compressed and rarified air. Two operating tanks at the base of the machine fill

and empty alternately by means of an automatic valve, and in doing so compress the air in the empty tank and produce a partial vacuum in the full one. Pipes connect the upper part of each tank to alternate compartments in the lifting column, and each partition in this column carries a transfer valve which dips into the chamber below to a depth corresponding to the amount of water lifted during each stroke.

A coal pulveriser, the "Atritor" (Fig. 2), is exhibited by Alfred Herbert, Ltd. In this machine a double pin disc type disintegrator is employed, and the fan is mounted on the same shaft as the rotor of the disintegrator, and ejects the coal dust direct into the furnace for burning. As the material falls from the feeder the induced current of air draws the coal into the disintegrator, but any heavier material



The "Atritor"

FIG. 2

It will be realised that the water in any compartment is forced upwards by the difference in pressure produced in the two sets of pipes. The water thus moves in a series of stages to the highest compartment.

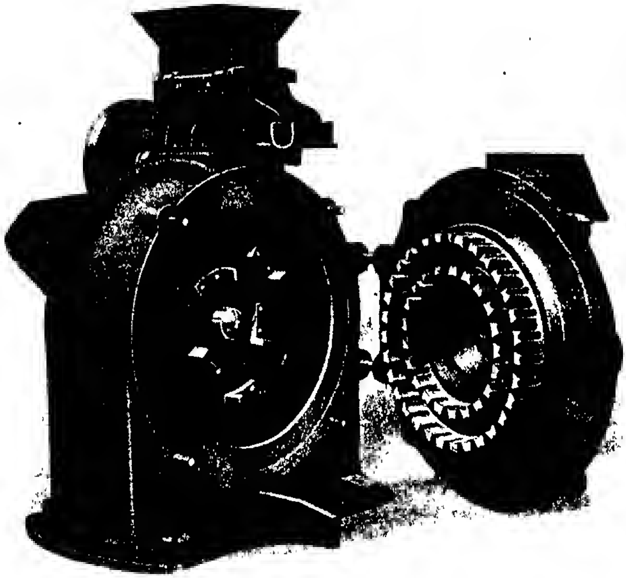
The increased efficiencies or special advantages obtained by using pulverised coal as fuel have led to developments in grinding machinery which, whilst important for the use for which they were designed, are also applicable for other purposes.

drops down a discharge shoot. Provision is made for a supply of hot air to dry the coal as it passes through the machine, and for the addition of small amounts of fuel oil when the coal to be burnt is of very low grade.

The "Impact Grinder" (Fig. 3) of W. S. Barron and Son, Ltd., is interesting on account of the simple method by which a fairly uniform product is obtained. It is not, however, a grinder, but a disc type of

disintegrator, similar to the "Perplex" machine. Any material which does not pass through the screen is raised by the rotor and discharged by the current of air produced, through a slot at the top of the pulverising chamber back again into the feed spout.

The acid-resisting Kitson-Utley rotary pumps may be mentioned. In this pump the casing is machined to a definite curve, so that sliding blades of fixed length, when rotated in a slotted eccentrically placed boss, fit without clearance in all positions. The



The "Impact Grinder"

Fig. 3

A simple "mill-stone" grinder which is worth inspection is to be seen on the same stand.

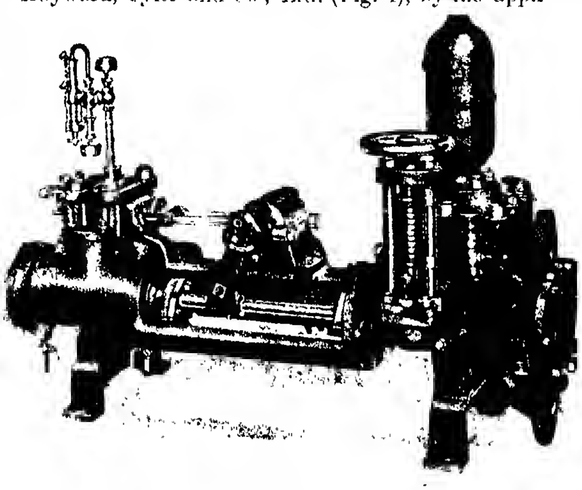
The Hurrell Homogeniser, a variety of colloid mill, may also be worth consideration. The rotor consists of what may be said to be two half width pulleys fixed web to web, and revolving close to an outer jacketted casing. The material to be treated is fed to the centre of the compound pulley, passes between the two webs, and is delivered between the two rims and the casing, where it is subjected to powerful shearing forces. The feed of material regulates the rate of working.

The concrete mixer exhibited by Drummond and Co., Ltd., is obviously suitable for other mixing operations, *e.g.*, furnace charges, batch mixings, etc.

The "Flexala" and "Resiline" centrifugal pumps shown by the Pulsometer Engineering Co., and due to the late Hon. R. C. Parsons, should interest every chemical engineer who has to pump sludge or liquids charged with solids or abrasive materials. The feature of these pumps is the use of a rubber coated impeller with flexible vanes of pliant rubber. The resistance to erosion of rubber is well known. In the "Resiline" pump the whole of the impeller and the interior of the casing is covered with rubber. The resistance to wear of these pumps brings to mind the recent use of rubber linings to ball and tube mills in place of the usual quartzite or metal linings.

pump has proved itself during the last two years; it may be used as a blower or exhauster with success.

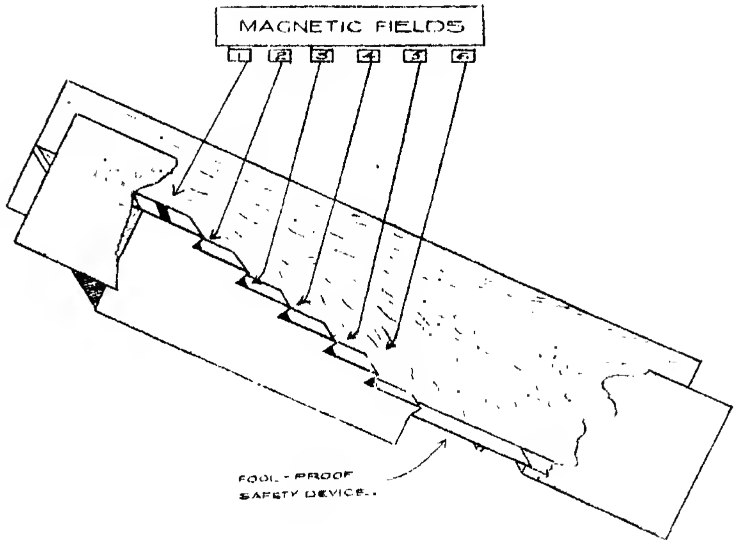
An improvement in the duplex pump shown by Hayward, Tyler and Co., Ltd. (Fig. 4), by the appli-



Duplex Pump with Twells Valve Motion

Fig. 4

cation of the Twells' valve motion is well demonstrated by a pump in work. It differs from the usual valve-gear in the closing of the steam ports; although each piston controls the opening of the opposite valve it closes its *own* valve. A hydraulic pump by work or where shocks may occur; the flaws or blow holes present in cast bodies are absent, and the seatings are made of a hard alloy autogenously united to the working parts of the valve. Drop-forged bodies of valves in special bronze shown by



The "Cascader" Separator

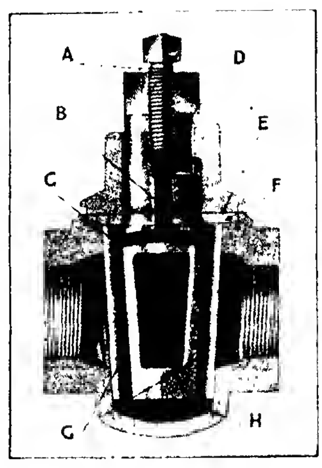
FIG. 5

the same makers and actuated by compressed air is worth attention on account of its value in providing hydraulic water in places where a compressed air service only is available.

New means of transport in factories are always of interest, and the Redler conveyor for grain, flour or powders should be examined. The conveyer is shown at work, and the effective way in which a casing full of flour is moved is very convincing. A chain of simple flat design ⅜ in. thick is carried by sets of sprocket wheels at each end of the conveyor casing. The height of material which may be carried by the chain is equal to the width of the chain. It is in fact a kind of scraper conveyor in which no scraping takes place. It is stated that 4 horse power will convey 50 tons through 100 ft. per hour by means of the Redler conveyor, whilst 20 h.p. is required if a screw conveyor be used. An important improvement in magnetic separators is the "Cascader" (Fig. 5), demonstrated by the Magnetic Separator Co., of Liverpool. The poles of a series of magnets are arranged to form undercut steps in a delivery shoot. At each step a very strong field is produced which holds any shape of iron or steel with remarkable security and certainty. A flap at the last step falls when the current is cut off and diverts the separated iron into a special receptacle.

Valves and cocks are a source of trouble to the chemical engineer, and at times a faulty valve is responsible for the failure or comparative failure of a new plant. The wrought steel valves shown by Victory Valves, Ltd., give confidence in high-pressure

P. D. Mitchell, of Dundee, are also of interest in this connexion when steel is inadmissible. This firm have an interesting exhibit of containers with an ingenious "capsule closing."



The Merco Plug Valve

FIG. 6

The "Klinger" valve is essentially a chemical works valve; it has no seat to corrode and any leakage is readily stopped. A smooth cylindrical

plunger moves through two jointing rings of flexible material, separated by a bush of similar material to that of the plunger, in which are placed passages for the fluid. A gland provides for the constraint of the flexible rings. It will be seen that such a valve will prevent many troubles in chemical plant, to avoid which in some cases two or more ordinary valves are fitted.

The careful design and excellent workmanship shown in the valves of normal pattern shown by J. Blakeborough and Sons, Ltd., deserve attention, whilst their exhibit of the Lundgren-Boyd Rotary Valve, the Edwards automatic stop valve, and the Larner-Johnson hydraulic valves, are of the greatest interest to the water-power engineer. A plug cock that will neither stick nor leak is the attractive claim made for the "Merco" plug valve (Fig. 6), manufactured by the Audley Engineering Co., Ltd. Lubricant ducts are provided in the plug and a lubricant chamber at its base. By means of a screw at the end of the plug, compression of the lubricant takes place, the plug is released and lubricant distributed over it. The feasibility of the claims is obvious. Another cock made by the same firm is provided with recesses in both the body and plug, so that no working surfaces are exposed to the fluids whether the cock is in the open or closed position; any deposit formed cannot therefore affect these surfaces and scoring and jamming are avoided.

(To be continued.)

NOTES FROM CANADA

General Notes

The sugar refineries of Canada, are very active and the export business has been good.

The first unit of the National Cement Co., Montreal, is under construction. It will have a capacity of 900 000 barrels per annum. The company has acquired a large acreage of raw material adjacent to railway and harbour facilities.

The raw fur crop for the last fiscal year was valued at $16,761,597, greater portion being exported. There is no large establishment for the dressing and dyeing of furs in Canada. There are approximately 1000 fox farms in the country.

A company has been formed in Alberta under the name of the Prairie Oils Ltd., for the manufacture of carbon black at High Prairie, Alberta, from the large natural gas wells of the district. The Dominion Government has granted a permit for this purpose, as the wells are located in a district where the gas cannot be economically utilised for heating or lighting purposes.

The Utah-Idaho Sugar Co., one of the largest U.S.A. sugar-beet refiners, contemplates erecting a sugar refinery at Macleod, Southern Alberta. It is at present negotiating with the farmers of the district for a guaranteed production from 6000 acres of beet culture. This is receiving favourable consideration. Many farmers in the adjacent State of Montana have adopted sugar-beet growing and are obtaining good results.

Messrs. Courtaulds, Ltd., have commenced the erection of an artificial silk plant, at Cornwall, Ont. The Foundation Co., of Canada has the contract for the general construction, and the Canadian Vickers that of steel supply.

The Dominion Tar, Chemical and Paper Co., which is sponsored by British interests, represented recently in Canada by the Earl of Dunmore and Sir Harold Botton, has leased land in Toronto, Ont., for the purpose of erecting a factory. Similar sites have been secured in Montreal, St. Boniface and Vancouver, so that the company will possess a chain of works from ocean to ocean.

Canadian Company News

Notwithstanding depression in the steel industry at the early part of last year, the annual financial statement of the Steel Co., of Canada, shows satisfactory earnings for 1923. These earnings amounted to $3,284,467, after providing for repairs, maintenance and improvements and providing for inventory reserve and income tax for 1923, but before making provision for depreciation and bond interest. These latter disbursements were- depreciation reserve $377,651, bond interest $441,962 and dividends on shares $1,259,741, leaving the sum of $627,875 to be credited to profit and loss account.

There have been no new developments in the affairs of the Bay City Pulp and Paper Co., or the Saguenay Pulp and Power Co., which have been in the past, more or less, under the direction of Sir Frederick Becker, of London. The financial report of the Saguenay Co., shows a deficit of $183,826 in 1923, compared with a deficit of $419,579 the previous year. The financial condition of the Becker concerns, in Canada, is attributed to poor management and direction.

The annual statement for the year 1923 of the Consolidated Mining and Smelting Co., of Canada, is very satisfactory, notwithstanding the power shortage which prevented a full realisation of the earning potentialities of the concern. After all charges, including those for depreciation and taxes which are both about double what they were in 1922, there is a net profit of $1,681,162 available for common stock, as compared with $975,449 in 1922, and $270,722 in 1921. This sum is equivalent to $3.98 per share on the stock, or 15·9 per cent. on the $25· par value of shares.

The asbestos mines of Quebec have had a lean year, and one of the larger companies has gone into liquidation. The annual report of the Asbestos Corporation of Canada Ltd., very well illustrates the condition of these industries. The operating profits for the year, after provision for income tax, were $368,936, as compared with $727,093 in 1922, with no write off for depreciation and depletion. After curtailed dividend distribution of the year, a surplus of only $22,230 existed. It is stated the company intends to try the wet process for the extraction of asbestos instead of separating the fibre by screening. The process is claimed to give increased production of asbestos, at less cost and improved quality.

FORTHCOMING EVENTS

June 11. FARADAY SOCIETY AND THE TEXTILE INSTITUTE, at the British Empire Exhibition, Wembley, in Conference Hall No. 4, from 2.30 p.m. to 6.30 p.m. Various papers will be read and discussed.

June 11 to 13. SOCIETY OF DYERS AND COLOURISTS. Annual dinner on June 11 at the Hotel Victoria, Northumberland Avenue, London, S.W. 1. Conference on June 11 and 12 at the British Empire Exhibition, Wembley; on June 11 (3 p.m.) J. R. Hannay will give "An Historical Survey of Dyeing and Calico Printing," and on June 12 (11 a.m.) Prof. A. G. Green, F.R.S., will speak on "Modern Methods of Dyeing." River outing (cost 15s. per person) to Windsor on June 13. Application for tickets should be made to the Society of Dyers and Colourists, 30, Pearl Assurance Buildings, Bradford.

June 11. BRITISH EMPIRE EXHIBITION, WEMBLEY. Conferences on "Heredity as the Basis of National and Industrial Efficiency." Also on June 18 and 25.

June 12. CHEMICAL SOCIETY. Meeting to be held in the Theatre of the Royal Institution, 21, Albemarle Street, W. 1, at 5.30 p.m., when the Faraday Lecture, entitled "Atomism in Modern Physics," will be delivered by Prof. R. A. Millikan.

June 13. UNIVERSITY OF LONDON, University College, Gower Street, W.C. 1, at 5.30 p.m. First of Three Lectures on Physics by Prof. R. A. Millikan. Lectures 2 and 3 to be delivered on June 17 and 19, respectively.

July 15. THE INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (LONDON). Visit of Chemical Students to Wembley. At 9.45 a.m. an Inaugural Meeting will be held at University College, Gower Street, W.C. 1, at which the President of the Institute, Prof. G. G. Henderson, LL.D., F.R.S., will take the chair. Mr. W. J. U. Woolcock, C.B.E., General Organiser of the Chemical Section of the Exhibition and President-elect of the Society of Chemical Industry, will explain the objects of the exhibits and the special features of interest. Prof. W. P. Wynne, C.B.E., F.R.S., President of the Chemical Society, hopes to support the speaker at the meeting. The cost of the visit, including return ticket to Wembley, entrance to the Exhibition, and ticket for luncheon, will be 5s. Further information can be obtained from Mr. G. S. W. Marlow, 30, Russell Square, London, W.C. 1, and applications should be made not later than June 28.

Sept. 8 to 11. INSTITUTE OF METALS. Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at the British Empire Exhibition. On September 10 further papers will be presented for discussion, the afternoon being devoted to visits to works. A reception will be held in the evening at the National Physical Laboratory, Teddington. A detailed programme will be issued in August.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 10.30 a.m.

The following is the official Programme :—

Tuesday, July 8, 9.0 p.m. Informal Reception by the President and the Local Committee at the Midland Adelphi Hotel.

Wednesday, July 9, 10.30 a.m. Annual General Meeting in the Arts Theatre, The University, and Presidential Address, "A Neglected Chapter in Organic Chemistry: The Fats." 2.30 p.m. Visit to White Star Liner, "Cedric," and tea on board, by invitation of the White Star Line. 8.30 p.m. Reception and Dance in the Town Hall, by invitation of the Rt. Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.).

Thursday, July 10, 10.30 a.m. (hour subject to alteration). Messel Memorial Lecture by the Rt. Hon. Viscount Leverhulme, in the Arts Theatre, and presentation to the Lecturer of the Society's Messel Medal for 1924, 12.30 p.m. (hour subject to alteration). Visit to the Works of Messrs. Joseph Crosfield and Sons, Ltd., Warrington. Luncheon by invitation of the Directors. Inspection of the Works of Messrs. Joseph Crosfield and Sons, Ltd. Cost of travelling, 5s. 7.30 p.m. Annual Dinner, in the Midland Adelphi Hotel. Tickets, exclusive of Wines, 12s. 6d.

Friday, July 11, 10.0 a.m. Business Session in the Physics Lecture Theatre, The University. 1.0 p.m. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of The United Alkali Co., Ltd., followed by visit to Works of The United Alkali Co., Ltd. Cost of travelling, 3s. 6d. 7.30 p.m. Dinner at Port Sunlight, by invitation of the Chairman and Directors of Messrs. Lever Bros., Ltd. Cost of travelling, 2s. 6d.

Saturday, July 12. About 9.30 a.m. (details later) Visit to Lake Vyrnwy. Inspection of the Liverpool Corporation Waterworks (limited to 150). Luncheon and tea, by invitation of the Water Committee of the Corporation of Liverpool. Arrive Liverpool about 9.30 p.m. Cost, dinner on train included, 25s.

Unofficial Excursions. Tickets to be booked in Liverpool at Reception Room :—Chester, River Dee and Eaton Hall; Isle of Man; Llandudno and Beaumaris (sea); Lake District (two days).

Members intending to attend the meeting are asked to send their applications, accompanied by the appropriate remittance, as early as possible to Mr. E. Gabriel Jones, City Laboratories, Mount Pleasant, Liverpool, to whom all inquiries relating to private hospitality, railway travelling and other matters connected with the meeting should be addressed.

A ballot list for the election of Members of Council has been despatched to each member entitled to vote.

J. P. LONGSTAFF,
General Secretary

OBITUARY

Dr. G. H. BAILEY

George Herbert Bailey was born on May 17, 1852, at Barnard Castle, in the County of Durham. From early years he was particularly attracted by scientific pursuits. In 1879 he graduated Bachelor of Science, London University, and from 1880 to 1882, was science master at Tattenhall College, near Wolverhampton, resigning this appointment to become a student at the Owens College, Manchester, where he took the second and third year's courses in Chemistry and Physics, at the same time carrying out spectroscopic researches under Prof. Schuster, also researches on chlorophyll with Dr. Schunck, and on vanadium compounds in the Laboratory of Prof. H. E. Roscoe. Whilst at Owens College he was awarded the Dalton Chemical Scholarship.

From 1884 to 1885 he continued his studies at Heidelberg, under Profs. Bunsen, Kopp, Quincke and Rosenbusch, obtaining at the end of this period the D.Sc. (London) and Ph.D. (Heidelberg).

He now became demonstrator and lecturer in Chemistry at the Owens College remaining there for the long period of 24 years, during which time he carried out a considerable number of researches.

The technological side of chemistry appealed to him particularly, and he was associated from early days with the Manchester Section of the Society of Chemical Industry, of which Section he was Chairman in 1905–7. During his residence in Manchester he undertook a considerable amount of consulting work, particularly on behalf of the Corporation of Manchester.

In April, 1909, he was appointed Chief Chemist to the British Aluminium Company, Ltd., his headquarters being at the Kinlochleven works of the company. In this appointment he found considerable scope for his activities until 1920, when, at the age of 68, the company permitted his retirement, retaining him however, as their Advisory Chemist up to the time of his death. Two attacks of pneumonia, in 1906 and 1909, had left a heart weakness, which, though it had troubled him comparatively little in recent years, nevertheless persisted, and a day spent in too great activity in his garden at Datchet, that he loved so much, appears to have been responsible for a heart seizure which brought to a sudden termination a life in which one can truthfully say there had been no idleness. He leaves a widow, three sons and a daughter; his eldest son is a squadron leader in the Royal Air Force, the second is in Rhodesia, and the third in New Zealand.

His published words include: -1881: Componenten der absorption spectrum erzeugenden seltenen erden (*Ber.*, 21, 1520). 1884: Some vanadates of the ammes (*Jour. Chem. Soc.*, 1884, 690). 1886: Separation and estimation of zirconium (*Jour. Chem. Soc.*, 1886, 149 and 181), also (*Annalen*, 232, 352); Analysis of coppite (*Jour. Chem. Soc.*, 153); (*Annalen* (232), 357) 1887: The double sulphate of lead and aluminium (*Jour. Soc. Chem. Ind.*, 1887, 415); Determination of atomic weight by means of the normal sulphate (*Jour. Chem. Soc.*, 1887, 676 T); Silver suboxide (*Chem. News.*, 55 and 263), and with C. J. Fowler, Silver-suboxide (*Jour. Chem. Soc.*, 416 T and 54 P); Interpenetration of absorption spectra (*Jour. Chem. Soc*, 141 T); Atomic weight of zirconium (Brit. Ass., 1887); Absorption spectra of rare earths (Brit. Ass., 1887); Absorption spectra of the haloid salts of didymium (Brit Ass., 1887); Components of the rare earths yielding absorption spectra (*Ber.* 1887, 2769 and 3325); Temperatures at which various sulphates undergo decomposition (*Jour. Chem. Soc.*, 1887, 100 P.); Influence of mass on chemical decomposition (*Jour. Soc. Chem. Ind.*, 91). 1889: Estimation and occurrence of sulphur in coal (*Jour. Soc. Chem. Ind.*, 360); On the vitrified cement from an ancient fort (Memoirs, Manc. Lit. and Phil. Soc.); Method for the separation and estimation of zirconium (*Annalen* (232), 3). 1890: "With A. A. Read:" The behaviour of the more stable oxides at high temperatures (Brit. Ass. 1890); "With J. C. Cain": A method of quantitative analysis (Brit. Ass., 1890); The spectra of the haloid salts of didymium (Brit. Ass., 1890); "With A. Hopkins:" The behaviour of the more stable oxides at high temperatures (*Jour. Chem. Soc.*, 269 T). 1890: The effect of noxious gases on plant life (Manc. Field. Naturalists. Soc., 56). 1891: A report on the atmosphere of Manchester (Manc. Field Naturalists Soc.). 1892: Conditions affecting plant life in a town atmosphere (Brit. Ass.).; Air impurities of towns (*Jour. Soc., Chem. Ind.*, 769); "With Lamb": The atomic weight of palladium (*Jour. Chem. Soc.*, 745 T). 1893: On the liability of pine trees to lightning strokes (Mem., Manc. Lit. and Phil.). 1894: Some aspects of town air as contrasted with that in the country. (Mem., Manc. Lit. and Phil.); The stability of oxides considered in relation to the periodic law (*Jour. Chem. Soc*, 315 T.); The volatility of salts during evaporation (*Jour. Chem. Soc.*, 445). 1903: "With Hart": The manufacture of sulphuric acid by the chamber process (*Jour. Soc. Chem. Ind.*, 538). 1905: Higher education in the chemical industry (*Jour. Soc. Chem. Ind.*, 1205). 1910: A record of analysis (*Jour. Inst. Met.*, 1. 210); Analysis of aluminium and its alloys (*Jour. Inst. Met.*, 1, 151). 1913: The corrosion of condenser tubes (*Jour. Inst. Met.*, 71). 1916: Electric furnaces applied to non-ferrous metallurgy (*Jour. Inst. Met.*, 305); on the third report of the corrosion research committee (*Jour. Inst. Met.*, 1, 185). 1917: The effect of heat on the rate of softening of cold rolled aluminium sheets (*Jour. Inst. Met.*, 11, 164). 1919: The action of hard industrial waters on aluminium (*Jour. Inst. Met.*, 1, 187); On the fourth report of the Corrosion Research Committee (*Jour. Inst. Met.*, 1, 234). 1920: The corrosion of aluminium (*Jour. Inst. Met.*, 2, 404); The rate of corrosion of aluminium (*Jour. Soc. Chem. Ind.*, 118 T).

Dr. Bailey was the author of the following textbooks:—First stage Inorganic Chemistry, the New Matriculation Chemistry, Elements of Quantitative Analysis, Tutorial Chemistry. Part 2, "Metals and Physical Chemistry," Advanced Inorganic Chemistry.

The above notice has been compiled at the request of the Manchester Section and the writer is indebted to Mr. T. Lewis Bailey, his brother, for most of the above information.

ATOMS AND ISOTOPES*

By Dr. F. W. ASTON

That matter is discontinuous and consists of discrete particles is now an accepted fact, though it is not obvious to the senses on account of the extreme smallness of the particles. Some idea of their size and numbers can be gained by the hypothetical division of a piece of matter into smaller and smaller pieces until the ultimate atom is reached. For this purpose a model decimetre cube of lead is taken and cut in such a manner that after each operation a similar cube of half the linear dimensions and one eighth the volume results. Modern science shows that this operation can be repeated no less than 28 times before the ultimate atom of lead is reached, and that the number of atoms in the original cube is so enormous that placed in a string as close together as they are in the lead they would extend over six million million miles. Again, if an ordinary evacuated electric light bulb were pierced with an aperture such that one million molecules of the air entered per second, the pressure in the bulb would not rise to that of the air outside for a hundred million years.

Dalton, in his atomic theory, postulated that "Atoms of the same element are similar to one another and equal in weight," a simple and definite conception which has been of inestimable value in the development of chemistry. A little later Prout suggested that the atoms of all elements were made of atoms of a primordial substance which he endeavoured to identify with hydrogen. If Dalton and Prout were both right the chemical atomic weights should all be whole numbers, hydrogen being unity. Chemical evidence was against this, and Prout's theory was abandoned for the time. We cannot test the truth of Dalton's postulate by chemical methods since these require countless myriads of atoms, and, therefore, only give a mean result.

The weights of individual atoms can be investigated by means of the analysis of positive rays and the early experiments of Sir J. J. Thomson suggested that one element—neon—had atoms of two different weights but the method of analysis was not accurate enough to prove the point. The requisite accuracy has been obtained by means of an instrument called the "mass-spectrograph." In this the charged atoms in a beam of positive rays are sorted out according to their weight by means of magnetic and electric fields so that they strike a photographic plate at different points. A mixture of atoms of different weights will give a series of focussed lines called a mass spectrum and the relative weights of the atoms can be calculated from the position of their lines to an accuracy of 1 in 1000.

As the result of this analysis it has been shown that neon (Atomic Weight 20·20) is a mixture of atoms of weights 20 and 22. These constituents have identical chemical properties and are called "isotopes." Chlorine (At. Wt. 35·46) is a mixture of isotopic atoms of weights 35 and 37. About half the elements so far analysed are mixtures and some are very complex. Thus krypton has six, tin at least seven and xenon possibly nine constituent isotopes. Recently, by means of the method of "accelerated anode rays," the work has been extended to many metals and already some fifty of the eighty-four known non-radioactive elements have been analysed into their constituent isotopes or shown to be "simple."

Most important of all is the fact arising out of these measurements that all true weights of atoms can be expressed as whole numbers to a very high degree of accuracy. This remarkable generalisation known as the "whole number rule" has removed the last obstacle in the way of a simple unitary theory of matter. We now know that Nature uses the same bricks in the construction of the atoms of all elements, and that these standard bricks are the primordial atoms of positive and negative electricity, protons and electrons.

According to the nucleus theory of the atom first suggested by Sir Ernest Rutherford, which has led to such wonderful advances recently in the hands of Professor Bohr, all the protons which are much heavier than electrons, are packed with some of the electrons in a central nucleus or sun round which circulate the remaining electrons like planets in orbits. The protons and electrons are so minute compared with the atom itself that it is difficult to indicate their numerical relations. If we were to construct a scale model of the atom as big as the dome of St. Paul's we should have some difficulty in seeing the electrons, which would be little larger than pin heads, whilst the protons would escape notice altogether as dust particles invisible to the unaided eye. Experimental evidence leaves us no escape from the astounding conclusion that the atom of matter as a structure, is empty, empty as the solar system, and that what we measure as its spherical boundary really only represents the limiting orbits of its outermost electrons.

All the chemical and spectroscopic properties of an atom depend on the movements of its planetary electrons, and these in their turn depend on the positive electric charge on the central nucleus. In the case of isotopic atoms the net positive charge on their nuclei is the same, giving identical chemical properties but the total number of protons is different, giving different atomic weights.

Transmutation of one element to another can only be achieved by the disruption of the nucleus. This requires enormous forces, but by the bombardment of atoms by swift alpha particles Rutherford has succeeded in breaking up the nuclei of several of the lighter elements. This transmutation only takes place as the result of a direct hit on the nucleus, the chance of which is only one in many millions. The quantity of matter so transmuted is indeed almost inconceivably small, but it is the first step towards the release and control of the so called "atomic energy." We know now with certainty that four neutral hydrogen atoms weigh appreciably more than one neutral helium atom, though they contain the same units, 4 protons and 4 electrons. If we could transmute hydrogen into helium matter

* May Lecture, delivered before the Institute of Metals, on May 4.

would, therefore, be destroyed and a prodigious quantity of energy would be liberated. The transmutation of the hydrogen contained in one pint of water into helium would set free sufficient energy to propel the Mauretania across the Atlantic and back at full speed. With such vast stores of energy at our disposal there would be literally no limit to the material achievements of the human race.

AMMONIUM PERCHLORATE

ROYAL COMMISSION ON AWARDS TO INVENTORS

This Commission heard on May 26 and June 2 the claims by Messrs C. W. Bailey, H. S. Denny, A. J. Dunk, J. A. Cresswick, R. Young, J. G. Williams, and A. T. Jefferis for awards in connexion with the manufacture during the war of ammonium perchlorate at Langwith in Derbyshire. The hearing was before Mr. Justice Tomlin, the chairman, Mr. F. Norton, C.B.E., K.C., and Mr. A. Chaston Chapman, F.R.S. Several of the claimants appeared in person; Mr. Whitehead, K.C., and Mr. Courtney Terrell appeared for the Crown. Ammonium perchlorate was, in small quantity, used during the war as an explosive, but it is fairly easily detonated and seems to have been less suited for marine mines than for quarry work, where its use is well known. It has for many years been manufactured by Mr. Carlson in Sweden, and when the British Government decided to manufacture in this country it obtained from Mr. Carlson's firm full details of the manufacture of ammonium perchlorate by mixing solutions of sodium perchlorate, prepared electrolytically, and ammonium sulphate. Solubility curves of ammonium perchlorate and sodium sulphate are said by the Crown to have been supplied by Mr. Carlson's firm. The Langwith factory was a difficult problem and the Government sent a number of trained and capable chemists and chemical engineers to put it in order and manufacture economically. The claimants after many difficulties succeeded in making a considerable quantity of ammonium perchlorate and they claim that the improvements made on the Carlson process deserve special recognition. The Crown claims that such improvements as were made could have been thought out by any competent and skilful chemists who were supplied with the necessary information and that the claimants, though they did good work, did merely that for which they were employed and paid. The case is not yet completed and is being heard *in camera*. It is understood that the improvements in respect of which awards are claimed are all for methods of separately crystallising out the sodium sulphate and ammonium perchlorate.

Prof. O. Hahn has been invited to succeed Prof. M. Bodenstein in the chair of physical chemistry in the Hanover Technical *Hochschule*.

THE INSTITUTE OF PHYSICS

At the Annual General Meeting held on May 26 Sir Charles A. Parsons, K.C.B., F.R.S., was re-elected President. The Vice-Presidents are Prof. W. H. Eccles, F.R.S., Mr. C. C. Paterson, Dr. E. H. Rayner, and Sir Napier Shaw, F.R.S. Sir Robert Hadfield, F.R.S., is Treasurer, and Prof. Alfred W. Porter, F.R.S., Honorary Secretary.

From the Annual Report it appears that the demand for highly trained and qualified physicists at present exceeds the supply. The Report deals at some length with the new monthly *Journal of Scientific Instruments*, which is being produced by the Institute, and edited at the National Physical Laboratory. It also refers to the Lectures on Physics in Industry, which are being delivered under the auspices of the Institute, and a second volume of which will shortly be published by the Oxford University Press. It is pointed out that the publication of these lectures and their circulation among manufacturers should do much to promote one of the main objects of the Institute, which is to urge the importance of physics in industry, and to encourage the employment of physicists qualified to understand where and how physical principles and knowledge may be utilised in increasing the efficiency of existing processes, and in the development of new applications.

ACADÉMIE DES SCIENCES

During the meeting on May 19, Prof. Richet described a new treatment of tuberculosis by the juice of pure, dried, and raw meat, a method suggested by the fact that the reparation of the tuberculous organism takes place by the reconstruction of muscular tissue disorganised by the disease. Monsieur G. Bertrand described a method for "stoving" cocoons, in which the action of heat was replaced by that of chloropicrin which ensured the death of the pupa without harming the silky envelope. Monsieur de Broglie described a method of determining the wavelengths of γ rays by their photo-electric effect. Monsieur Breton communicated a paper by G. Kimpflin on the permeability of synthetic resin to infra-red rays. A plate of bakelite, 5 mm. thick, allowed the passage of 35 per cent. of the rays, and the introduction of two per thousand of ferric chloride reduced the transparency by one per cent. The permeability of a "bakelised" plate of paper of the same thickness was 17 per cent., whereas under similar conditions, that of a plate of ebonite was three per cent. The author hopes by reducing the thickness of the plate of resin, and by compensating the slightest mechanical resistance by introducing a suitable charge, to increase the permeability to the infra-red, and to obtain results of interest to industry.

During the meeting on May 26, MM. Lumière described the results of developing silver bromide photographic plates after fixation. The method is long, but has the advantage that development can be carried out in daylight and gives a negative with a finer grain. Prof. Moureu and C. H. Dufraisse described further work on oxidation catalysis utilising free oxygen. The authors emphasised the theoretical

importance of the catalytic action of sulphur and its compounds, not only because of its direct theoretical consequences, but also because of its bearing on biology. In fact, according to recent work, sulphur appears to play a most important part in oxidations in the living body. Monsieur Schloesing described the influence of soil bacteria on plant life, and Prof. Urbain described an anomaly observed in the reduction of bichloride of mercury by sodium formate, which was of considerable theoretical interest. Prof. Le Chatelier communicated a note by Monsieur Peczalski, describing a new observation on salts in metals. MM Desgrez, Bierry and Ratherry described further work on diabetes, showing that the quantity of fat to be used in the diet for diabetic patients should be regulated according to the chemical structure of the fats, and to the relative proportion of the proteins and carbohydrates in the diet. Each individual needs a certain characteristic amount of fat, which is usually small in serious cases of diabetes. Insulin increases the absorptive capacity for fats, permitting a better utilisation of the carbohydrates.

THE BRITISH CHEMICAL AND DYESTUFFS TRADERS' ASSOCIATION, LTD.

The first annual meeting was held in London on May 15, eighty-five representatives being present from various parts of the country. In submitting a report of the first year's work, the chairman, Mr. Victor Blagden, said that previously there had been two associations having the same objects. So as to present a united front to the Government, the manufacturers and the consumers, an amalgamation was effected, the result being the present trade organisation, now registered as a non-trading concern. Roughly 36 new members had been elected during the year and further applications were promised. There were now 128 members, whilst only 20 firms had discontinued membership, and considering the trade depression, this was very satisfactory. Increased membership was required to provide for increased activities. The Association was a non-trading concern, but when chemical or dyestuffs traders' interests were unfairly encroached upon, or when any point of principle was raised affecting their interests, either by a Government Department or by some commercial or industrial interest, the Association was prepared to offer resistance. Valuable assistance had been rendered to members in connexion with the Reparations Recovery Act. In numerous cases the Association obtained satisfactory settlements for members in contesting Customs' claims for reparations levy on goods that were not liable. The committee was not satisfied with the attitude of the Board of Trade towards merchanting interests in respect of dyestuffs. It was unfortunate that the Board of Trade refused to publish particulars of all licences granted. The importance of the various consuming industries seemed to have been lost sight of altogether. The Board of Trade and the Licensing Committee appeared to be willing to inflict any handicap involving the production of inferior finished goods so long as they could, by refusing to grant import licences, push unsatisfactory home-made colours. It was difficult to understand why the Association's request for representation on behalf of dyestuff traders on the Licensing Committee was so persistently refused when it was remembered that over 75 per cent. of the applications for licences came from merchants. The committee had submitted a memorandum regarding the proposed agreement between the British Dyestuffs Corporation and the Interessen Gemeinschaft. Lists of reparation colours had been issued to members, but despite the approval of the consumers, it was not possible to induce the Board of Trade to introduce a special discount to merchants purchasing supplies from reparation stocks, for re-sale. Much work had been done in relation to Part I of the Safeguarding of Industries Act, and the Customs had been persuaded to accept invoice values and not to assess the value of dutiable goods on their own estimate. He (Mr. Blagden) had no comment to make on the desirability of protecting certain essential industries, but he had no hesitation in stating from close and continued experience, that Part I of the Key Industries Act was doing a great deal more harm to the trade of the country, especially to re-export business, than was necessary in order to provide a shelter for such industries. It had cut us off completely from the freedom of international trade in chemicals in which we had previously played a leading part, and this country had lost its place as the best source of supply for every and any chemical whether made here or not. Many cases of hold-up and delay in clearing goods through customs had been dealt with, and an attempt was being made to induce the Treasury to introduce a system of "bonding" of goods liable to Key Industry duty. In general commercial matters the Association had been active. It had dealt with the question of the right of wharfingers to put a general lien on goods. Action had been taken regarding the revision of railway freight rates and negotiations were in progress for the reduction of the Port of London Authority charges for chemicals. A great deal of press propaganda had been carried out and effective work had been performed with the aid of the Association's parliamentary machine.

In proposing a vote of thanks to Mr. Blagden, Mr. F. T. T. Reynolds expressed his appreciation of the work performed by him as their first chairman, and pointed out that organisation was of vital necessity. Manufacturers and consumers had realised this long ago, but traders had only come together recently and had leeway to make up. The trader was appreciated as an indispensable link in the chain of trade. Great Britain was the leading trading country, not only because it was the largest producer or the largest consumer of essential commodities, but because it was the largest trader. Chemicals and dyestuffs were indispensable in times of peace or of war, and the Association had to emphasise the further truth that efficient and effective distribution was the bridge between producer and consumer, and that the trader provided that bridge much more economically and effectively than irresponsible officials.

CORRESPONDENCE

THE HISTORY OF THE GAS PROCESS

Sir,—With regard to your interesting short editorial note in the issue of May 30, concerning the history of the gas process, perhaps you would allow me to give you—as concisely as possible—the facts with regard to the early history of this industry.

The evolution of gas from decaying vegetable matter had been known for centuries, and in 1600 for example, Van Helmont, then resident in Brussels, observed that coal "did belch forth a wild spirit or breath," and the word "gas" itself seems to have been first used by this famous Dutch chemist.

The earliest account of illuminating gas given off by coal is that of Thomas Shirley in the "Philosophical Transactions" of 1667, who noticed (very appropriately) that gas was being issued from a spring near Wigan. The first man who definitely prepared a gaseous product by the carbonisation of vegetable matter, including coal, was Robert Boyle in 1691, and in 1726 Stephen Hales mentions early experiments in this direction in his publication, "Vegetable Staticks." The Rev. John Clayton, Dean of Kildare, whom you mention, was also one of the earliest investigators, and he showed that the inflammable gas given off by the spring at Wigan was really due to the coal underneath. He then heated coal in an open vessel and there is an account of his experiments in the "Philosophical Transactions" of 1739.

Coal was first carbonised on a commercial scale merely for the production of coke, and not for gas at all, at the iron works of the Prince of Nassau-Saarbrucken at Sultzbach, and this process is described in detail by the French author, De Gensanne, in his book printed in Paris in 1770. Also the results of experiments on the distillation of coal were published by Watson in 1781, and the Earl of Dundonald interested himself in the matter, as you state, whilst in 1784 Professor J. P. Minckelers suggested the use of gas for filling balloons.

Indisputably, however, the real pioneer of the gas industry, that is the systematic carbonisation of coal or other vegetable material for the production of gas on a practical scale, was William Murdoch, who was born in 1754 at the village of Lugar in Ayrshire. He began to experiment with the carbonisation of shale and coal when he was a boy, and as a matter of fact there was a small outcrop of shale in his father's cabbage garden. He seems to have commenced these experiments about 1770.

As is well known, he became one of the chief men of the very remarkable staff that Boulton and Watt were able to get together, and for a number of years was their engineering representative in Cornwall. He continued his experiments with gas and in 1792 lighted his house at Redruth with coal gas, which was the first building in the world to be illuminated in this way, and the house is still shown to visitors. James Watt, however, not for the first time in his career, showed an utter lack of imagination in the matter and did his best to discourage Murdoch in every possible way, whilst he also prevented him from continuing his experiments on the locomotive. Incidentally, Murdoch seems to have been the first man in the world to have ever constructed a steam-driven model locomotive, although because of Watt's influence, already mentioned, the work was abandoned. The real pioneer of the steam locomotive is Richard Trevithick, who was unquestionably the greatest engineer in the world, and it is hopeless to get the ordinary man to understand that Stephenson was not the pioneer of the locomotive, but that Trevithick constructed the first steam railway in the world in Wales years before Stephenson was ever associated with locomotives.

Murdoch was subsequently appointed manager of Boulton and Watt's factory in Birmingham, and continued his experiments in spite of Watt, lighting the factory throughout with gas in 1802, the first industrial establishment to be lighted in this manner, the occasion being the celebrations for the peace of Amiens. He then began to supply gas plant to factories, and the first factory to be lighted—apart from the Birmingham establishment—was the cotton mill of Messrs. Phillips and Lee in Manchester in the year 1805, which was fitted with a complete gas plant and 900 gas burners. Murdoch described this installation in the most lucid and detailed manner before the Royal Society of Arts in 1808, and the account can of course be read in their journal, whilst at the same time he was awarded for this paper the Society's Rumford Gold Medal. Murdoch's work on the gas process is almost incredible, and his retorts and gasometer, for example, which are still in existence in Birmingham, might be comparatively modern productions.

Quite independent of this work of Murdoch's, the gas process was also developed in France by the famous Phillippe Lebon, who was an engineer in the service of the French Government (Department of Bridges and Roads), and who seems to have commenced his work—using sawdust in place of coal—about 1791. He completed his investigations by 1799, and caused a great sensation in France in 1801 by lighting his house in the Rue St. Dominique, Paris, with gas. Lebon, of course, met with the usual fate of almost all great men, and after being subjected to petty persecution and derision for the greater part of his life, came to a miserable end, being as a matter of fact stabbed to death in mistake for Napoleon, whom he strongly resembled in appearance.

Finally, although I do not want to make this letter too long, I should like to add a few words about the immortal Winsor (whose name was spelt indiscriminately as Winsor, Winzer, or Wintzler), a German born in Moravia, and who first of all travelled from Frankfort apparently to try to come to some business arrangement with Lebon. The latter very wisely would have nothing to do with him, and Winsor therefore came to London to start a gas lighting company, since he writes in one of his pamphlets:—

"The thought of introducing the discovery for the advantage of the British realm struck me like an electric shock."

He took up his quarters in 1806 at the Star and Garter Hotel, 97, Pall Mall, a site which is now occupied by the Carlton Club, and his efforts to establish a gas industry by means of lectures, demonstrations and pamphlets were one of the sensations of England. The whole episode, which of course has its humorous side, is almost incredible, and to give one example, Winsor promised to anyone who would subscribe to his gas company that he would give them a profit of 6000 guineas per year for every 7 guineas invested (!!). 17,000 shares on these lines were sold in 10 days, rising from one guinea at par to 7 guineas per share, whilst it was reputed that they would rise to 100 guineas, and according to one letter of the period Pall Mall was blocked with people in carriages, on horseback, and on foot rushing to invest. Whether Winsor was stark crazy or only a mountebank is not clear, but at any rate it was due to his efforts that gas lighting commenced in Great Britain, and Pall Mall was the first public thoroughfare in the world to be lighted in this way, on January 28, 1807.

When Winsor and his supporters tried to get a Bill through the House of Commons to authorise the formation of a company, it was opposed very vigorously by Boulton and Watt, who by this time seem to have had some glimmering of the possible value of the gas process, and by their efforts the Bill was thrown out. Subsequently, however, it became law on June 9, 1810.

In one last word I would like to mention also that, in addition to Murdoch and Lebon, another man who ought fitly to be regarded as a pioneer of the gas process is Samuel Clegg, who was very luckily appointed chief engineer of the first gas company in London, and who had been a mechanic under Murdoch. This Clegg was also an extraordinary man, and it may interest your readers to know that with regard to the present "Caracristi" low-temperature carbonisation plant now being erected by the Ford Company in the United States, in 1825 Samuel Clegg designed and worked a retort on almost identical lines, that is a travelling cast-iron plate continuous carbonising apparatus, although he used a fire underneath and not a bath of molten lead.

I may say that I gave some time ago a paper on the history of the gas process before the Newcomen Society for the Study of Historical Engineering, which name may perhaps not be familiar to the average chemist, and this paper will be available in the "Transactions" of that Society in the near future.—I am, Sir, etc., DAVID BROWNLIE

BETTON'S BRITISH OIL

Sir,—In the article by Dr. W. Forbes-Leslie (May 23), on "The Oil Shales of Somerset," mention is made of the extraction of oil for medicinal purposes in 1761. It would be of interest to know if this refers to "Betton's British Oil," which was stated to have been obtained by the distillation of the bituminous sandstone of Pitchford, in Shropshire. The oil was sold by a family named Boyce in Shrewsbury, about eighty years ago, and was much esteemed as a cure for sprains and rheumatism. The pitch well does not now appear to be productive, but it was the means of making a considerable fortune for the inventor of the medicament. The introduction of the shale-oil industry is somewhere stated to have its origin in the refining, in 1847, by James Young, of the crude petroleum of Alfreton, in Derbyshire, to which attention had been called by Lord Plyfair.

Perhaps some further information, or verification of the points mentioned, though only of historic interest, may be forthcoming.—I am, Sir, etc.,

H. A. AUDEN

Whitehedge Road,
Garston
June 2, 1924

VIEWS FROM DOWN UNDER

Sir,—"Caret Law" from Paisley has a go at you on March 14, this number has just come to hand here, and as I had already made some similar reflections about chemists and lawyers, I am encouraged to raise my voice from Down Under, so look out.

Personally I do think that the canny lawyers have got the advantage in respect to the organisation of their profession, but then they never do anything new, they always look up all manner of musty precedents before they begin, and above all things, they never get in a hurry. What on earth would a lawyer do if he were asked unceremoniously for a decision on some important matter and was expected to answer in, say, a couple of hours, yet how many chemists are expected to provide accurate data for the buying department based on analysis which can only be given by a good expert in the time named; what on earth does a lawyer ever produce except long series involving n to n+m multiples of 6/8 where n and m are any large numbers.

With such a narrow outlook how relatively easy it was for them to have so organised and arranged their profession as to be able to secure easy times for themselves and good remuneration. Then again, their work brings them all the time into close contact with the human side of affairs, they are not called upon to live half their lives in a mental world remote from all the commonplace affairs around them, the lawyer is always commonplace, it is his job. The creative chemist spends more than half his life thinking of things as remote as possible from this; even fellow chemists wrapped in their own particular affairs and difficulties, only similar in their remoteness from the commonplace find it difficult to understand each other. I noticed in one of the journals the other day (I am not sure if it were yours) that some chemist had been "slinging off" as we say out here, about the absence of chemists on boards of guardians, town councils and the like, how in the world does he suppose that a man is to spend all his day, for instance, on the synthesis of $aa\beta\beta$ dextro-laevomethylethyl anthraquinonal sulphonamide, and then go and spend his evening listening to complaints from Jones about the failure of the drains in X street, or to plumb the depths of subtlety involved when Mrs. Y, with n+1 children and a husband who "drinks" applies for new blankets for the winter.

But seriously I am really delighted with the effort Mr. Woolcock is making to found Chemistry House, and I shall have little sympathy with you if you grumble when our energetic president (where does he get it all from) demands that YOU, from the height of your Olympic Chair, should see that the lower world gets moving in the matter. Tell Mr. Woolcock that I wish him every conceivable success, and that I look forward on my return (if ever I do return) to an invitation from him to a nice cosy, comfortable, well-furnished place (in Chemistry House) somewhere near a "bar" where a good whiskey and soda will make us both feel very human and of the world, and perhaps even delightfully commonplace.—I am, Yours, etc.,

HARRY WILLIAMS

Arlington Mills,
Botany, N.S.W.
April 25, 1924

PERSONAL AND OTHER ITEMS

The following names are included in the official list of His Majesty's Birthday Honours:—Baronet: Alexander Grant, chairman of Messrs. McVitie and Price. Knights: W. Galloway, D.Sc., A. Smith Woodward, D.Sc., F.R.S., lately Keeper of Geology in the British Museum. Order of Merit: Prof. Sir C. S. Sherrington, President of the Royal Society. G.B.E.: Sir Josiah Stamp, K.B.E., D.Sc. C.B.E.: Dr. E. P. Cathcart, M.D., F.R.S., professor of chemical physiology, Glasgow University; R. Townsend, chief superintendent of ordnance factories, War Office. Imperial Service Order: W. J. Bean, curator of the Royal Botanic Gardens, Kew. Congratulations are to be offered to Sir Alexander Grant, who has been a member of the Society of Chemical Industry since 1905.

The Council of the Royal Society of Arts has unanimously resolved to confer the Albert Medal for 1924 on the Prince of Wales, in recognition of services rendered to arts, manufactures and commerce as president of the British Empire Exhibition, and by his visits to the Dominions and India.

It is reported by *The Times* that an assistant chemist formerly employed by Bayer's dye works at Leverkusen, has been sentenced at Würzburg to six months' imprisonment for the betrayal of industrial secrets. He was convicted of having sold a number of dye secrets, of which he had illegally obtained possession, to persons in Great Britain and the United States.

At the sale of the late Sir J. Dewar's library, 37 guineas was paid for the Journal of the Chemical Society, 1871–1923 and that Society's Annual Reports on the Progress of Pure Chemistry, 1904—1922.

From Paris the death is announced of Monsieur Emile Deutsch de la Meurthe, a director of the petroleum refinery bearing the same name.

Mr. J. G. A. Roberts, J.P., vice-chairman of Boake, Roberts and Co., Ltd., manufacturing chemists, Stratford, E., who died on February 10, has left £110,128, with net personalty, £108,059.

Dr. N. Comber has been elected to the chair of agricultural chemistry in the University of Leeds, which has been vacant since the retirement of Prof. C. Crowther, now Principal of the Harper Adams Agricultural College.

The University of Melbourne has decided to confer the title of emeritus professor of chemistry upon Sir David Masson in recognition of his services to the University.

The death of Commendatore Ersilio Baroni deprives the Associazione Chimica Industriale di Torini of one of its founders. Comm. Baroni was the president of the Società Italiana Esplosivi e Munizioni.

Dr. H. O Hofman, professor of metallurgy in the Massachusetts Institute of Technology, and author of valuable treatises on metallurgy, died recently in Cambridge, Mass.

Dr. K. G. Jonas, of the Breslau Technical *Hochschule*, has been appointed to succeed Prof. E. Heuser in the chair of cellulose chemistry, in the Darmstadt Technical *Hochschule*.

At the annual meeting of the Institution of Civil Engineers, the following officers were elected:—President, Mr. Basil Mott. Vice-Presidents, Sir W. H. Ellis, Mr. F. Palmer, Sir Archibald Denny, and Mr. E. F. Crosbie Trench. Members of Council: Mr. H. N. Allott, Mr. A. A. Biggs, Sir J. Cadman, Sir D. Clerk, Colonel R. E. B. Crompton, Mr. H. A. Cutler, Mr. W. W. Grierson, Sir R. A. Hadfield, Sir B. H. Henderson, Mr. E. P. Hill, Mr. G. W. Humphreys, Sir C. R. S. Kirkpatrick, Sir M. Macdonald, M.P., Mr. J. MacGlashan, Mr. J. P. Maxwell, Sir H. P. Maybury, Sir J. Monash, Mr. G. T. Nicholson, Mr. J. B. Porter, Sir R. A. S. Redmayne, Sir H. Reid, Capt. M. H. P. R. Sankey, Sir J. F. C. Snell, Mr. W. A. P. Tait, Mr. J. D. Watson, and Sir A. F. Yarrow.

The Sugar Industry in France

The total production of sugar from October 1, 1923, to April 15, 1924, was 436,894,166 kg., whilst the output of glucose was 17,077,295 kg.

The Physics of Textile Fibres

One of the Sessions of the Empire Textile Conference which will be held at the British Empire Exhibition, Wembley, during Whitsun week, will be devoted to a General Discussion on "Physical and Physico-chemical Problems relating to Textile Fibres." This Discussion is being arranged jointly by the Faraday Society and the Textile Institute, and it will be held on Wednesday, June 11, from 2.30 to 6.30 p.m., in Conference Hall No. 4. The Introductory Address will be given by Dr. W. Lawrence Balls, F.R.S., and the programme of 12 papers includes contributions from all the leading laboratories in Great Britain and Ireland engaged in textile research. Full particulars may be obtained from the Secretary of the Faraday Society, 10, Essex Street, London, W.C. 2, or from the Secretary of the Textile Institute, St. Mary's Parsonage, Manchester.

REVIEWS

CHEMISTRY IN THE TWENTIETH CENTURY

AN ACCOUNT OF THE ACHIEVEMENT, AND THE PRESENT STATE OF KNOWLEDGE IN CHEMICAL SCIENCE. London: Ernest Benn, 1924. Pp. viii + 281. Price 15s.

The volume under review, which contains twenty-four essays written by experts in each selected branch of chemical science, has been compiled under the guidance of a Committee representing the Scientific Societies. Among these learned associations the Society of Chemical Industry has made important contributions, for the preface is furnished by its President-designate, Mr. W. J. U. Woolcock, and the introduction, a comprehensive survey of current chemical activities, is the work of the President, Dr. E. F. Armstrong.

This treatise should be considered in conjunction with the scientific exhibits in the Chemical Hall of the British Empire Exhibition (1924), to which collections it is to be regarded as a supplementary handbook. The articles may be divided broadly into two classes: monographs dealing with the fundamental principles of chemistry, and those describing the manifold applications of the science.

A philosophical dissertation by Prof. Irvine Masson on "The Rôle of Chemistry in Physical Science," which might with equal appropriateness have been termed the rôle of physics in chemical science, indicates clearly and in homely language the manner in which the two kindred sciences are becoming more and more intertwined.

In "The Structure of the Atom" Dr. Andrade discusses the nuclear atom, atomic number, isotopes and atomic energy. Chemists who are busy with less fundamental problems will find in this essay a useful synopsis illustrated by striking diagrams. It may, however, be remarked that there are still two modes of considering chemical elements, just as there are two ways of looking at a flock of sheep. In the latter instance there is the brutally detached view of the butcher who regards sheep in the aggregate merely as portable forms of mutton from which he can by the aid of appropriate physical instruments cleave off cutlets and other oddments. But there is another and more sympathetic viewpoint, that of the shepherd who distinguishes clearly between one member of his flock and another, and to whom these individuals represent personalities with distinctive traits and peculiar idiosyncracies. Only a butcher physicist, gazing without a sigh on the ruin he has made, by a bombardment with α-particles, could conclude (p. 50) that "nitrogen which has lost a proton becomes carbon; aluminium which has lost a proton becomes magnesium and so on." The perplexed and saddened chemist—the shepherd of his elementary flock—is tempted to ask whether, indeed, carbon has ever been definitely identified among the sub-atomic mangled remains of nitrogen, and if so how could this astounding transmutation have been accomplished merely by the loss of one proton?

The confused description of the formation of ammonium chloride (p. 55), in which the hydrogen of hydrogen chloride, "negatively charged" after losing an electron to chlorine, becomes attracted by the nitrogen kernel, is not going to help chemical students to a clear comprehension of complex salts, still less will it convert to a belief in the modern electrical theory of combination those writers (pp. 107 and 174) who retain the opinion that oxonium and carbonium salts contain quadrivalent oxygen.

These comments may serve to emphasize what in the reviewer's opinion is the singular omission from this volume of an article dealing specifically with valency and chemical combination from the chemist's viewpoint. Many papers have appeared recently in *Chemistry and Industry* on these topics, and similar discussions have taken place at the Chemical Society. Yet in this popular treatise on modern chemistry there is no adequate treatment of the contributions by British chemists to these fundamental problems.

The visitor to the Scientific Section of the British Empire Exhibition will notice on several stalls models illustrating the structure of chemical molecules, yet apart from incidental references under crystallography and under the chemistry of carbon compounds there is no simple description of the fascinating subject of general stereochemistry. A great opportunity has thereby been lost of bringing home to the intelligent enquirer the outstanding fact that, although molecules are infinitely small in comparison with ordinary every-day dimensions, nevertheless the component atoms of these tiny particles behave as if they had a definite arrangement in space. This intimate knowledge of the chemical molecule, first discovered in the case of carbon derivatives, is ever growing and becoming applicable to the compounds of other elements, and to this extension of science British chemists have contributed notably, as will be seen by a survey of the scientific exhibits.

Mr. Barker's article on "Crystallography," written in characteristically lucid style, is based on his highly educational exhibit which includes Wollaston's reflecting goniometer representing a crucial step in the development of crystallographic science, and the identical crystal of potassium ferrocyanide employed by Moseley in his classical research on atomic numbers. The interest attaching to this excellent monograph is greatly increased by the inclusion of a judicious selection of typical diagrams and plates.

Sir William Bragg contributes a short essay on X-ray analysis and deals with the structure of such representative substances as rock salt, fluorspar, calcite, diamond, graphite, naphthalene and anthracene.

The article by Dr. Travers on the discovery of the rare gases of the atmosphere should serve as a tonic for those doubting souls who are dubious about the principle of "science for science's sake." Although only thirty years have passed since the discovery of argon, three of the five inert gases have found application in the arts and manufactures. Concerning the other two the author ends with a

note of interrogation, "Yet who shall say that industry may not some day find use for them?" A similar question may be asked concerning all the other less common elements.

The chemistry of carbon compounds, the story in simple terms of organic chemistry, deals with structure and with the unsaturated state of carbon derivatives. Reference is made to the functions of oxygen and nitrogen in organic compounds and to tautomerism and the chemistry of benzene. The ultimate aim of organic chemistry is revealed in the statement that "the whole subject of biochemistry, which is the chemistry of life, will form but a part of organic chemistry." This anticipation is followed by a gleam of cheery optimism which one may readily associate with the author, Prof J. F. Thorpe:—"When this is the case the causes of our bodily ills will be as clear as the structure of indigo; and their removal as easy as a test tube reaction. The treatment of disease will be as sure and as certain as the neutralisation of ammonia by sulphuric acid." Whatever may be the result of this simplification on the panel system, "'tis a consummation devoutly to be wished."

"Milestones in Organic Chemistry," the title of Prof Armstrong's reminiscences from 1865 to the present, serve to define modern stages in the development of the organic branch in chemistry.

The article on the chemistry of colloids deals not only with the fundamental study of the colloidal condition but also with practical applications in the arts. Highly informative résumés are contributed on catalysis, fats and oils, sugar and carbohydrates, cellulose and synthesis in the terpene series. The essay on colour in nature ranges from chlorophyll to blue skies, blue eyes and the iridescence of feathers. The article on coal tar colours, written at a few hours' notice by Mr. Bearder, refers *inter alia* to the effect of the great war on the home production of synthetic dyes and intermediates. Essays on the biological aspect of chemistry deal with the alkaloids, the nitrogenous constituents of the living cell, biochemistry and fermentation and chemistry in agriculture. The applications of chemistry in metallurgy and ceramics are outlined in authoritative contributions on alloys and on pottery and refractories. Flame, fuel and explosion furnish a popular theme dealing with modern researches on coal, the nature of flame and hydrocarbon combustion.

It is apparently a far cry from explosives to the chemistry of photography, yet it will be noticed in the two concluding articles that each of these applications of chemical science has made important progress as the result of the great war. There is only too great a tendency nowadays to forget the enormous impetus which this regrettable catastrophe has had on the development of British chemistry in the colleges and universities and also in the arts and manufactures. This treatise, together with the splendid exhibits of the Chemical Hall in the Palace of Industry, will be a timely reminder of what the British Empire owes to chemical science.

G. T. M.

CHEMICAL INDUSTRY PAMPHLETS

CHEMISTS AND THEIR WORK. By Stephen Miall. THE QUEST FOR COLOUR. By A. T. de Mouilpied, B.Sc. (Lond.), M.Sc. (Vict.), Ph.D., F.I.C. WOOD PRODUCTS. By T. W. Jones, B.Sc. FINE CHEMICALS. By T. W. Jones, B.Sc. THE HEAVY CHEMICAL INDUSTRY. By Rex Furness. CHEMISTRY IN THE MANUFACTURE OF PIGMENTS, PAINTS AND VARNISHES. By C. A. Klein, M.Sc. London: Ernest Benn, Ltd. 1924. Price 6d. each net.

These are the first six of a series of "Chemical Industry Pamphlets" which are being issued under the ægis of the Society of Chemical Industry and the Association of British Chemical Manufacturers. They are most fascinating tracts written in an engaging manner understandable by all, and possess high literary merit. Though prepared with a view to propaganda the interest which most of them arouse is in no way tainted by this fact. The enlightenment of the public as to the nature and extent of the services rendered to the community by chemists is a task which many people think needs to be undertaken, but one which is so little to the taste of men of science that few care to undertake it. The self-sacrificing authors of these booklets have acquitted themselves remarkably well.

In most cases the subject is dealt with historically, and a clear picture is given in simple yet accurate language of what applied chemistry achieves in providing the comforts of modern life, its security, enjoyment, freedom, and leisure. They are not "dry-as-dust" publications, but by a truly eloquent appeal to the imagination rank as first-class literary productions. This is especially true of "The Quest for Colour," by Dr. de Mouilpied, "The Heavy Chemical Industry," by Mr. Rex Furness, and "Chemists and their Work," by Dr. Miall, the Editor of this *Journal*, whose ability to arouse the interest of the non-chemist in matters generally regarded as only of interest to chemists is already well known.

It is to be hoped that the pamphlets will reach the wide circle of readers for whom they are intended, and that all members of the Society of Chemical Industry will do their utmost to assist in fulfilling this purpose.

F. H. CARR

THE CHEMISTS' YEAR BOOK, 1924. By Dr. F. W. ATACK, assisted by L. WHINYATES; American data in collaboration with F. M. TURNER. Pp. 1147. Manchester: Sherratt and Hughes, 1924. Price 21s.

The Chemists' Year Book has undergone many changes in its ninth edition. Instead of appearing in two volumes, the *Year Book* now is issued in one volume, at no sacrifice of its handiness, and the work has been subjected to considerable revision and amplification, including the addition of a quantity of American data. New sections have been added on Water Analysis (by S. E. Melling), on Essential Oils (by T. H. Durrans), and on Spirits (by F. Robinson), whilst considerable changes have

been made in the sections on the General Properties of Inorganic Compounds, Physico-Chemical Constants, Leather Analysis, Brewing Materials, Dairy Products (which now includes both British and United States methods of examination), Analysis of Tobacco, and Agricultural Chemistry, the last-named section being contributed by Sir John Russell and H. J. Page. It is impossible to make a detailed examination of a work that covers so much ground, but a comparison with previous editions shows that the editors are fully aware of their responsibilities in keeping the work up to date and in striving to improve it. Suggestions given in reviews of former editions have been adopted in some cases, but the section on neutralisation methods still awaits revision and a few minor points require attention. A work that has reached its ninth edition requires no further blessing, and it will suffice to say that the improvement evident in each subsequent edition is most satisfactory evidence of the desire for perfection.

(1) Light and Colour. By R. A. Houstoun, M.A., Ph.D., D.Sc. Pp. xi+179. London: Longmans, Green and Co., 1923. Price 7s. 6d.

(2) A Treatise on Light. By R. A. Houstoun, M.A., Ph.D., D.Sc. Pp. xi+486. New edition, revised and enlarged. London: Longmans, Green and Co., 1924. Price 12s. 6d.

(1) Any work that presents the facts of science in a really sound, non-technical way is to be welcomed, and Dr. Houstoun's work on "Light and Colour" deserves a warm welcome. Dr. Houstoun treats mainly of aspects of light and colour that make a general appeal, not only to the amateur or the public, but to the growing number of those who are concerned with subjects such as photography, the medical and social effects of light and lighting, colour matching and many more.

After discussing the spectrum, the nature of light, and invisible rays in the first three chapters, an interesting account is given of spectroscopic investigation and the structure of the atom and of stars. Chapters follow on the primary colours, colour blindness, colour photography, the light of the future, photochemistry, phototherapy, and the psychology of colour. The writing is easy and thoroughly interesting, and the book can be safely recommended. In a future edition it would be well to give the equivalent of μ in the metric system on page 26.

(2) In this treatise Dr. Houstoun caters for those who possess a good knowledge of elementary physics and mathematics, but he has wisely dealt with the full scope of the subject and has included the results of important recent work. The work is divided into four parts, devoted to geometrical optics, physical optics, spectroscopy and photometry, and mathematical theory. All but one of the chapters conclude with a number of examples, and the book will be of value to all students of physics and chemistry, as well as to chemists who wish to refresh their knowledge of optical principles. A commendable feature of both works is their moderate price.

COMPANY NEWS

SAN SEBASTIAN NITRATE CO., LTD.

The directors report that the net profit in 1923 was £8418, compared with £807 in 1922. The balance available, with £8055 brought in, is £16,473, and a dividend of 5 per cent., less tax, is proposed (against nil), £5000 is applied in reduction of property account, and £5948 is carried forward (against £8055 brought in). Last August the directors acquired for £15,000 the "Enriqueta" grounds immediately adjoining the company's old properties. The manufacture of nitrate was resumed on May 1, 1923, and has been carried on steadily and economically. Profit has been taken in the accounts on 66,570 metric quintals of nitrate produced by the company itself, and on 22,876 metric quintals representing sales to other producers.

NORTH BRITISH RUBBER CO., LTD.

The report states that after transferring £50,000 from general reserve and allocating £16,020 for depreciation on buildings, machinery, plant, etc., and £43,150 as provision for loss on foreign exchange and stocks of canvas, motor tyres, and paying the dividends for the year on the first and second Preference shares, there remains £24,092 to be carried forward.

SAN PATRICIO NITRATE CO., LTD.

The report for 1923 shows a profit, after providing stoppage expenses and the usual administrative charges, of £4443, which increases the profit and loss credit to £10,025. A dividend of 6d. per share, free of tax, is recommended, absorbing £2500. The report states that the oficina remains closed, and that the quota to June 30 next has been sold. For 1922 there was a loss of £1348, but a dividend of 6d. per share, free of tax, was paid.

BURMAH OIL CO., LTD.

According to the report, all fields expenditure has been charged direct to revenue, and the profit for the year, after deducting income-tax, contribution to employees' provident fund, directors' fees, etc., and writing off £333,237 for depreciation, is £2,203,896. There has been transferred to insurance reserve £20,000, and to general reserve £200,000, leaving £1,983,896. To this is added £201,095 brought forward, making £2,184,991. Preference dividends absorb £257,500, and the interim dividend of 2s. per share, free of tax, on the ordinary shares, £515,119, leaving £1,412,372. The directors recommend a final dividend on the ordinary shares of 4s. per share free of tax, leaving £382,133 to be carried forward, subject to corporation profits tax.

SCOTTISH OILS, LTD.

The report for the year ended March last states that the balance at credit of profit and loss account, including £31,465 brought forward and after providing for depreciation, is £103,528. The directors recommend a dividend of $3\frac{1}{2}$ per cent., less tax, on the participating preference shares, requiring £80,379. The carry forward is £23,149.

ALIANZA CO.

The net profit for 1923 is £183,536, after providing £45,903 for exhaustion of raw material, and £5450 for depreciation of plant (in 1922 the net profit was £152,759, and £22,850 was allowed for exhaustion of raw material, and £10,947 for depreciation. With £447,090 brought forward, a total of £630,626 is available, and allowing for a carry forward of £130,626, it is proposed to pay a final dividend of 20 per cent., making a total distribution of 100 per cent. (40 per cent. in 1922). The company has acquired from the Liverpool Nitrate Co. the plant, grounds, and stocks of Oficina Buenaventura for £120,000. The local board has declared a further interim dividend of 20 per cent., and this dividend, which will be payable on June 20, is intended to take the place of the above proposed dividend at the same rate, and no further dividend will accordingly be recommended at the meeting on July 23.

FULLERS' EARTH UNION

The accounts to March 31 show a net profit of £14,963, and it is proposed to pay a dividend of 15 per cent., to place £5256 to reserve (which becomes £29,750) and to carry forward £762.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Smoke Abatement

In a written answer addressed to Mr. Lorimer, Mr. Wheatley said that the Government hoped to introduce a Bill dealing with the subject of smoke abatement, at an early date.—(May 28.)

Dyestuffs

Replying to Mr. Baker, Mr. Lunn gave the following statement showing the quantities of intermediate coal-tar products used in the manufacture of dyes, and finished coal-tar dyestuffs registered as imported into the United Kingdom during the year ended December 31, 1923:—

	Intermediate coal-tar products used in the manufacture of dyes (including aniline, oil and salt, and phenylglycine)	Finished coal-tar dyestuffs.		
		Alizarine	Synthetic indigo	Other sorts
	Cwt.	Cwt.	Cwt.	Cwt.
Sweden ..	—	—	—	16
Germany ..	267	8198	8274	25,179
Netherlands ..	10	7	—	60
Belgium ..	—	—	—	205
France ..	20	56	—	465
Switzerland ..	30	148	—	13,077
Italy ..	22	—	—	82
Austria ..	—	—	—	55
United States ..	1000	—	—	39
British India ..		—	—	39
Canada ..	—	—	—	257
Total ..	1249	8409	8274	39,474

	Alizarine and Anthracene Dyestuffs	Aniline and Naphthalene Dyestuffs	Synthetic Indigo	Other Coal-tar Dyestuffs
	Cwt.	Cwt.	Cwt.	Cwt.
Germany ..	60,315	258,629	23,888	147
Netherlands ..	18	634	1	—
Belgium ..	—	1286	—	8
France ..	—	98		—
Switzerland ..	—	22,141	—	—
Italy ..	—	48	—	—
Austria-Hungary	480	17	—	
United States	—	174	—	—
Total ..	60,813	283,027	23,889	155

The latter statement shows the quantities of dyes and dyestuffs obtained from coal tar, registered as imported into the United Kingdom from the several countries of consignment, during the year ended December 31, 1913.—(May 30.)

REPORT

Report on the Economic and Commercial Conditions in Switzerland, to February, 1924. By O. A. Scott, Secretary in Charge of Commercial Affairs, Berne. Department of Overseas Trade. Pp. 88. H.M. Stationery Office, 1924. Price 2s. 6d.

The year 1923 must again be considered as one of transition, but conditions are better than they were when the last report was drawn up (*cf. Chem. and Ind.*, 1923, 795). Imports during the first nine months of 1923 amounted to 1536 million frs., compared with 1356 mill. frs. the previous year, whilst exports were valued at 1270 mill. frs. against 1318 mill. frs. Foodstuffs and textiles are the principal items of import. Coal is the next in importance, 1,349,456 t. being imported in the period mentioned above, or 85 per cent. of the pre-war quantity. Increased building activity has had the effect of increasing imports of timber, and in the middle of the year of metals also, both manufactured and semi-manufactured. Imports of chemicals show an increase, the following being some of the items in 1923:—Colophany, 2293 t.; soft pitch, 3698 t.; caustic potash and soda, 6152 t.; sulphate of alumina etc., 2957 t.; tanning substances, 2632 t.; aniline, 1563 t.; linseed oil, 3569 t.; machinery oil, 9829 t.

Exports appear to have taken a favourable turn. The aluminium industry continues to develop, and exports in the period under review were valued at 14·7 mill. frs. The machine industry showed a slight improvement over 1922 conditions; the future of the industry is considered to depend on the increased output of high-grade products rather than on cheap mass-production. The situation in the chemical industry is satisfactory; the restrictions on importation into Britain have reduced this trade, but not stopped it, whilst German competition is less keen. Notwithstanding foreign competition it was found possible to maintain the production of dyestuffs; exports of aniline dyes in 1923 amounted to 3166 t., and of indigo to 2828 t.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech. .. £23 10s. per ton.

Acid Hydrochloric .. .. 3s. 6d.—6s. per carboy d/d., according to purity, strength and locality.

Acid Nitric 80° Tw. .. £21 10s.—£27 per ton makers' works according to district and quality.

Acid Sulphuric .. .. Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.

Ammonia Alkali .. .. £6 15s. per ton, f.o.r. Special terms for contracts.

Bleaching Powder .. Spot £11 d/d.; Contract £10 d/d. 4 ton lots.

Bisulphite of Lime .. £7 per ton, packages extra.

Borax, Commercial—

Crystal .. .. .. £25 per ton.

Powder .. .. £26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)

Calcium Chloride .. £5 17s. 6d. per ton d/d.

Potash Caustic .. .. £30—£33 per ton.

Potass. Bichromate .. 5¾d. per lb.

Potass. Chlorate .. .. 3d.—4d. per lb.

Salammoniac .. .. £32 per ton d/d.

Salt Cake .. .. £3 10s. per ton d/d.

Soda Caustic, solid .. Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.

Soda Crystals .. .. £5 5s.—£5 10s. per ton ex railway depots or ports.

Sod. Acetate 97/98% .. £24 per ton.

Sod. Bicarbonate .. £10 10s. per ton carr. paid.

Sod. Bichromate .. .. 4½d. per lb.

Sod. Bisulphite Powder 60/62% .. .. .. £18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.

Sod. Chlorate .. .. 3d. per lb.

Sod. Nitrate refd. 96% .. £13 5s.—£13 10s. per ton ex Liverpool. Nominal.

Sod. Nitrite, 100% basis £27 per ton d/d.

Sod. Sulphide conc. 60/65 About £14 10s. per ton. d/d

Sod. Sulphide cryst. .. £9 per ton d/d.

Sod. Sulphite, Pea Cryst. £15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—

Golden .. .. .. 5¾d.—1s. 4d. per lb., according to quality.

Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.

Arsenic Sulphide, Yellow 1s. 11d. per lb.

Barytes .. .. .. £3 10s. to £6 15s. per ton, according to quality.

Cadmium Sulphide .. 3s. 9d. per lb.

Carbon Bisulphide .. £24—£26 per ton according to quantity.

Carbon Black .. .. 6¼d.—6¾d. per lb. Market firmer.

Carbon Tetrachloride .. £56 per ton, drums free.

Chromium Oxide, green .. 1s. 3d. per lb.

Indiarubber Substitutes, White and Dark — 4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.

Lamp Black .. .. 43s. 6d. per cwt., barrels free.

Lead Hyposulphite .. 7½d. per lb.

Lithopone, 30% .. .. £22 10s. per ton.

Mineral Rubber "Rubpron" .. .. .. £15 10s. per ton f.o.r. London.

Sulphur .. .. .. £10—£12 per ton, according to quality.

Sulphur Chloride .. 3d. per lb., carboys extra.

Thiocarbanilide .. .. 2s. 9d. per lb.

Vermilion, pale or deep .. 5s. 1d. per lb. Much dearer, following rise in quicksilver.

Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—

Brown .. .. .. £14 10s. per ton d/d. Demand active.

Grey .. .. .. £19—£20 per ton.

Liquor .. .. .. 9d. per gall. 32° Tw.

Charcoal .. .. .. £7 5s.—£9 per ton, according to grade and locality. Market steady.

Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. „ „ 24° Tw.

Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.

Wood Creosote .. .. 2s. 7d. per gall. Unrefined.

Wood Naphtha—

Miscible .. .. 5s.—5s. 3d. per gall. 60% O.P. market stiffer.

Solvent .. .. 5s. 6d.—6s. per gall. 40% O.P. Fairly good demand but little offering.

Wood Tar .. .. £5 per ton.

Brown Sugar of Lead .. £49 per ton.

TAR PRODUCTS

Acid Carbolic—

Crystals .. .. 6½d.—7d. per lb. Demand quiet.

Crude 60's .. .. 1s. 9d.—1s. 10d. per gall. Market flat. Only odd lots being offered.

Acid Cresylic, 97/99 .. 2s. 1d.—2s. 2d. per gall. Demand still good. Market firm.

Pale 95% .. .. 1s. 10d.—1s. 11d. per gall. Steady demand.

Dark .. .. .. 1s. 8d.—1s. 11d. per gall. Steady business.

Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.

Anthracene Oil—

Strained .. .. 9½d. per gall. Very quiet.

Unstrained .. .. 8½d.—9d. per gall.

Benzole—

Crude 65's .. .. 10½d.—1s. per gall. ex works in tank wagons.

Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.

Pure .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.

Toluole—90% .. .. 1s. 5½d. per gall.

Pure .. .. 1s. 10d.—2s. per gall.

Xylol coml. .. .. 2s. 3d. per gall.

Pure .. .. 3s. 3d. per gall.

Creosote—	
Cresylic 20/24% ..	9d.—9½d. per gall. Few inquiries.
Middle Oil ..	7½d.—9d. per gall. according to grade and district. Demand not so strong.
Heavy	
Standard Specification	
Naphtha—	
Solvent 90/160 ..	1s. 4d.—1s. 5d. Market steady.
Solvent 90/190 ..	1s. 2d.—1s. 3d. Fair business, passing.
Naphthalene Crude—	
Drained Creosote Salts	£6—£6 10s. Demand falling off.
Whizzed or hot pressed	£9—£12 per ton. Little business.
Naphthalene—	
Crystals and Flaked ..	£17—£18 per ton.
Pitch, medium soft ..	52s. 6d.—57s. 6d. per ton. Market steadier. Few inquiries for forward delivery. Very little business for prompt.
Pyridine—90/160 ..	21s. 6d.—22s. per gall. Demand well maintained.
Heavy ..	12s.—12s. 6d. More business passing.

Deliveries are still only required in very small quantities owing to the desire of consumers to keep stocks down.

INTERMEDIATES AND DYES

Business in dyestuffs has improved slightly during the week.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 6d. per lb.
Acid H.	4s. 4d. per lb. 100% basis d/d.
Acid Naphthionic ..	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. ..	1s. 2d.—1s. 3d. per lb. Steady
Acid Sulphanilic ..	10d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% ..	1s. 3d. per lb.
p Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o Cresol 19/31° C. ..	4¾d. per lb. Demand moderate.
m Cresol 98/100% ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
p Cresol 32/34° C. ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid ..	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	5s. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol ..	£84 10s. per ton d/d.
Dinitrotoluene—48/50°C.	8d.—9d. per lb. naked at works.
66/68°C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. per lb. d/d.
Monochlorbenzol	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine ..	1s. 4½d. per lb. d/d.
β-Naphthylamine ..	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol ..	2s. per lb. 100% basis d/d.
Nitronaphthalene ..	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine ..	4s. 2d. per lb. d/d.
p-Phenylene Diamine ..	10s. 4d. per lb. 100% basis d/d.
R. Salt	2s. 5d. per lb. 100% basis d/d.
Sodium Naphthionate ..	2s. 6d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 6d. per lb. naked at works.
m-Toluylene Diamine ..	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P. ..	£48 per ton.
Acid, Acetyl Salicylic ..	3s. 3d.—3s. 5d. per lb. In good demand.
Acid, Benzoic B.P. ..	3s. 9d. per lb. Larger supplies available.
Acid, Boric B.P. ..	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6½d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal. Market very steady.
Acid, Pyrogallic, Cryst. ..	7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic	Prices quoted from 2s. per lb. down to 1s. 9d. for ton lots. Market weak.
Acid, Tannic B.P. ..	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 3d. per lb. for quantity. Stocks are small.
Amidopyrin	13s. 6d. per lb. Neglected. Stocks low.
Ammon. Benzoate ..	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate ..	12s. per oz. for English make.
Barbitone	15s. 6d. per lb. Quiet market.
Benzonaphthol	5s. 6d. per lb. Small inquiry.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate ..	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate ..	10s. 2d.—12s. 2d. „
„ Subnitrate ..	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	Fluctuating market. Continental prices decidedly firmer.
Potassium	11d. per lb.
Sodium	1s. „
Ammonium	1s. 1d. per lb.
Calcium Lactate	Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate	3s. 10d. per lb., duty paid. Advanced. Higher prices are quoted from the Continent.
Chloroform	2s. per lb. for cwt. lots. Market more active. Makers busy.
Creosote Carbonate ..	6s. 6d. per lb. Little demand.
Formaldehyde	£57 per ton, *ex* works. English make.
Glycerophosphates—	Fair business passing
Calcium, soluble and citrate free	7s. per lb.
Iron	8s. 9d. per lb.
Magnesium	9s. per. lb

Potassium, 50% .. 3s. 6d. ,,
Sodium, 50% .. .. 2s. 6d. ,,
Guaiacol Carbonate .. 12s. per lb. for cwt. lots. Supplies not plentiful.
Hexamine .. .. 3s. 9d. per lb. for English make. Market dull.
Homatropine Hydrobromide .. .. .. 30s. per oz.
Hydroquinone .. .. 4s. 3d. per lb. in cwt. lots. Foreign make.
Hypophosphites—
Calcium . .. 3s. 6d. per lb., for 28 lb. lots.
Potassium . .. 4s. 1d. per lb.
Sodium.. . 4s. ,,
Iron Ammon Citrate B.P. 2s. 1d.—2s. 5d. per lb., according to quantity. Advanced by 2d. per lb.
Magnesium Carbonate— ..
Light Commercial £36 per ton net.
Magnesium Oxide—
Light Commercial .. £75 per ton, less 2½%.
Heavy Commercial .. £26 per ton, less 2½%.
Heavy Pure .. .. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—
A.B.R. recryst. B.P. . 60s. per lb. Weaker.
Synthetic .. .. 26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials .. .. Market firm.
Red oxide .. .. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate .. 3s. 6d.—3s. 7d. ,,
White precip. .. .. 4s. 7d.—4s. 8d. ,,
Calomel .. .. 3s. 11d.—4s. ,,
Methyl Salicylate .. 2s. 3d.—2s. 9d. per lb. for carboys. A slightly better market.
Metol .. .. .. 11s. per lb. British make.
Paraformaldehyde .. 3s. 6d. per lb. Better inquiry.
Paraldehyde .. .. 1s. 4d.—1s. 6d. per lb. in free bottles and cases. Better demand.
Phenacetin . . 6s. per lb.
Phenazone .. .. 7s. 3d. per lb. for cwt. lots. Quiet.
Phenolphthalein .. .. 6s. 9d.—7s. 3d. per lb. In more plentiful supply.
Potass. Bitartrate—
99/100% (Cream of Tartar) .. .. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate .. .. 1s. 10d.—2s. 2d. per lb. Dearer.
Potass. Iodide .. .. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite .. 7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate—
B.P. Crystal .. .. 8¾d.—9d. per lb. carriage paid.
Commercial .. .. 8d.—8¼d. per lb. carriage paid.
Quinine Sulphate .. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin .. .. .. 5s. 6d. per lb.
Saccharin . .. .. 63s. per lb., in 50-lb. lots
Salol . 3s. 6d. per lb. Very quiet.
Silver proteinate .. 9s. 6d. per lb.
Sod. Benzoate, B.P. .. 2s. 6d. per lb. In steady demand for good qualities.
Sod. Citrate, B.P.C., 1923 2s.—2s. 2d. per lb., according to quantity. Much firmer in common with other citrates. Prices advanced by 2d. per lb.
Sod. Hyposulphite—
Photographic .. .. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst. 37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside .. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt) .. 77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet
Sod. Salicylate .. .. Market easier. Powder 2s. 3d.—2s. 6d. per lb. Crystal at 2s. 5d.—2s. 8d. per lb. Flake 2s. 9d.—2s. 10d. per lb.
Sod. Sulphide—
Pure recryst. .. .. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous £27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol .. .. .. 15s. per lb. for good white crystal from ajowan seed. Very firm and scarce.

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Acetophenone .. .. 12s. 6d. per lb.
Aubepine .. .. .. 14s. 6d. per lb.
Amyl Acetate .. .. 2s. 9d. ,,
Amyl Butyrate . .. 6s. 9d. .. Cheaper.
Amyl Salicylate .. .. 3s. 3d. ,,
Anethol (M.P. 21/22° C.) 4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol 3s. 3d. ,,
Benzyl Alcohol free from Chlorine .. .. 3s. 3d. ,,
Benzaldehyde free from Chlorine .. .. 3s. 6d. ,,
Benzyl Benzoate .. 3s. 6d. ,,
Cinnamic Aldehyde Natural.. .. .. 15s. 6d. ,,
Coumarin .. .. 20s. ,,
Citronellol .. .. 16s. ,,
Citral .. .. .. 10s. ,,
Ethyl Cinnamate .. 15s. ,,
Ethyl Phthalate .. .. 3s. 3d ,,
Eugenol .. .. .. 11s. ,,
Geraniol (Palmarosa) .. 35s. ,,
Geraniol .. .. .. 11s.—18s. 6d. per lb.
Heliotropine .. .. 6s. 6d. per lb.
Iso Eugenol .. .. 15s. 9d. ,,
Linalol ex Bois de Rose.. 28s. 6d. ,,
Linalyl Acetate .. .. 28s. 6d. ,,
Methyl Anthranilate .. 9s. 6d. ,,
Methyl Benzoate .. 6s. ,,
Musk Ambrette .. .. 48s. 6d. ,,
Musk Xylol .. .. 16s. 6d. ,,
Nerolin .. .. .. 4s. ,,
Phenyl Ethyl Acetate .. 12s. 6d. ,,
Phenyl Ethyl Alcohol .. 16s. ,,
Rhodinol .. .. .. 57s. 6d. ,,
Safrol .. .. .. 1s 10d. ,,
Terpineol .. .. .. 2s. 9d. ,,
Vanillin .. .. .. 25s. 3d.—26s. 6d. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. .. .. .. 15s. 6d. per lb.
Anise Oil .. .. .. 3s. per lb.
Bergamot Oil .. .. 18s. 6d. per lb.
Bourbon Geranium Oil .. 36s. 6d ,, Advanced.
Camphor Oil .. .. 75s. per cwt.
Cananga Oil, Java .. 10s. 6d. per lb.
Cinnamon Oil, Leaf .. 6½d. per oz.
Cassia Oil, 80/85% .. 9s. 3d. per lb.
Citronella Oil—
Java 85/90% .. .. 6s. per lb. Again dearer.
Ceylon .. .. .. 3s. 9d. per lb.

Clove Oil ..	.. 7s. 6d. ,,
Eucalyptus Oil 70/75% ..	2s. 2d. ,,
Lavender Oil—	
French 38/40% Esters	.. 27s. 6d. per lb.
Lemon Oil ..	.. 3s. 2d. per lb.
Lemongrass Oil ..	.. 3d. per oz.
Orange Oil, Sweet	.. 13s. 9d. per lb.
Otto of Rose Oil—	
Bulgarian ..	.. 27s. 6d. per oz.
Anatolian ..	.. 23s. 6d. per oz.
Palma Rosa Oil ..	.. 19s. per lb.
Peppermint Oil—	
Wayne County	.. 21s. 6d. per lb.
Japanese ..	.. 16s. 3d. per lb.
Petitgrain Oil ..	.. 10s. per lb.
Sandal Wood Oil—	
Mysore	.. 26s. 6d. per lb.
Australian ..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before July 28th; they are on sale at 1s each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on June 12th.

I.—Applications

Anderson. Installation for separation of liquids. 12,277. May 19. (Fr., 7.6.23.)

Brandwood. Filtering apparatus. 12,561, 12,562. May 22.

Carpenter. Separation of liquids from solids. 12,826. May 24. (U.S., 25.7.23.)

Hoganas Billesholms Aktiebolag. Expelling gas from solid bodies. 12,565. May 22. (Sweden, 15.6.23.)

Metallbank und Metallurgische Ges. Treating gases with granular adsorption agents. 12,258. May 19. (Ger., 13.6.23.)

Nyrop. Drying liquids yielding residues. 12,745. May 23.

Partridge and Thompson. Separation of solid particles from flue gases. 12,591. May 22.

Perkeo Akt.-Ges. fur Schaumloschverfahren. Production of foam for fire extinguishing. 12,410. May 20. (Ger., 9.6.23.)

Soc. Chimique des Usines du Rhône. Catalysts. 12,295. May 19. (Fr., 26.7.23.)

Thermal Syndicate Ltd. Apparatus for condensing vapours. 12,580. May 22.

Wilton. Mechanical furnaces. 12,713. May 23.

I.—Complete Specifications Accepted

1591 and 1982 (1923). Rigby. Drying processes. (215,812.)

10,338 (1923). Gill (Sharples Specialty Co.). Preventing formation of emulsions. (215,929.)

17,147 (1923). Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges.) *See* II.

27,611 (1923). Marchant, and Marchant Bros., Ltd. Roller grinding-mills. (216,048.)

9115 (1924). Farberei u. Appretur Ges. vorm. Clavel und Lindenmeyer. Centrifugal drying apparatus. (214,279.)

II.—Applications

Appleby and Bentley. Gas-producers. 12,606. May 22.

Badische Anilin- und Soda-Fabrik. Manufacture of liquid fuels. 12,697. May 23. (Ger., 14.1.24.)

Beale, Pitkethly, and Smith. Apparatus for cracking mineral oils. 12,620. May 22.

Berg- und Huttenwerks Ges., and Gobiet. Process for improving coke. 12,407, 12,408. May 20. (Czechoslovakia, 17.3.24.)

Coke and Maxted. Catalytic oxidation of paraffin hydrocarbons. 12,654. May 23.

Ges. fur Chemische Produktion, and Clemm. Manufacture of decolorising charcoal. 12,268. May 19. (Ger., 5.7.23.)

Hurrell. 12,446. *See* IX.

Küng. Generation of heating flames. 12,696. May 23. (Switz., 1.6.23.)

Prudhomme. Manufacture of carburetting liquids similar to petrol. 12,689. May 23.

Rude. Carbonisation of solid fuel. 12,681. May 23.

Testrup. Distillation of shales etc. 12,368. May 22.

II.—Complete Specifications Accepted

25,790 (1922). Neath. Manufacture of gas from coal or from coal and oil. (215,496.)

4632 and 10,555 (1923). Stenning, and Minerals Separation, Ltd. Concentration of coal. (215,811.)

10,338 (1923). Gill (Sharples Specialty Co.). *See* I.

17,147 (1923). Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges.). Cleaning gases, more particularly producer gases. (216,001.)

19,826 (1923). Humphreys and Glasgow (Rusby). Gasification of bituminous coal etc. (216,021.)

19,975 (1923). Humphreys and Glasgow (Dashiell). Manufacture of gas. (216,022.)

23,952 (1923). Koppers. Coke ovens. (204,345.)

8896 and 8897 (1924). Algem. Norit Maatsch., and Sauer. Reactivating decolorising carbon. (213,939 and 213,940.)

IV.—Applications

Chemische Fabrik Griesheim-Elektron. Manufacture of azo dyestuffs. 12,626. May 22. (Ger., 22.5.23.)

Farbwerke vorm. Meister, Lucius, u. Bruning. Manufacture of vat dyestuffs. 12,625. May 22. (Ger., 21.8.23.)

Imray (Soc. of Chemical Industry in Basle). Manufacture of indigoid dyestuffs. 12,284. May 19.

Johnson (Badische Anilin- u. Soda Fabr.). Manufacture of black vat dyestuffs. 12,795. May 24.

Menke. 12,717. *See* XX.

V.—Applications

Amber Size & Chemical Co. Ltd. 12,736. *See* VII.

Bloxam (Chemische Fabrik Griesheim-Elektron). 12,283. *See* XIII.

Know Mill Printing Co., Ltd., Mort, and Weeks. Treatment of cellulosic materials, fibres, etc. 12,330. May 20.

Lilienfeld. Manufacture of cellulose compounds. 12,627, 12,628, and 12,629. May 22. (Austria, 4.4.24.)

Stevenson. Manufacture of artificial silk from viscose. 12,797. May 24.

V.—Complete Specifications Accepted

4332 (1923). Dreyfus. Manufacture of pressed or moulded articles from compositions containing cellulose derivatives. (215,823.)

4896 (1923). Mordioni. Manufacture of viscose silk. (215,851.)

11,248 (1923). Radolin. *See* XIX.

14,675 (1923). Van Overstraeten. Purification of wool washing waters. (215,985.)

VI.—Applications

Bedford. Mordanting and dyeing wool. 12,550. May 22.

Carstairs, and Martin and Co. Process of waterproofing fabrics. 12,779. May 24.

Day. Dyeing-machine. 12,670. May 23.

Lepine. Desulphurising, bleaching, washing, and dyeing fibres etc. 12,223. May 19.

Morton Sundour Febrics, Ltd., and Harris. Dyeing. 12,733. May 23.

VI.—Complete Specification Accepted

5231 (1923). Calico Printers' Association, Ltd., and Roberts. Production of pattern effects on fabrics. (215,860.)

VII.—Applications

Amber Size and Chemical Co., Ltd. Production of aluminium compounds for paper-making etc. 12,736. May 23. (Ger., 2.7.23.)

British and Foreign Lime and Power Corporation, Ltd., and Reid. Burning of limestone etc. 12,622. May 22.

Chemical Engineering and Wilton's Patent Furnace Co., Ltd., and Wilton. Manufacture of sulphate of ammonia. 12,508. May 21.

Hackford. 12,291. *See* IX.
Höganäs-Billesholms Aktiebolag. Production of aluminium oxide. 12,566. May 22. (Sweden, 15.6.23.)
Robinson. Production of oxides of sulphur. 12,730. May 23.
Russell. Production of colloidal sulphur. 12,707. May 23.

VII.—Complete Specifications Accepted

1301 and 24,711 (1923). Frank. Producing alumina and glass-making salts. (215,810.)
1673 (1923). Laporte, Ltd., and Alcock. Manufacture of phosphoric acid.

VIII.—Applications

Babcock and Wilcox Co. Refractory product. 12,299. May 19. (U.S., 25.5.23.)
Babcock and Wilcox Co. Kaolin refractory. 12,300. May 19. (U.S., 25.5.23.)
Mead. Coating metal with enamel, glass, etc. 12,394. May 20.

VIII.—Complete Specifications Accepted

1301 and 24,711 (1923). Frank. *See* VII.
28,996 (1923). Huard. Manufacture of glass. (207,195.)

IX.—Applications

British and Foreign Lime and Power Corporation, Ltd. 12,622. *See* VII.
Francois and Williams. Wood-preserving compound. 12,286. May 19.
Hackford. Manufacture of lime, mortar, or cement. 12,291. May 19.
Hurrell. Emulsions of bituminous substances. 12,446. May 21.

X.—Applications

Indiana Steel and Wire Co. Process of zinc coating of iron etc. articles. 12,387. May 20. (U.S., 10.12.23.)
Mandowsky. Manufacture of sulphur-containing casting compounds. 12,619. May 22. (Ger., 13.6.23.)
Mead. 12,394. *See* VIII.
O'Donovan. Muffle furnaces. 12,380. May 20. (Union of S. Africa, 25.1.24.)

X.—Complete Specifications Accepted

31,685 (1922). Edwards and Durant. Treatment of oxidised ores or other oxidised compounds of copper and zinc. (215,802.)
4286 (1923). Eisen- und Stahlwerk Hoesch. Heating and smelting furnaces. (193,401.)
4690 (1923). Beasley, Edser, and Minerals Separation, Ltd. Briquetting of ores. (215,815.)
5716 (1923). Ashcroft. *See* XI.
7253 (1923). Marks (American Manganese Steel Co.). Melting manganese steel. (215,895.)
7281 (1923). Passalacqua. Tin-plating metals, particularly aluminium and its alloys. (194,729.)
7970 (1923). Dunford and Elliott, Ltd., and Pehrson. Manufacture of zinc.
11,235 (1923). Rushen (Krupp). Magnetic separation of materials. (215,935.)
13,519 (1923). Junghans. Plating metals. (204,303.)
19,622 (1923). Saklatwalla. Ferrous alloys. (202,971.)

XI.—Application

Soc. Italiana E. Breda. Electric furnaces. 12,514. May 21. (Italy, 28.5.23.)

XI.—Complete Specifications Accepted

5716 (1923). Ashcroft. Apparatus for electrolysing fused salts. (215,872.)
208 (1924). Metropolitan-Vickers Electrical Co. Electrical insulating Coatings. (209,421.)

XIII.—Applications

Bloxam (Chemische Fabrik Griesheim-Elektron). Manufacture of coloured cellulose-ester varnishes. 12,283. May 19.
Gehrke and Martin. Manufacture of white paint etc. 12,263. May 19.
Preiss. Coating material, and manufacture thereof. 12,260. May 19.
Ueter. Manufacture of lacquers, paints, etc. 12,802. May 24. (Ger., 28.5.23.)

XIII.—Complete Specification Accepted

4336 (1923). Hynson and Stephens. Manufacture of a basis composition for printers' and like inks. (215,824.)

XIV.—Complete Specification Accepted

29,191 (1922). Dunlop Rubber Co., and Twiss. Vulcanisation of india-rubber. (215,796.)

XV.—Application

Carmichael and Ockleston. Tanning. 12,324. May 20.

XVII.—Application

Alves da Cunha, Ltd. Sugar refining apparatus. 12,692. May 23. (Portugal, 10.7.23.)

XVIII.—Complete Specification Accepted

16,564 (1923). Klein. Manufacture of pressed yeast. (203,300.)

XIX.—Applications

Bloxam (Akt.-Ges. für Anilin-Fabrikation). Disinfecting seed grain. 12,716. May 23.
Slate. Refrigeration and preservation of perishable products. 12,711. May 23.

XIX.—Complete Specifications Accepted

11,248 (1923). Radolin. Cereal husks etc. (215,936.)
14,675 (1923). Van Overstraeten. *See* V.

XX.—Applications

Blagden, and Howards and Sons. Making synthetic menthol. 12,520. May 21.
Coke and Maxted. 12,654. *See* II.
Johnson (Badische Anilin- und Soda-Fabrik). Manufacture of organic compounds. 12,794. May 24.
Menke. Production of nitrated organic compounds. 12,747. May 23.

XX.—Complete Specification Accepted

18,853 (1923). Deutschmann and Kotzenberg. Antitoxic serums. (216,014.)

XXI.—Application

Sury. Photographic pigmentary printing paper. 12,363. May 20. (Belgium, 30.5.23.)

XXIII.—Applications

Mono Ges. Analysing test gases. 12,377. May 20. (Ger., 31.5.23.)
Owens. Instrument for estimating suspended matter in gases etc. 12,512. May 21.

XXIII.—Complete Specification Accepted

877 (1923). Laese. Apparatus for determining the specific gravity of gases. (191,738.)

PUBLICATIONS RECEIVED

TEXTBOOK OF CELLULOSE CHEMISTRY. By Emil Heuser. Translated from the second German edition by C. J. West and G. J. Esselen, Jr. Pp. xi+212. London: McGraw-Hill Publishing Co., Ltd., 1924. Price 12s. 6d.

ORE DRESSING, PRINCIPLES AND PRACTICE. By T. Simons. Pp. xvii+292. London: McGraw-Hill Publishing Co., Ltd., 1924. Price 17s. 6d.

SOIL MANAGEMENT. By Firman E. Bear. Pp. vi+268. London: Chapman and Hall, Ltd., 1924. Price 10s.

THE TEXTILE FIBRES. THEIR PHYSICAL, MICROSCOPICAL, AND CHEMICAL PROPERTIES. By J. M. Matthews, Ph.D. Fourth edition, revised and enlarged. Pp. xviii+1053. London: Chapman and Hall, 1924. Price 50s.

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EDITORIAL

A CORRESPONDENT proposes to add a new charm to life by publishing a volume of chemical verse. We ourselves have often speculated on the possibility of doing this, but ours was a mere dream when we were "careless and unthoughtful lying hearing soft winds about us flying." Our correspondent is putting his ideas into execution, and we are well content to wait until his volume appears. In this journal several verses, some of them we can hardly call poetry, have already appeared, and we think that if discreet enquiries are made in Cambridge, in the chemical laboratory will be found one at least who, while engaged in filtration or titration, builds the lofty rhyme, "for he on honey-dew hath fed and drunk the milk of Paradise." Chaucer deals with alchemy, Lucretius with atomic theories, Dr. Bridges in "Wintry Delights" has a turn at chemistry, Mr. Ellis in "Samson Adami" has a stanza on Kékulé's benzene formula, and there are probably many chemists who at some time or other have been lifted out of their usual level into the sublime. "So some strange thoughts transcend our wonted themes, and into glory peep." We envy our correspondent his task, we picture him as Matthew Arnold described another scholar "nursing the project in unclouded joy, and every doubt long blown by time away." Sir Frederick Pollock turned the Leading Cases into verse, and very good verse too, and he appealed to his muse for a terrible punishment on all critics: "Deadly and swift thy revenge on such carping and cavilling creatures, grievous and grim their reward at thine hand, and the sword of thy vengeance: All the Reports at large we will take and versify likewise." We look forward to the book with eager anticipation; it will be the sort of book described in the "Ars Poetica" as bringing profits to the booksellers, crossing the briny ocean and giving eternal renown to the famous man who strings these pearls together. We trust many of our readers will call attention to some of the gems of purest ray serene lying hid in Victorian treatises. For our part we intend to furbish up some early verses of our own composition—"our joy in them was past expression, but that was thirty years ago," and if you include us in the list of lyric poets we shall be exalted to the skies in our sublimity: *Quodsi me lyricis vatibus inseres, Sublimi feriam sidera vertice.* Bring us quick the Golden Treasury and a flagon:—

"Oh, for a draught of vintage! that hath been
Cool'd a long age in the deep delved earth,
Tasting of Flora and the country green,
Dance and Provençal song and sunburnt mirth."

* * *

Everyone who is accustomed to consult scientific literature must be well aware how often authors neglect to go back to the original sources for authoritative statements. A publishes a certain opinion, B copies it, then C copies B, D copies C, omitting the name of A, and, long before the alphabet ends and our readers' patience is exhausted, the opinion, with probably a little embroidery, has become that snare, an "accepted fact." The history of mankind bears its full burden of "accepted facts"; indeed, this extremely human process of transmission is the source of much of the charm of history. But there is, or should be, no excuse for obscurities in the history of fairly recent chemical processes. Recently we drew attention to obscurities in the history of the gas process, and a correspondent, who had evidently been at great pains to authenticate his facts, showed, conclusively it seemed, that William Murdock was the true pioneer of the industrial production of gas. None of the accounts of

early experimenters in gas lighting, however, has mentioned George Dixon, of Cockfield. According to a letter published in *The Times*, Mr. W. Dixon possesses indisputable evidence that the original inventor was his namesake, George, who possessed collieries near Durham, "near one of which he had a small manufactory to produce coal tar, which was first used in shipbuilding at Sunderland, and where he first made inflammable coal gas about 1760." About that time Dixon had lit his house with coal gas and he was thinking of using it for lighting his collieries. But during the distillation of a ton of coal with the object of finding the yield of tar, an ill-advised experiment with a candle led to the not unnatural conclusion that his project of lighting collieries and rooms with gas lights was very dangerous. The facts of the case are to be found in the "General View of the Agriculture of the County of Durham," published by John Baily, a nephew of Dixon, in 1810. We are glad to add this information to that already published, but we are becoming very sceptical. Did Faraday really discover benzene in 1825?

* * *

Our readers must have had many and varied occupations during the past week-end. Some probably joined in the light fandango at Brighton or Blackpool, others may have gone to Wembley to see the spirit-stirring bullfight, or to consider the fascinations of the Chemical Section in the Palace of Industry, and others, wise men, may have stopped at home in cushioned ease, considering, merely considering, how much needs to be done in the garden. No one, however, had sufficient energy to reproach us for omitting to notice the centenary of the birth of Alexander William Williamson, on May 1. We remember reading a poem which ran: "Here early parts accomplished Jones sublimes, and science blends with Asia's lofty rhymes. Harmonious Jones! who in his splendid strains sings Camdeo's sports, on Agra's flowery plains." Who was Harmonious Jones we do not know and we fear that to many students of chemistry the name of Williamson is equally unenlightening. Yet Williamson's ideas had incontestibly an influence on the development of modern chemical theory. He was the first to explain the process of etherification and, in 1850, he put forward a view which, in modified form, is of fundamental importance in the modern theory of ionic dissociation the idea of intermolecular exchange and atomic motion. If only for his active advocacy of the atomic theory at a time when chemists were reluctant to accept atoms as physical units, he deserves our warm remembrance. And, during his presidency of the Chemical Society in 1870 he brought about an innovation of the greatest importance; he initiated the practice of issuing abstracts of papers on chemical subjects, an innovation which has been adopted as standard practice by practically all scientific societies, with far reaching effects on the propagation of scientific knowledge. No further title to our gratitude is needed.

SOME FURTHER REMARKS ON OPTICAL ROTATION-DISPERSION

By T. S. PATTERSON

Mr. Hunter, in his article in *Chemistry and Industry* of May 23, devotes some attention to views which I have published elsewhere on the subject of Optical Activity, and I welcome his article partly because I think it most desirable that these questions should receive adequate discussion, so that we may perhaps reach some opinions in common; and also because—I say it without intending any malice—I feel that another article or two like Mr. Hunter's would suffice firmly to establish my point of view.

It is a little difficult to deal with Mr. Hunter's article, however, because of his lack of precision in certain important respects. He will clearly have none of my views, and yet he seems to disclaim allegiance to the views of Lowry. Nevertheless, he is of opinion that "dynamic isomerism furnishes the best, in fact, the only explanation of the phenomena of rotation-dispersion." He adopts therefore the rather paradoxical position of agreeing "in the main," with my criticisms of Lowry's views, and yet continuing to hold the views which my criticisms undermine. It is fortunate that Mr. Hunter explicitly mentions the fact of this agreement with me, for so skilfully does he dissemble his approval that I should certainly have been left, otherwise, in some doubt on the subject. He also indulges in a certain exuberance of language leading him into some serious dialectic difficulties which will be referred to further on.

Mr. Hunter discusses first what he calls my "sine curve" theory, but which I should prefer to call a "periodic curve" theory; and he finds it to be unsatisfactory. I need only say that here, to a large extent, Mr. Hunter merely beats the air, as he ascribes to me views that, as shown even in the passages he quotes, I expressly disclaimed. I mentioned a sine curve merely as an example of a periodic curve, and I clearly stated in my paper (*J.C.S.*, 1913, **103**, 156) that I considered the experimental data insufficient to allow of an attempt to express them mathematically. At the same time if I were minded to make such an attempt I should not be deterred by any of the difficulties which trouble Mr. Hunter, especially by the consideration that the period of the sine curve which is "very nearly linear for a temperature range of nearly 200° C.," "must be very large in order to accommodate a linear curve of this great temperature range," an objection which he says, "alone robs Prof. Patterson's suggestion of most of its claim to be regarded as a valuable contribution to our knowledge of the subject." That the period of a graph should be large is not necessarily in contradiction to my views. But I agree to a large extent with Mr. Hunter when he says "the fact that an expression can be made to fit a given set of figures is no guarantee that it is the correct equation to apply—no theoretical deductions whatever can be drawn from its use," and I presume that he intends this remark to apply also to the Drude expressions, to which he seems to be so firmly attached.

After stating, fairly enough, my suggestion in regard to the periodicity of temperature-rotation curves, Mr. Hunter decides that it "has very little to recommend it"; that it "fails to co-ordinate the observed experimental facts"; that "it requires a good deal of faith for its acceptance." Periodicity, it seems, is very difficult to observe in my results, "no trace of it is to be found in the results obtained by other investigators," a statement which, considering the fact that I have developed my views by making extensive use of the results of Frankland, Pickard, Armstrong, Walden, Grossmann and others, giving full references, seems to indicate in Mr. Hunter's attitude a slight trace of injustice. It is true that it is difficult, within the range of temperature accessible to us, to observe a sufficient length of a temperature-rotation curve, completely to show its periodicity. But when, as in the case of ethyl tartrate, the T—R curve rises rapidly from a fairly high negative value, passes through the zero of rotation, reaches a maximum and begins to descend again; when, in certain temperature-rotation curves, notably those of the benzoyl tartrates examined by Frankland and Wharton*, a minimum and a point of inflection both occur, the assumption that this is part of a periodic curve is completely in accordance with the facts as far as they are known.

Mr Hunter's next point is quite an important one. He says that the practice of grafting on to the temperature-rotation curve for a homogeneous substance, that for the same substance in some solvent, is entirely indefensible and impracticable, because there is no guarantee that the scales of temperature and rotation respectively are the same in each case. Now the fact, demonstrated in so many cases by the work of Dr Pickard and his collaborators, that the data for the rotation of a homogeneous substance at different temperatures; for various derivatives of that substance also at different temperatures: for that substance or its derivatives in different solvents, and again at different temperatures; all fit, as a general rule, in a most interesting manner on to one characteristic diagram, seems, in my opinion, to show that the grafting, to use Mr. Hunter's word, of temperature curves is quite a legitimate operation, even if, in the meantime, we are not able to deal with it quantitatively. I do not know how Mr. Hunter reconciles his disapproval of my procedure with the fact of the characteristic diagram.

Mr Hunter then cites *d.-sec.* octyl formate (*J.C.S.*, 1923, **123**, 1) and acetate (*J.C.S.*, 1914, **105**, 861) to show "that closely-related compounds do not always have similar temperature-rotation curves," from which it would appear that Mr. Hunter's opinion has undergone a considerable change since the more recent of these papers was published. On page 8 we find it stated that "the temperature-rotation curves of *d.* β octyl formate are similar to those of the acetate, etc., in that its lævo-rotation increases with rise of temperature whilst in the case of the acetate, etc., the rotation decreases with rise of temperature, that is to say, in all cases rise of temperature produces a change in rotatory power in the same sense." It is clear also from the data quoted in these two papers that, as Mr. Hunter says, the T—R curves for the octyl formate would intersect at a low temperature, whilst those of the acetate do actually intersect at a temperature of about 160°; and that those of the homologues would, in all probability, intersect at higher and higher temperatures. The data for all of these substances fall upon the very interesting characteristic diagram shown on p. 845; the point of intersection of the T—R curves for two given colours of light of these different substances—the rational zero—is the same or very nearly the same for all. Therefore, the case quoted by Mr. Hunter as an objection to my view is, in fact, entirely in agreement with it: there is no contradiction whatever. It appears that there may be found, even in Mr. Hunter's own work, a trace of evidence in favour of my views. It is true that the point of intersection of the T—R curves for the acetate is at a considerably higher temperature than that for the formate, but the sequence in the whole series is consistent; that the temperature interval should be large is, in itself, not a difficulty.

Mr. Hunter describes my suggestion to calculate rotation-dispersion from the rational zero as "merely a piece of geometrical legerdemain, in which the properties of similar triangles are employed to obscure the real scientific issue," stating that I set "out to find a way of calculating dispersion ratios in order to *make* them constant," and remarking that "a constant is useful only when we know what it means," and that "no meaning can be assigned to a dispersion ratio—it is entirely arbitrary."* This seems to raise, amongst others, the question, what is "the real scientific issue"? Is it to investigate by inductive methods the phenomena of nature, or is it to return to the times of the Schoolmen and adapt nature to *a priori* principles? I prefer the former. I do not attempt to *make* dispersion ratios constant: I simply adopt the very significant fact that the difference between the rotations—the dispersion—for two different wave lengths for a given substance and for a series of related substances, over wide limits of temperature, solvent and concentration is directly proportional to the rotation value calculated from a particular point. This is, again, the very obvious lesson of the characteristic diagram: it appears to me to be of the utmost significance, but to Mr. Hunter it apparently has no significance at all. I am afraid we must just leave it at that.

The constancy in the dispersion ratio obtained by use of the rational zero is thus, says, Mr. Hunter, "the rediscovery in a particular form of facts which have been known to scientists for at least two thousand years"—a pronouncement out of which I have not yet been able to extract any meaning.

Mr. Hunter then says that I "cannot be unaware of the fact that there are two kinds of characteristic diagram: those in which all the lines intersect at one point, the zero of rotation: and those in which the lines do not intersect in one point." In one of my papers which Mr. Hunter quotes (*J.C.S.*, 1916, **109**, 1193), I pointed out that if ordinary dispersion

* Full references will be found in J.C.S., 1913, **103**, 145; 1916, **109**, 1139, 1176, 1204; Proc. Roy. Soc. Edin., 1918-19, **39**, 18.

* Surely this is rather an astonishing statement.

coefficients were constant for any substance, it follows that the T—R curves for all the different colours of light must meet on the zero of rotation. I am, however, unaware that any substance has really been found which actually shows quite strictly this behaviour, and it would have been interesting if Mr. Hunter had told us to which substance or substances he was referring.

For substances showing visibly anomalous rotation-dispersion, Mr. Hunter quite correctly points out —as I had pointed out previously (*loc. cit.*, 1191)—that there would be an infinite number of rational zeros, and he seems to find this a difficulty, but he fails to observe that exactly the same difficulty applies to ordinary dispersion coefficients of which, for substances showing anomalous rotation-dispersion, there must also be an infinite number. I can only say that if nature happens to be made in this way we must simply accept the fact. It seems to me to be better to have an infinite number of rational zeros from which the dispersion ratios for the two colours of light concerned are constant over wide ranges of temperature and external circumstances, than to have, as we do have when we calculate them in the ordinary way, an infinite number of dispersion coefficients which show no constancy at all. Mr. Hunter, however, concludes that "the conception of a rational zero must be dismissed as unworthy of further consideration; it was designed for a purpose which has been shown to be unscientific and its adoption leads to a labyrinth of arithmetical computation from which there is no escape." *Et sic transit gloria doctrinae meae!*

Mr. Hunter then passes on to the consideration of my views in regard to the Drude equation, and to dynamic isomerism, as an explanation of anomalous rotation-dispersion. My objection to the Drude expression as interpreted by Lowry is simply that it does not agree with the facts. It is the business of those who adhere to the esoteric cult of the dynamic isomeride* to show that it does. Hitherto they have completely failed. They will not even attempt to discuss the difficulties to which, in my recent article, I referred.

Mr. Hunter says that "to ignore the fact that dynamic isomerism does occur in many cases known to chemists is hardly scientific," with which I quite agree, but I fail to see what bearing it has on my attitude, as I am quite aware of the occurrence of dynamic isomerism, and have indeed concerned myself experimentally with it. But Mr. Hunter adds the statement, "it is known, too, that labile isomerism is sometimes accompanied by complex rotatory dispersion." If this means that the phenomena of labile isomerism and complex rotatory dispersion are associated in these cases as cause and effect, it is a pity that Mr. Hunter has not informed us to which substances he refers. In my article of May 2nd, I pointed out that the phenomenon of dynamic isomerism is quite independent of, and therefore has nothing to do with, the rotatory phenomena in the case of nitrocamphor, which is, I think, the only case that has been definitely discussed in this connexion.

* Dynamicisomeridolatry.

Mr. Hunter simply professes a blind faith in the Drude equation. Although it is, as he says himself "merely an aspiration," he holds that "for the time being we must be content with the knowledge that the modifications (in its constants) we seek must surely be found because the search is being conducted in a logical manner." This is another of Mr. Hunter's indiscretions of language. He cannot *know* that the modifications which he seeks will surely be found and the method of search must be unusual for, "it is true, of course, that the hypotheses are incapable of direct proof, or even, at present, of direct experimental test"; although it seems that Lowry's views—like mine—*have* been "subjected to the acid test of experiment and have been found wanting." Mr. Hunter's views do not constitute even an hypothesis and certainly not a theory; they are merely a fantasy. It would be well if we scientists were to realise more fully the truth of a statement of Karl Pearson, which I have quoted before, that "all science is description and not explanation."* I commend it to Mr. Hunter's attention.

Organic Chemistry Department,
University of Glasgow
May 30, 1924

* Grammar of Science, 3rd Ed., p. viii.

EXPLOSIBILITY

By A. MARSHALL, A.C.G.I.

More than fifty years ago M. Berthelot showed clearly by his researches that all explosives are bodies which are capable of undergoing a rapid reaction with evolution of heat, and subsequent experience has shown the importance of this conception. Even such an insensitive substance as ammonium nitrate can become a dangerous explosive if it be treated too contemptuously, as was revealed by the catastrophes at Kriewald and Oppau. In this case the principal reaction that takes place on detonation is the deep-rooted one:—

$$NH_4NO_3 = 2H_2O + N_2 + \tfrac{1}{2}O_2 + 27\cdot 6 \text{ Cal.}$$

although a number of others are possible and occur when ammonium nitrate is merely heated. It is probable that every compound or mixture that can undergo such an exothermic reaction can be made to explode, provided that there be an adequate evolution of gas or vapour, and the power of the explosive depends principally on the amount of heat evolved in the reactions.

The effect of an explosion depends, however, not only on the power, but also on the velocity of detonation. Various explosives also differ from one another enormously in their sensitiveness to detonation, to heat and to impact and other mechanical impulses. Whereas ammonium nitrate, for instance, requires another powerful explosive and strong confinement to send it off, silver fulminate can be detonated by little more than a touch or by a small spark. Some when ignited, burn rapidly to detonation, whereas

others, such as trinitrotoluene, will generally burn right away without exploding. What causes these differences in behaviour ?

A. Stettbacher lays great stress on the differences to be observed between compounds of the aliphatic and aromatic types. He found that a few grammes of trinitrotoluene detonated in an open crucible or small-arm cartridge case had more effect on the plate underneath than the same amount of nitroglycerin but he ignores the influence of the physical condition and of the density. Liquid nitroglycerin is notoriously difficult to detonate at its maximum velocity, and if it had been used in the form of dynamite it would probably have had a greater effect than the TNT. Or if the latter had been melted and cast into the containing vessel, it would probably have produced but little effect in consequence of the incompleteness of the detonation. Stettbacher further draws attention to the fact that unconfined dinitrobenzene and even dinitronaphthalene are more easily detonated than collodion cotton, although they have much greater deficits of oxygen, and that mono-nitroglycerin cannot be detonated at all, but he overlooks the fact that the heat set free on detonating dinitrobenzene is about the same as with collodion cotton, and that dinitronaphthalene gives off more heat on detonation than mono-nitroglycerin would. This is due to the fact that the heats of formation of the aromatic nitro-compounds are small and those of the nitronaphthalenes are even negative, whereas those of the nitric esters such as the nitroglycerins and nitrocelluloses are high. Nevertheless, it is a fact that the aromatic nitro-compounds are more easily detonated unconfined, although Stettbacher seems to over-emphasize it. He ascribes it to a collapse of the benzene ring on detonation, and there may be some truth in the theory, but speculations of this sort should take into account other types of explosives such as fulminates, azides and ordinary gunpowder.

An explosive has a considerable store of potential energy, and may be likened to a reservoir of water held up by a dam. When a high explosive is detonated it is like the bursting of the dam by an earthquake; the water is suddenly released and sweeps away everything in the valley below, and if there be other reservoirs there, their dams will also be burst by the rush of water. When an explosive is ignited it is like knocking a hole in the dam near the top. If the dam be strong, the water will only flow for a time, and will then cease after it has fallen to the level of the hole. But if the dam be weak it will be eroded rapidly until all the water has escaped, and in an extreme case it may be weakened so much that ultimately it will collapse with results much the same as those caused by the earthquake, except that the water that runs through in earlier stages causes comparatively little damage.

This resembles an explosive burning to detonation. Some sorts, such as fulminate, detonate when less than a milligramme has burned, but of others, such as guncotton or TNT., many kilogrammes or even tons may burn away before there is an explosion.

The slow decomposition of an explosive such as cordite on storage is like water percolating through a porous dam. This also may eventually lead to a catastrophe if the percolation becomes so rapid as to break down the dam.

Such similes must not, of course, be carried too far, but it is hoped that this one will help to afford a clearer conception of the various sorts of explosive. It raises the question: why does the dam sometimes collapse from the base, and sometimes erode from the top ? That is, why does an explosive sometimes detonate and sometimes merely burn or deflagrate ? When it burns, the molecule evidently only breaks down gradually or partially, whereas when it detonates, the molecule is broken up suddenly into its component atoms. The simile therefore continues to hold. On burning, the nitrogen is mostly given off in the form of oxides, and the rest of the molecule oxidises in stages much as a hydrocarbon or alcohol does during combustion. On detonation, on the other hand, the nitrogen is evolved in the elementary form, and the other elements also are converted into very simple compounds, which however, may combine during the cooling of the products to form more complex compounds.

Why do some compounds break down completely and violently when only slightly heated, or struck whereas others which have more available energy break down partially and quietly. The following series of mercury compounds brings out these differences :—

	Heat of Formation Mercury liquid	Heat of Explosion Mercury gas
Mercuric cyanide $Hg(CN)_2$	—55·4	—
Mercuric sulphocyanide $Hg(CNS)_2$	—50·2	—
Mercuric fulminate $Hg(ONC)_2$	—62·9	101·5
Mercurous azide HgN_3	—71·4	57·8
Mercuric oxalate HgC_2O_4	+171·3	3·7

The figures are large Calories per gramme-mol. and are derived from the results given by Berthelot. The fulminate and the azide are, of course, sensitive explosives that can be used to detonate other explosives. The oxalate is only a very mild explosive, as would be expected from the small amount of energy liberated, but it does deflagrate when heated. The cyanide, on the other hand, does not explode under ordinary circumstances in spite of the fact that it is an endothermic compound. When heated it decomposes into mercury and cyanogen with absorption of heat :— $Hg(CN)_2 = Hg + C_2N_2$ 10·3 Cal. The sulphocyanide, also, when ignited undergoes a quiet decomposition, giving off gas and leaving a very voluminous residue. This is our old friend Pharaoh's Serpent.

The following simple endothermic nitrogen compounds are also curious :—

	Heat of Formation.
Ammonium azide $N_4H_4 = H_3N{\cdot}N_3$	—19·0
Nitrogen sulphide N_4S_4	—127·6
Nitrogen chloride NCl_3	—38·5
Cyanogen $(NC)_2$	—73·9

The first three are sensitive explosives, but cyanogen can only be detonated with some difficulty.

We shall probably understand these peculiarities better when we know a good deal more about the structure of the molecules of these substances. As

some of them are very simple crystalline compounds there should be no great difficulty in investigating them by means of the X-ray spectrometer. Such an investigation would throw a light not only on the nature of explosives but also on chemical stability and instability.

Explosives can also be made by mixing together mechanically substances that alone are almost or entirely devoid of explosive properties. It is noteworthy that the addition of sulphur or a sulphide renders a mixture considerably more sensitive. This is the principal function of the sulphur in ordinary gunpowder, for without it the reaction between the saltpetre and the charcoal would be too difficult to initiate. Mixtures containing potassium chlorate are much more sensitive than those containing the nitrate, and this may perhaps be ascribed to the fact that it breaks down with the evolution of heat. Potassium perchlorate, on the other hand, absorbs heat on breaking down and does not produce sensitive mixtures. Ammonium perchlorate, like potassium perchlorate, can be detonated by itself and yields somewhat sensitive mixtures. Ammonium chlorate is so unstable that it cannot be kept.

$$KClO_3 = KCl + 1\tfrac{1}{2}O_2 + 11{\cdot}9 \text{ Cal.}$$
$$KClO_4 = KCl + 2O_2 - 19{\cdot}7 \text{ Cal.}$$
$$NH_4ClO_4 = HCl + 2H_2O + \tfrac{1}{2}N_2 + \tfrac{1}{2}O_2 + 58{\cdot}5 \text{ Cal.}$$

When a mixture contains both a chlorate and sulphur or a sulphide it becomes dangerously sensitive. That of potassium chlorate and sulphide of arsenic (orpiment) is astonishingly so, and has been the cause of numerous accidents, as it is a favourite composition with firework makers in consequence of the ease with which it can be set off and the brilliance of the effects. Only a few days ago I was called on to give expert evidence in a case where an Indian youth had lost both hands through the explosion of a small vaseline bottle filled with this mixture. It has even been known to go off spontaneously. It does not appear possible to account for these facts, unless it be assumed that atoms of sulphur are liable to become attached to chlorate molecules on the surface of the crystal and so form a sort of complex molecules that are highly unstable.

During the war the French used in their aerial bombs a liquid mixture of nitric peroxide and hydrocarbons, and it was found that unless the latter were purified from unsaturated compounds the mixture was too sensitive. This again points to formation of complex molecules of high sensitiveness. With liquid oxygen explosives the experience has been somewhat similar. The American investigators found that when wood pulp or cellulose was used as the oxidisable absorbent, the explosive was too insensitive, and they recommended the addition of crude oil or similar hydrocarbons. The Germans usually employ a mixture of soot and naphthalene when they want a brisant liquid oxygen explosive.

References :—
1. A. Stettbacher, Z. ges. Schiess-u. Sprengstoffw., 1918, 13, 225.
2. C. Moureu, La Chimie et la Guerre, 1920, p. 28.
3. S. P. Howell, J. W. Paul and J. L. Sherrick, U.S. Bureau of Mines Tech. Paper 294, 1923.

FORTHCOMING EVENTS

June 15 to 21. SOCIÉTÉ DE CHIMIE INDUSTRIELLE. Fourth Congress of Chemical Industry, will be held at Bordeaux.

June 16. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2, at 4.30 p.m. "The Mineral Wealth of the pre-Cambrian in Canada," by C. V. Corless, M.Sc., LL.D.

June 16. BIOCHEMICAL SOCIETY, Chemical Department, St. Thomas's Hospital, S.E. 1, at 5 p.m. (1) "Millon's Reagent," by W. H. Hurtley. (2) "The Amino Acids of Flesh," by J. L. Rosedale. (3) "Some Conditions Affecting the Action of Arginase," by A. Hunter. (4) "The Transformation in the Calcium Content of the Hen's Egg during Development," by R. H. A. Plimmer and J. Lowndes. (5) "The Action of Nitrous Acid upon Amides and other Amino Compounds." (6) "Hæmolysis of Red Corpuscles," by J. Mellanby and V. J. Woolley. (7) "Further Experiments on the Nutrition of Birds," by R. H. A. Plimmer and J. L. Rosedale.

June 18 and 25. BRITISH EMPIRE EXHIBITION, Conferences on Heredity as the Basis of National and Industrial Efficiency. In Conference Hall No. 3 Wembley.

July 15. THE INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (LONDON). Visit of Chemical Students to Wembley. At 9.45 a.m. an Inaugural Meeting will be held at University College, Gower Street, W.C. 1, at which the President of the Institute, Prof. G. G. Henderson, LL.D., F.R.S., will take the chair. Mr. W. J. U. Woolcock, C.B.E., General Organiser of the Chemical Section of the Exhibition and President-elect of the Society of Chemical Industry, will explain the objects of the exhibits and the special features of interest. Prof. W. P. Wynne, C.B.E., F.R.S., President of the Chemical Society, hopes to support the speaker at the meeting. The cost of the visit, including return ticket to Wembley, entrance to the Exhibition, and ticket for luncheon, will be 5s. Further information can be obtained from Mr. G. S. W. Marlow, 30, Russell Square, London, W.C. 1, and applications should be made not later than June 28.

Sept. 8 to 11. INSTITUTE OF METALS. Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corse, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at the British Empire Exhibition. On September 10 further papers will be presented for discussion, the afternoon being devoted to visits to works. A reception will be held in the evening at the National Physical Laboratory, Teddington. A detailed programme will be issued in August.

Sept. 15. BRITISH EMPIRE EXHIBITION. Conferences of Engineering Societies, to be held in Conference Hall No. 1, at 10.30 a.m. Short papers on various Engineering Subjects will be read and discussed. Further information and tickets may be obtained from the Secretary, Society of Engineers, 17, Victoria Street, Westminster, S.W. 1.

THE LOW-TEMPERATURE CARBONISATION OF COAL

There has long been much discussion of the merits and demerits of the process for the carbonisation of coal at low temperatures, but up to the present little progress towards a definite decision seems to have been made. The use of coalite, the smokeless fuel produced by the process, has been slowly extending and the chemical and industrial characteristics of the by-products are beginning to be known. But our heavens are still smoky, our houses sooty, and we still import fuel oil in bulk. It is therefore of much interest to reproduce a letter, which we are able to print by the courtesy of the *Daily Telegraph*, which records a step forward in the history of the process. The letter runs as follows:—

To the Editor of the *Daily Telegraph*.

Sir,—I read on Saturday in the *Daily Telegraph* the inspiring report of what is being done at Alton at Mayor Treloar's Cripples' Hospital, and of the miraculous healing powers of sunshine and light.

To-day I read in the *Nottingham Journal* of the enterprise of the citizens of Nottingham in taking definite steps to make their city the first smokeless town in the country. They are building a low temperature carbonisation plant capable of handling in a scientific manner 1000 tons of coal a day, to render it smokeless and at the same time to produce gas at less cost than hitherto possible, while at the same time the coal oils are to be extracted. These oils are to be converted into motor spirit, Diesel and lubricating oils, which this country now imports. But nothing is of greater importance for the benefit of the community than the abolition of the pall of smoke that hangs over our industrial centres, depressing and fatiguing the inhabitants and rendering them more prone to the diseases of darkness. We must have our full ration of sunshine. It is earnestly to be hoped that other cities will investigate the Nottingham enterprise and follow the lead of this great Midland centre.—Yours faithfully, GEORGE H. ROBERTS

Addison House, Bedford Street, Strand, W.C.
June 3, 1924

It appears that the Nottingham Corporation has arranged to take the gas produced by a low-temperature carbonisation plant which is to be erected in conjunction with the Digby Colliery Company by the Low Temperature Carbonisation Co., Ltd., at the colliery at Gedling. Small, that is, waste coal will be treated for the production of motor spirit, lubricating oil, cheap gas and a perfectly smokeless fuel for industrial or domestic use. It is stated that a plant with a capacity of only 1000 tons a day will, as a beginning, provide Nottingham with roughly 250,000 tons of smokeless fuel a year at a price not higher than that of the best house coal. Such a plant can yield over seven million gallons of crude oil and over one million gallons of motor spirit a year, and the by-products will include not less than 700 million cubic feet of gas of high quality annually. Plans have already been prepared for the new low-temperature carbonisation plant which, it is estimated, will cost between £250,000 and £300,000.

At present we spend between 50 and 60 millions sterling annually on imported oil and each 1000 tons of coal burned in the raw state implies a loss of nearly 20,000 gallons of fuel and other oils, as well as a polluted atmosphere and the waste of large sums on cleaning and redecorating. The installation of low-temperature carbonisation at Nottingham will be watched keenly and success will create a host of imitators. At last there are hopes of real smoke prevention and of real fuel economy.

THE FEDERAL COUNCIL FOR PURE AND APPLIED CHEMISTRY

At the meeting of the Council held on Wednesday, May 14, the following report from the Chemistry House Committee was circulated:—"The Committee is of opinion that the interests of academic, technical and manufacturing chemical science would be well served by the immediate establishment of a Chemistry House on a scale involving an outlay of at least £30,000, but it desires to point out that such an establishment should be regarded as the basis of a larger scheme for providing adequate accommodation for all the organisations representing the corporate interests of academic, technical and manufacturing chemistry. The Committee therefore recommends that the Federal Council should immediately appoint an Executive with instructions to organise and set in motion a scheme for the provision of Chemistry House. (Signed) W. J. Pope, Chairman. 2nd May, 1924." The report was adopted, and it was decided that Messrs. E. F. Armstrong, H. E. Coley, G. G. Henderson, S. Miall, T. Miller-Jones, Sir William Pope, Messrs. W. J. U. Woolcock and W. P. Wynne be the Executive; that they should have power to add to their number and should report progress at suitable intervals to the Federal Council.

Sir William Pope was re-elected President of the Federal Council for a further year.

A Committee, consisting of Sir William Pope, Prof. H. E. Armstrong, Messrs. Bolton, Coley, Drummond and Miall was appointed to draw up a provisional constitution for the Federal Council, and report in the autumn.

Since the Council Meeting preparations have been made for the meeting of the Union Internationale at Copenhagen at the end of June. The following have signified their intention of attending:—Sir William Pope, Prof. C. S. Gibson, Messrs. F. H. Carr, R. L. Collett, Prof. J. C. Drummond, Prof. A. Harden and Mrs. Harden, Dr. Stephen Miall. Others who wish to attend are requested to communicate with Dr. Miall.

A meeting of the Chemistry House Executive has been held recently at which Dr. E. F. Armstrong was appointed Chairman, and other preliminary business transacted.

The next meeting of the Federal Council is fixed for the 11th inst., and a report of the meeting will appear in this journal shortly afterwards.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 10.30 a.m.

The following is the official Programme :—

Tuesday, July 8, 9.0 p.m. Informal Reception by the President and the Local Committee at the Midland Adelphi Hotel.

Wednesday, July 9, 10.30 a.m. Annual General Meeting in the Arts Theatre, The University, and Presidential Address, "A Neglected Chapter in Organic Chemistry: The Fats." 2.30 p.m. Visit to White Star Liner, "Cedric," and tea on board, by invitation of the White Star Line. 8.30 p.m. Reception and Dance in the Town Hall, by invitation of the Rt. Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq).

Thursday, July 10, 10.30 a.m. (hour subject to alteration). Messel Memorial Lecture by the Rt. Hon. Viscount Leverhulme, in the Arts Theatre, and presentation to the Lecturer of the Society's Messel Medal for 1924. 12.30 p.m. (hour subject to alteration). Visit to the Works of Messrs. Joseph Crosfield and Sons, Ltd., Warrington. Luncheon by invitation of the Directors. Inspection of the Works of Messrs. Joseph Crosfield and Sons, Ltd. Cost of travelling, 5s. 7.30 p.m. Annual Dinner, in the Midland Adelphi Hotel. Tickets, exclusive of Wines, 12s. 6d.

Friday, July 11, 10.0 a.m. Business Session in the Physics Lecture Theatre, The University. 1.0 p.m. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of The United Alkali Co., Ltd., followed by visit to Works of The United Alkali Co., Ltd. Cost of travelling, 3s. 6d. 7.30 p.m. Dinner at Port Sunlight, by invitation of the Chairman and Directors of Messrs. Lever Bros., Ltd. Cost of travelling, 2s. 6d.

Saturday, July 12. About 9.30 a.m. (details later). Visit to Lake Vyrnwy. Inspection of the Liverpool Corporation Waterworks (limited to 150). Luncheon and tea, by invitation of the Water Committee of the Corporation of Liverpool. Arrive Liverpool about 9.30 p.m. Cost, dinner on train included, 25s.

Unofficial Excursions. Tickets to be booked in Liverpool at Reception Room :—Chester, River Dee and Eaton Hall; Isle of Man; Llandudno and Beaumaris (sea); Lake District (two days).

Members intending to attend the meeting are asked to send their applications, accompanied by the appropriate remittance, as early as possible to Mr. E. Gabriel Jones, City Laboratories, Mount Pleasant, Liverpool, to whom all inquiries relating to private hospitality, railway travelling and other matters connected with the meeting should be addressed.

A ballot list for the election of Members of Council has been despatched to each member entitled to vote.

J. P. Longstaff,
General Secretary

TORONTO SECTION

The attendance was good during the winter, being as high as 57 at the dinner and 75 at the lecture. The session was a very successful one for the Toronto Section, eight meetings having been held in Toronto and one at Guelph. In December, Mr. R. C. Purdy addressed the Section on "The Vitrification of Clays and Allied Problems in the Ceramic Industry." He particularly stressed the point that one could not predict the temperature at which vitrification would begin, from a chemical analysis of the clay, since this depended upon the character of the minerals present.

Mr. James Vail spoke in January on "The Manufacture, Properties and Uses of Sodium Silicate." At present, solutions of various compositions were on sale, and for each there was a specific use. As an adhesive certain solutions were almost ideal in that they underwent great changes in viscosity upon the subtraction of small amounts of water. This property enabled the manufacturers of certain paper products to operate their machines at much greater velocities when this adhesive was used. The use of sodium silicate in the beating process in paper manufacture greatly aided in the hydrolysis of the fibre.

On February 22, Professor Harcourt, Director of the Department of Chemistry, Ontario Agricultural College, discussed the "Chemistry of Bread and Flour Making." The Canadian miller had at hand a fairly uniform source of raw materials so that he was not faced by a difficult blending problem He did, however, watch his supply of such materials closely since the method of grading wheat would put a slightly shrivelled wheat in a low grade, whereas such a wheat would probably be higher in gluten than a highly graded wheat. Bleaching was not particularly detrimental to flour and enabled one to market a flour from new wheat. The action of such agents was to hasten the ageing of the flour.

A joint meeting with the Canadian Institute of Chemistry on February 29, was addressed by Dr. Banting and Mr. Best, upon the subject "The Application of Chemistry to Chemical Research." Dr. Banting first outlined the general problem of diabetes and its relation to metabolism and then Mr. Best spoke at length upon the role played by chemistry in the development of "Insulin."

Dr. P. E. Klopsteg, who was the speaker at the meeting held on April 4, outlined the fundamental principles underlying the practical determination of the hydrogen ion in an extremely lucid fashion and carried out a number of demonstrations.

The last regular meeting of the session was held on May 2, when the election of officers took place The result of the election was reported elsewhere Mr. A. R. Duff discussed the problem of "Wood Drying." He first gave a summary of the principles underlying the process and then described the various methods employed to obtain as nearly ideal drying as was economically possible. The drying of wood is of vital importance to those engaged in wood distillation since the transportation of useless water presents to them an economic problem.

SOCIETY OF GLASS TECHNOLOGY

During May a party of some twenty members of the Chambre Syndicale des Maîtres de Verreries de France paid a visit to England at the invitation of the Society of Glass Technology, thus returning a visit paid last year to France by members of the British Society. The programme included various visits, and the delegates were guests at the Annual Dinner of the Society in London. The other guests were Dr. E. F. Armstrong, F.R.S. (President of the Society of Chemical Industry), Judge F. E. Bradley, LL.D. (Master of the Glaziers Company), J. Holland, Esq. (President of the Ceramic Society), and Dr. C. Baring Horwood (Master of the Glass Sellers Company).

During the week two meetings were held. The first was held in University College, London, on May 27, and was a joint meeting with the British Society of Master Glass Painters. The President of the latter Society, the Earl of Crawford and Balcarres, was in the chair. Three papers were presented.

Dr. Ethel Mellor, in a paper on "The Decay of Window Glass from the Point of View of Lichenous Growths," gave an interesting account of the acceleration of the decay of glass in ancient stained glass windows by the growth of lichens on the glass. Mr Noel Heaton, B.Sc., discussed "The Decay of Mediæval Stained Glass." The wide variations in resistance to decay found in mediæval stained glass was to be attributed mainly to variations in the composition and physical structure of the glass. Window glass was introduced by the Romans, and their glass was remarkably durable. Analyses of glass of different periods revealed the loss of durability which resulted from a departure from the Roman tradition in mediæval times. The lowest ebb was reached about the end of the fourteenth century, a notable example being the glass of York Minster. Two causes of decay operated simultaneously; surface weathering due to atmospheric action, and pitting due to the structure of the glass. The variations found in stained glass of the same period were due mainly to primitive methods of manufacture. It was characteristic of mediæval glass that the painted portions resisted decay better than the glass itself, which might be attributed to the lead silicate used uniting with the glass to form a more durable composition. The reverse occurred in later times.

The last paper was "The Weathering and Decay of Glass," by Prof. W. E. S. Turner, D.Sc. The nature of the corrosion of glass had been methodically studied by the physical chemist, and the principal causes were now fairly well known. The chief agent of atmospheric action was moisture. All glassware absorbed moisture to an extent dependent on its composition, but partly also on the manner in which it had been treated by the workman. The compositions of stable and unstable glasses were discussed, and it was pointed out that the eventual hollowing out and the furrowing of glass in process of decay were associated with the mechanical treatment which it had received.

The second meeting was held in the Applied Science Department, Sheffield University, on May 29, Col. S. C. Halse, C.M.G., in the chair. The following three papers were presented:—

"Alumino-Silica Minerals in Fired Glass Pots," by W. J. Rees, B.Sc. N. L. Bowen and J. W. Greig, of the Geophysical Laboratory, Washington, U.S.A., had recently investigated the binary system $Al_2O_3 : SiO_2$. They showed that only one compound of alumina and silica was stable at high temperatures; this compound had a composition $3Al_2O_3$, $2SiO_2$. Researches made by the author during the firing of pots, and blocks for glass works, as well as during their use at high temperature, corroborated the results obtained by Bowen and Greig. The proportion of $3Al_2O_3$, $2SiO_2$ was found in refractory materials after firing depended upon the composition of the material, upon the degree and duration of the heating, and upon contact with siliceous matter.

"The Effect of Various Constituents on the Viscosity of Glass," by S. English, M.Sc. To the glass manufacturer, the viscosity of molten glass was perhaps the most important of its properties, as the viscosity and the way in which it varies with alteration of temperature determined whether a glass could be satisfactorily melted, plained and worked. Of the various methods for the determination of the viscosity of liquids the "rotation" method seemed to be the most useful for glass, as it could be used over such a large range of viscosity. In applying this method, the glass was melted from cullet in a standard cylindrical crucible, and an iridioplatinum sheath secured on the end of a porcelain rod was rotated on its own axis in the centre of the crucible. The time required for the sheath to complete one rotation under different loads at various temperatures was determined, and the viscosity was given as a function of the product of the net effective pull and the time of rotation. The apparatus was calibrated by using syrup, the viscosity of which had been previously determined. "The Thermal Endurance of Glass (Part I.)," by V. H. Stott, M.Sc. In spite of its practical importance the theory of the thermal endurance of isotropic bodies had been somewhat neglected. A theory was submitted which, owing to the complexity of the phenomena involved, was necessarily not entirely satisfactory. It was possible to increase the thermal endurance of glass by a suitable thermal treatment, but a general method for effecting this could not be given. Another question was that of finding the shapes of glassware which were most resistant to thermal shock in the limits imposed by usage. From the point of view of thermal endurance, they could choose a glass which suited a given purpose according to its physical properties, but it was most difficult to determine the best process of manufacture for an actual article, or to arrive at a proper method of testing the value of the object made. It was therefore not desirable at present to fix any formal method of testing. Part II., by V. H. Stott, M.Sc., and Edith Irvine, B.Sc. Experiments were made which showed that rupture was generally due to local differences of temperature, rather than to the uniform shrinkage of large surfaces. Since rupture was almost instantaneous, the conductivity of glass could not have great importance.

CORRESPONDENCE

SYNTHETIC ORGANIC COMPOUNDS—A REPLY TO MR. KAY

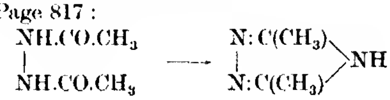
Sir,—I do not propose to deal with all the questions raised by Mr. Wm. E. Kay in your issue of May 2, but I crave your hospitality for a few remarks on his criticisms of my interpretation of the term "synthetic organic chemical."

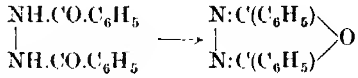
Mr. Kay is mistaken in supposing that I have in any way modified my conception of a synthetic organic compound since discussing the nature of calcium carbide in your columns early last year. On that occasion I stated and considered all the definitions of any authority with which I was acquainted, and quoted finally as much of Posner's definition as was relevant to the carbide case; Posner's whole statement, which occupies about a page, distinguishes carefully between the several types of organic syntheses and receives, I think, the general assent of organic chemists. His whole book deals with the multitude of available synthetic methods for converting organic compounds into others containing new units of constitution, whether these latter contain or do not contain carbon.

It is too late, at the present day, to regard Lieben's defintion as of other than historical importance; the transition from Lieben to Posner became necessary when general reactions for preparing specific types of compounds were being intensively studied, and when analogies between the several reactions of one particular radicle were being traced. Without the transition we could not ask what general synthetic methods are available for the preparation of ethers, because the word "synthetic" would be meaningless in this connexion; further, the combination of acetaldehyde with hydrogen cyanide would be a synthesis, whilst the closely analogous reaction of the aldehyde with ammonia or sodium bisulphite would not be a synthesis. Elbs made it quite clear that the scope of his work was to be limited to a particular class of syntheses, namely, to those in which carbon atoms become joined together; he thus gives no syntheses of organic compounds containing only one carbon atom in the molecule and, indeed, calls attention to the fact that his restricted definition excludes the classical example of organic synthesis which is generally the first placed before the student, that of the conversion of ammonium cyanate into urea. One purpose of my previous article was to show that calcium carbide was a synthetic organic compound in the light of the very restricted definition to which Elbs confined himself, apparently for the purpose of limiting the magnitude of his treatise.

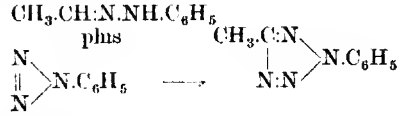
Mr. Kay's attempt to limit Richter's conception of an organic synthesis to cases in which two carbon atoms become joined together or in which carbon compounds are formed from their elements is not justifiable. Richter speaks (*Chemie der Kohlenstoffverbindungen*, 1913, vol. 2, p. 709) of the production of derivatives of furfurane, thiophen and pyrrolidine from γ-diketones and from mucic acid as syntheses; in these reactions no addition of carbon atoms to the molecule takes place, and no carbon atoms become directly joined together. He also gives the following as syntheses:—

Page 817:





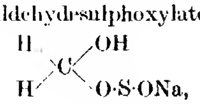
Page 830:



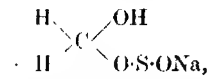
In none of these syntheses do carbon atoms become joined together, and in each case the synthetic process involves the shedding from the molecular complex of weighty scaffolding in the shape of certain components. The common element in the modern definitions of Richter, Posner and others lies in the association of a synthesis with the creation of a unit of molecular constitution not previously present; I submit that Mr. Kay has produced no argument in impeachment of this statement.

We may now pass from the general question to the particular one which gave rise to this correspondence. Mr. Kay appeared in support of an application to delete sodium formaldehydesulphoxylate from the Board of Trade list of substances covered by the Safeguarding of Industries Act, 1921, the chief contention in support of the application being that this substance is not a synthetic organic chemical. For the purpose of revealing the slender grounds upon which the application was based it will suffice to describe the preparation of sodium formaldehydesulphoxylate, and to state the chemical points raised in the cases presented respectively for its removal from, and for its retention in, the Board of Trade list. Of course, sodium formaldehydesulphoxylate differs widely in type of constitution and in modes of preparation from calcium carbide, and an argument applicable to the one substance becomes meaningless when applied to the other.

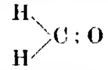
Sodium formaldehydesulphoxylate,



is obtained by the reduction of sodium formaldehyde bisulphite,



which is prepared by the interaction of formaldehyde,



and sodium bisulphite, $NaHSO_3$.

The case argued by Mr. Kay and his friends for the expulsion of sodium formaldehydesulphoxylate from

the Board of Trade list of synthetic organic chemicals premised that the substance is an "additive compound" of formaldehyde and sodium sulphoxylate, HO·S·ONa, notwithstanding that the latter salt cannot be prepared and that no reason exists for assuming its formation during the reduction of the formaldehyde bisulphite compound. In support of the case the chief expert witness gravely informed the learned referee, concerning sodium formaldehydesulphoxylate, that "it would be as correct to say it is organic as to say that it is inorganic. It is not correct to say that it is either," and, further, that "nobody in his sane senses could say whether it is either inorganic or organic"; it was also stated that sodium bisulphite is "a typical inorganic non-synthetic chemical." Further chemical evidence just as helpful as the above was given.

The case for the Board of Trade argued that chemical compounds cannot be classified as organic, inorganic and "hybrid," but that only the first two classes are distinguished by chemists; on this ground sodium formaldehydesulphoxylate can only be regarded as an organic compound. Further, that during the process of using formaldehyde and sodium bisulphite, with zinc as a reducing agent, to produce the organic sulphoxylate, the characteristic properties of the aldehyde and the sulphite disappear; an entirely new constitutional unit is produced by a synthetic process which falls within the modern definition considered above.

The learned referee decided in favour of the Board of Trade, and it is probably unnecessary for me to expand the above very brief summary of the chemical side of the proceedings in order to convince my chemical colleagues that the decision was entirely justified.

Mr. Kay moralises at some length on the unsatisfactory character of the proceedings under the Safeguarding of Industries Act, and concludes by putting four questions to which I may be allowed to give at least partial answers. The answer to question 1 is that the Government did not accept proferred advice; possibly no one foresaw how much ingenuity would be exercised for the purpose of defeating the obvious and simple purpose of the Act. The answer to question 3 is that no court of honour has been, nor probably can be, established in any profession with both legislative and advisory powers concerning professional ethics; the individual who counsels costly legal proceedings on a chemical matter without seeing a perfectly clear and logical road to success is judged by his own firm and by the chemical fraternity in general. To question 4 it may be replied that far too much is said nowadays about the humiliating state of affairs in chemistry; the position of the chemist in the public eye is far higher than it has ever been before.

Mr. Kay's question 2 I leave to the last. It involves a statement which I believe to be quite incorrect; the atmosphere of the law courts may be heating to the witnesses, but it is not sultry to counsel and it certainly does not perturb the tribunal. Few counsel and fewer judges have the instinctive knowledge of a technical subject which should be possessed by an expert witness, and they thus tend unwittingly to divert him from his true function and to assign to him advocative functions; I have more than once been asked to state my views on some particular subject when the proper request would have been that I should state the facts and point the logical conclusions, so that the court might itself digest the evidence and form a view. The difficulty thus indicated is doubtless inherent to the absence of the technical assessor whose appointment I have previously suggested; at the same time, it would not be easy to over-estimate the patience, the care and the intelligence which the President of the tribunal devotes to the hearing of these technical cases. I have described the proceedings in certain of these Board of Trade hearings as "an orgy of misinterpretation and misrepresentation," and I see the description still justified by the statement of an expert witness that "nobody in his sane senses could say whether it (sodium formaldehydesulphoxylate) is either inorganic or organic."

In conclusion I protest against Mr. Kay's suggestion that such a term as "synthetic organic chemical" is not interpretable in purely scientific terms, and that accepted commercial usage should be taken into consideration in this connection. A "synthetic organic chemical" can only mean a "synthetic organic compound," and neither expression has or ever has had any commercial usage; it is a purely scientific conception and must be interpreted as such. Similarly no scientific man, speaking as such, ever uses the phrase "fine chemical"; he cannot be quoted as an authoritative exponent of whatever meaning attaches to this term.

W. J. Pope

Cambridge
May 30, 1924

AN ANTHOLOGY OF VERSE RELATING TO SCIENCE

Sir,—During the past five years, I have been collecting verse, whose subject matter relates to the sciences, with the intention of publishing at some future date an anthology of this sort of verse. It has occurred to me that the readers of the *Journal* might be willing to help me in collecting this sort of poetry, in order to make such an anthology of the greatest value, and to this purpose I am writing to you to ask you to insert in the *Journal* this appeal for assistance and co-operation in gathering together this sort of verse. Verse of all moods and forms, provided that its subject matter relates to the sciences, will be welcomed. Contributions sent to C. E. Ruby, Mass Inst. of Technology, Cambridge, Mass., U.S.A., will be duly acknowledged. I am, Sir, &c.,

C. E. Ruby

Cambridge, Massachusetts

At the twenty-first convention of the Institute of British Foundrymen at Newcastle, Mr. John Shaw, of Sheffield, was presented with the Institute's gold medal for the most distinguished member.

PERSONAL AND OTHER ITEMS

The General Board of Studies of Cambridge University has reappointed Mr. F. W. Dootson, University lecturer in chemistry, and Mr. W. H. Mills, University lecturer in organic chemistry.

At a dinner held at the Guildhall in connexion with the Empire Mining and Metallurgical Congress, Prince Arthur of Connaught, at the request of Sir John Cadman and Mr. H. M. Morgans (presidents of the Institution of Mining Engineers and of the Institution of Mining and Metallurgy, respectively), presented medals to Prof. H. Louis and to Mr. H. W. Gepp, who also received a medal for Mr. G. Rigg.

On October 4, Dr. F. W. Aston is to give a lecture on atoms and isotopes before the Swiss Society of Natural Sciences at Lucerne, on the occasion of its 150th annual meeting.

Mr. J. E. P. Wagstaff, M.A., has been appointed professor of physics in the University of Leeds.

Mr. R. C. Richards, B.A., M.Sc., has been appointed Quain lecturer in physics in University College, London.

Sir Jeremiah Colman has given £2000 to establish a library for the School of Biochemistry in the University of Cambridge.

Mr. C. H. Hamilton has been appointed Chairman of Wm. Gossage and Sons, Ltd., in succession to Mr. John Gray, who has been compelled to resign owing to ill-health. In connexion with the retirement of Mr. Gray, Lord Leverhulme, on behalf of the board of Wm. Gossage and Sons, Ltd., and Mr. Gray's former colleagues at Port Sunlight, presented him with a handsome solid silver tea service and tray. Mr. J. A. Sterling, secretary of the company, also presented to Mr. Gray, on behalf of the senior managers of the company, a solid silver fruit and cake stand.

Salters' Institute of Industrial Chemistry

The Committee will, in July, allocate a limited number of Grants in Aid to young men and women, employed in chemical works in or near London, who desire to extend their education for a career in chemical industry. Applicants must not be under seventeen years of age. Applications, with particulars of age, nature of employment, and manner in which the grant would be used, and giving the name of some person to whom reference may be made, should be sent, as soon as possible, and in any case not later than June 14, 1924, to the Director of the Institute, Salters' Hall, St. Swithin's Lane, London, E.C. 4.

Chemical Workers' Wages

The award of the Industrial Court on the chemical workers' application for higher wages (*cf. Chemistry and Industry*, May 30, 1924), has now been issued. The Court has awarded that the wages of adult male time-workers shall be advanced 5d. a day or shift; of adult female time-workers, 4d. a day or shift; and that piece-workers shall receive equivalent advances. The decision states that the claim regarding week-end work has not been established. According to the *Manchester Guardian*, the award affects 22,000 workers, of whom 5 to 7½ per cent. are piece-workers.

Explosives in Canada

The report of the Explosives Division of Canada for the calendar year 1923 shows an improved condition in the industry. The increased production of blasting explosives, as compared with 1922, has been 25 per cent., while the detonator output has increased 48 per cent. Thirteen explosive factories were operating and during the year no employee or other person was injured by an explosive accident. The total accidents arising from the use and abuse of explosives were 183, with 43 killed and 164 injured, and of these 60 occurred in mines and quarries, causing 11 deaths and injuring 61 persons. The accidents attributable to railway, road, building and canal construction, farm clearing, etc., were 48 with 23 lives lost and 31 injured. Other accidents arising from explosives, such as playing with detonators and explosives, in which children are the principal victims, and other miscellaneous causes, were responsible for 75 accidents with 9 deaths and 72 injured. The production and importation of explosives for 1923, as well as the list of authorised explosives, are given in the report. All explosives on the British authorised list are provisionally authorised in Canada.

Australian Exports of Minerals and Metals in 1923

The Imperial Mineral Resources Bureau has received the following statistics from its corresponding member in Australia relative the exports of metals and minerals from Australia during the year 1923:

Exports (in long tons) 1923
(subject to correction)

Metal or Mineral	To British Empire	To Foreign Countries	Total
Copper, refined	6533	700	7233
,, blister	921	1372	2293
,, ore	277	—	277
Pig and antimonial lead	73,189	22,676	95,865
Lead bullion	4461	—	4461
,, ore and concentrates	695	25,638	26,333
Zinc (spelter and elec. zinc)	5076	27,784	32,860
Zinc concentrates	98,142	236,736	334,878
Cadmium	57	4	61
Tin, refined	1433	1432	2865
Mica	180 lb.	—	180 lb.
Antimony ore	379	50	429
Cobalt ore	798	16	814
Alunite	2180	—	2180
Asbestos	65	2	67
Osmiridium	333 oz.	176 oz.	509 oz.
Molybdenum concentrates	8	8	16
,, ore	—	2	2
,, metal	12	16	28
Arsenic	420	140	560
Auriferous antimony ore	127	—	127
Gold concentrates	55	—	55
,, containing platinum	17 oz.	—	17 oz.
,, in concentrates and ores	2611 oz.	47 oz.	2658 oz.
Platinum	170 oz.	21 oz.	191 oz.
Steel	62	27	89
Tantalite ore	3	—	3
Wolfram	13	64	77
,, concentrates	—	20	20
Plumbago	6	—	6
Silver, refined	435,199 oz.	—	435,199 oz.
,, in ore and concentrates	71,751 oz.	—	71,751 oz.

REVIEWS

General Chemistry. By H. G. Deming. Pp. xii+605. London: Chapman and Hall, Ltd., 1923. Price 17s. 6d.

In this book by the Professor of Chemistry in the University of Nebraska we have the outcome of an attempt to present an elementary survey of general chemistry, "emphasizing industrial applications of fundamental principles." It is evident that a vast amount of labour has been incurred, and that much thought has been expended in the effort to realise the stated aim. The result is a book which certainly has a very distinct individuality, and which, for that reason, will interest those who are charged with the duty of selecting a text-book for their students. The author, discussing the various ways in which general chemistry is now handled by University teachers, states that his own desire has been to give his book flexibility, so that it may be used by instructors in a way to meet their own individual ideas and needs in teaching. He takes credit for omission of excessive detail in order to gain space for the "development of such topics of lively interest as hydrogen ion concentration and its applications, an introduction to the chemistry of nutrition, electro-chemical principles and the constitution of matter."

Anyone who has to face the difficulty to-day of conducting an introductory course of chemistry in a University will feel indulgently towards every writer who makes an earnest effort to produce a book for his students. The growth of the science in the detail of new, important fact, the vast development on the physical and industrial sides, compel a constant readjustment of one's ways and a jettisoning of old contents to make room for the new. The last six years, in which there has been so much disturbance at the very foundation of the science, have been particularly tumultuous in this respect, and Prof. Deming's book seems to reflect the condition of chemical unrest. The very typography seems affected by it, for we have not only a differentiation into large and small type, but the interjectory use of heavy type for paragraph headings and for words and statements that are considered specially important.

The contents are divided into three parts:—

(1) "Preliminary," in which oxygen, hydrogen, water, chlorine, and a large amount of general theory are included;

(2) The Non-Metals, comprising further sections of general theory, as well as a certain amount of organic chemistry and a chapter on nutrition;

(3) The Metals.

Interspersed throughout are numerous references to industrial processes, and the book abounds in illustrations and schematic diagrams.

There is no doubt that Prof. Deming has broken away from the orthodoxy that so long ruled the elementary text-book of chemistry, and that in itself commands the reviewer's sympathy. But when we come to look for an educational plan or a rational sequence in his treatment of the subject, it is very difficult to find anything that can be formulated. On the contrary, the book seems, indeed, to be somewhat disjointed and breathless, especially in its exposition of theory. For example, on page 40, where valence is first dealt with, it is said that by the valence of an element we mean the number of atoms of hydrogen that one atom of the given chemical can *combine with* or *displace*." On page 136, we find, in equally heavy type, that "the valence of any element in the uncombined condition is assumed to be zero." This comes of a discussion of positive and negative valence, and is in advance of a brief reference to the structure of the atom on pp. 170—173. It is difficult to believe that the student will not be confused by this treatment.

The author has given his own turn in many cases to definitions and statements, but we cannot say they appear specially felicitous. On page 8 a molecule is described as "a group or cluster of atoms combined in a definite way," and on page 12 we have, under the heading of physical and chemical change, the statement that "any change in a substance which fails to alter its chemical composition and chemical properties is called a physical change." On page 110 we are told that "a sixteenth part of the oxygen atom is taken because the weight of the lightest atom, hydrogen, then turns out to be a trifle over one." The law of multiple proportions is called the "law of related composition."

These instances would not have been adduced were they not thought to be fairly illustrative of a character that pervades the book on the theoretical side. It is more agreeable to close on a note of praise, and to say that there is much in Prof. Deming's book that will be suggestive to chemical teachers, and that he has done especially good service in exhibiting the applications of chemistry to industry and other phases of human life.

Arthur Smithells

A Dictionary of Applied Chemistry. By Sir Edward Thorpe, C.B., LL.D., F.R.S., assisted by eminent contributors. Vol. V. Oxygen-Rye. Revised and enlarged edition, Pp. viii+722. London: Longmans, Green and Co., 1924. Price 60s. net.

The arrival of each new volume of this revised Dictionary arouses the same feeling and impels one to use the same words. The first thought is always of the labour imposed on the Editor, and of the sustained pace and standard of his achievement. We feel that our mission hardly goes beyond that of congratulating Sir Edward Thorpe and of offering our acknowledgments for each instalment of the Dictionary. Those who have ever contributed even a mite to the contents of a volume will know what vigilance and critical care are exercised by the Editor, and will be left with no doubt as to the thoroughness of revision. Once the form and plan of a Dictionary have been determined and its course has begun, there is hardly scope for criticism of a general kind, and, on the other hand, any adequate review of the contents is impracticable.

The present volume begins with Oxygen and ends with Rye. Looking through the list of contributors we find a fine warrant of authority for the chief articles, and here and there a reminder of the topics

that are new or have acquired increased importance in the last few years. A comparison of the present volume with the corresponding one of the preceding edition, however, does not reveal many major changes. It is perhaps not superfluous to remark upon the liberal interpretation which Sir Edward Thorpe gives to the term "Applied Chemistry," for this leads to the inclusion of a large element of theoretical matter which must be of interest and value to all chemists. This may be illustrated by a new article on Photo-Synthesis and Phyto-Synthesis by Professors Baly and Heilbron, as well as by many older ones that reappear. General technological questions are also discussed in such articles as that on Electrical Precipitation by Dr. H. J. Bush. When the chemical elements appear, as in the case of Phosphorus, Platinum, and Potassium, the general chemistry and chief compounds as well as the more strictly technological side are dealt with. The wide chemical appeal strengthens the position of the Dictionary as a standard work that will be looked for in every serious chemical library.

Sir Edward Thorpe is now nearing the completion of his task, and we are sure that all chemists will wish him well through the latest of the unceasing and multifarious labours which he has devoted for more than half a century, to the service of chemical science.

ARTHUR SMITHELLS

DIE FABRIKATION DER MARGARINE. By DIREKTOR P. POLLATSCHEK. Monographien aus dem Gebiete der Fett-Chemie, edited by Prof. K. H. BAUER. Vol. IV. Pp. 52. Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1923. Price bound, 2·20 marks, paper 1·80 marks.

This little work constitutes a brief essay on the manufacture of margarine, commencing with a short description of the raw materials used, including fats and auxiliary substances. Milk, which is of such vital importance to the margarine-maker, is discussed and, although in so short a work it is impossible to deal with so extended a subject adequately, a good idea is given to the reader of the quality of milk desirable and the method of treatment. Illustrations and descriptions of well-known margarine plant are given, and methods of manufacture of both animal and vegetable margarine are well described, including notes on methods of packing and distribution. Finally, the legal requirements as to margarine in various countries are contrasted, and a useful bibliography is appended. The pamphlet is undoubtedly of value to those who may require a brief and general survey of the art with information as to where further knowledge may be found.

E. R. BOLTON

Prof. W. L. Bragg, Langworthy professor of physics in the University of Manchester, is to give two courses in the summer session of the University of Michigan on X-ray crystal analysis and recent contribution in the field of X-rays and their interpretations.

COMPANY NEWS

DUNLOP RUBBER CO., LTD.

The profits for the eighteen months to December 31, less depreciation and after charging to reserve losses on forward contracts over market prices arising during the period, were £1,915,608 (£1,054,683 in the ten months to June 30, 1922). Debenture, income stocks, and loan interest totalled £463,816, leaving a net profit of £1,451,792. This is after providing for the preference dividend of No. 2 D. R. Cotton Mills (£86,363), but excluding the deficit of the American Co. for 1923, amounting to £383,179. This amount will be dealt with by the reconstruction scheme. The bankers' debt of £2,019,978 at June 30, 1922, has been discharged, and the company had on hand at December 31 cash and bills, War Loan, and bonds amounting to £1,024,405. Selling prices have been excessively low, chiefly owing to foreign competition. Further concentration of manufacture at Fort Dunlop is in progress. The rubber estates are stated to have shown a satisfactory profit. The French mills have attained a higher output. The German factory is stated to have been a source of continued anxiety, but it is hoped with the continued stabilisation of the rentenmark, to show a profit in the current year. The sales of the American factory are increasing. At the general meeting on June 16, the scheme for the reorganisation of the capital and for dealing with the preference arrears will be submitted.

UNITED PREMIER OIL AND CAKE CO., LTD.

The net profit for 1923 was £86,320 (against £90,649 in 1922), before providing for debenture interest (£22,855, against £23,301). The preference dividend takes £34,431 and a dividend of 5 per cent., less tax, is proposed on the ordinary shares (the same). The balance to be carried forward is slightly in excess of the amount brought in at £20,723.

BLEACHERS' ASSOCIATION, LTD.

The directors propose a final dividend of 15 per cent., making 20 per cent. for the year to March 31 last (the same as for the preceding year). It is proposed to place £125,000 to general reserve (the same) and £50,000 to superannuation fund (against £50,954), while £371,884 is carried forward (against £361,712).

REPORT

REPORT ON THE INDUSTRIAL AND ECONOMIC SITUATION IN CZECHOSLOVAKIA, FEBRUARY, 1924. By E. C. D. RAWLINS, Commercial Secretary, Prague. Department of Overseas Trade. Pp. 42. H.M. Stationary Office, 1924. Price 1s. 6d.

At the commencement of 1923 Czechoslovakia was faced with the economic problems raised by the sudden appreciation in value of the krone (*cf. Chem. and Ind.*, 1923, 1118). At this period the principal exports were coal, iron and timber to Germany, but with the complete collapse of the mark in the middle of 1923 such trade became impossible and Germany, which had absorbed 50 per cent. of the country's exports gave up the first place to Austria. The

United Kingdom has since taken the second place from Germany, though the latter country is still the principal supplier of imports. Czechoslovakia is mainly industrial and great efforts are being made to stabilise industries, though foreign competition and lack of markets abroad may cause the failure of some of the smaller enterprises.

Exports in 1923 were valued at K.č 12,517 millions, and imports at K.č 10,127 mill. (£1 = K.č 24 at par; about K.č 155 in 1923) against K.č 18,085 mill. and K.č 12,841 mill. respectively in 1922, when, however, the value of the krone was considerably less. The chief exports to Great Britain were sugar, glass, hides and leather, timber, and textiles, the articles mainly in demand from this country being textiles, iron and ironware, machinery and scientific instruments, colonial goods, and chemical products. Imports from Great Britain decreased considerably in 1923, but it must be remembered that local industries produce most of the classes of goods supplied from here, while some articles imported through Hamburg were probably considered as of German origin.

The steps taken by glass manufacturers have resulted in a remarkable recovery from the state of affairs at the beginning of 1923; in October 98 furnaces were working, the normal number being 138. Sugar production for 1924 is estimated at 9837 t., against the 1913 figure of 12,687 t., but considerably greater than in 1923. Trade in sugar is now unrestricted and farmers are finding its cultivation to pay better than that of wheat. A strike which lasted from August to October had an adverse effect on coal production; the total output in 1923 of hard coal, 11,596,000 t., was 1,600,000 t. greater than in 1922, but that of lignite fell by 2,700,000 t to 16,229,000 t. The iron industry suffered at the beginning of the year from having to dispose of stocks at low prices in order to keep the furnaces going; later the Ruhr occupation caused a big demand for iron, but the collapse of the mark resulted in the closing of the German market. The steel industry had a more favourable year. Export prices were good, better than those ruling inside the country, and the demand increased. Prices decreased in sympathy with the lessening in costs of raw materials, but further changes must depend on currency deflation.

FRENCH POTASH OUTPUT IN MARCH

During March the production of potash salts was 80,164 tons, equivalent to 21,591 t. of K_2O, distributed as follows:—Crude salts, 25,609 t; manure salts, 30,725 t.; manure salts, 10,058 t., and chlorides, 13,772 t. The four shafts of the Kali Ste. Thérèse now working, produced 442,956 t. of crude potash salts in 1923, against 382,000 t. in 1922. Sales were 367,195 t. of crude salts, equivalent to 65,658 t. K_2O. Stocks on December 31, 1923, were 9132 t. crude salts (3300 t. K_2O). During March the production of salt was 110,472 t., compared with 106,002 t. in February.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid Hydrochloric ..	3s. 6d.–6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. .	£21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric .. .	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations. 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali.. .	£6 15s. per ton. f.o.r. Special terms for contracts.
Bleaching Powder	Spot £11 d/d., Contract £10 d/d 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial	
Crystal . .	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.	
Industrial .	3s. 1d.–3s. 5d. per gallon, according to quantity.
Mineralised .	4s. 2d.–4s. 6d.
Potash Caustic	£30–£33 per ton.
Potass. Bichromate	5¼d. per lb.
Potass. Chlorate .	3d.–4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake.. ..	£3 10s. per ton d/d.
Soda Caustic, solid .	Spot lots delivered £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals .. .	£5 5s.–£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton, carr. paid.
Sod. Bichromate	4¼d. per lb.
Sod. Bisulphite Powder 60/62% . ..	£18–£19 per ton, according to quantity, f.o.b., 1 cwt. iron drums included.
Sod. Chlorate ..	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst. ..	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt kegs included.

RUBBER CHEMICALS

Antimony sulphide–	
Golden	5¾d.–1s. 1d. per lb., according to quality.

Crimson	1s. 3d.–1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24–£26 per ton according to quantity.
Carbon Black	6¼d.–6¾d. per lb. Market firmer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.–6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	45s. per cwt., barrels free. Dearer.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10–£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	4s. 10d. per lb. Easier.
Zinc Sulphide	7½d.–1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime–	
Brown	£11 10s. per ton d/d. Demand active.
Grey	£19–£20 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.–£9 per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. „ „ 24° Tw.
Red Liquor	10d.–1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha–	
Miscible	5s.–5s. 3d. per gall. 60% O.P. Market stiffer.
Solvent	5s. 6d.–6s. per gall. 40% O.P. Fairly good demand but little offering.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£49 per ton.

TAR PRODUCTS

Acid Carbolic–	
Crystals	6½d.–7d. per lb. Demand quiet.
Crude 60's	1s. 9d.–1s. 10d. per gall. Market flat. Only odd lots being offered.
Acid Cresylic, 97/99	2s. 1d.–2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.–1s. 11d. per gall. Steady demand.
Dark	1s. 8d.–1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil–	
Strained	9½d. per gall. Very quiet.
Unstrained	8½d.–9d. per gall.
Benzole–	
Crude 65's	10½d.–1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.–1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.–1s. 10d. per gall. ex works in tank wagons.
Toluole–90%	1s. 5½d. per gall.
Pure	1s. 10d.–2s. per gall.
Xylol comm.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote–	
Cresylic 20/24%	9d.–9½d. per gall. Few inquiries.
Middle Oil / Heavy / Standard Specification	7d.–9d. per gall. according to grade and district. Demand not so strong.
Naphtha–	
Solvent 90/160	1s. 4d.–1s. 5d. Market steady.
Solvent 90/190	1s. 1d.–1s. 2d. Fair business passing.
Naphthalene Crude–	
Drained Creosote Salts	£6–£6 10s. Demand falling off.
Whizzed or hot pressed	£9–£12 per ton. Little business.
Naphthalene–	
Crystals and Flaked	£16–£17 per ton.
Pitch, medium soft	52s. 6d.–57s. 6d. per ton. Market steadier. Few inquiries for forward delivery. Very little business for prompt.
Pyridine–90/160	21s. 6d.–22s. per gall. Demand well maintained.
Heavy	12s.–12s. 6d. More business passing.

INTERMEDIATES AND DYES

Business in dyestuffs has improved slightly during the week.

Deliveries are still only required in very small quantities owing to the desire of consumers to keep stocks down.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 6d. per lb.
Acid H.	4s. 4d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 2d.–1s. 3d. per lb. Steady.
Acid Sulphanilic	10d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.–8¼d. per lb. naked at works.
Aniline Salts	7¾d.–9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4¾d.–5¼d. per lb. Demand moderate.
m-Cresol 98/100%	2s. 1d.–2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.–2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	5s. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene 48/50° C.	8d.–9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. per lb. d/d.
Monochlorbenzol	£63 per ton.
β-Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.–5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.

Nitronaphthalene ..	.. 11¾d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p Nitro-*o*-amido phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine ..	4s. 2d. per lb. d/d.
p-Phenylene Diamine ..	10s. 3d. per lb. 100% basis d/d.
R Salt	.. 2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate ..	2s. 5d. per lb. 100% basis d/d.
o Toluidine ..	.. 8½d. per lb.
p Toluidine ..	.. 3s. 6d. per lb. naked at works.
m-Toluylene Diamine ..	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P. ..	£48 per ton.
Acid, Acetyl Salicylic ..	3s. 3d.– 3s. 5d. per lb. In good demand.
Acid, Benzoic B.P.	. 3s. 9d. per lb. Larger supplies available.
Acid, Boric B.P...	.. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 6½d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic ..	.. 3s. per lb. for pure crystal. Market very steady.
Acid, Pyrogallic, Cryst ..	7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic ..	.. Prices quoted from 2s. per lb. down to 1s. 9d. for ton lots. Market weak.
Acid, Tannic B.P	. 3s. per lb. Market quiet.
Acid, Tartaric	.. 1s. 1½d.– 1s. 2d. per lb. less 5%. Better tone but not yet very active. Cheap offers of second hand parcels of foreign acid. Higher prices expected in view of firmness of raw materials.
Amidol ..	.. 9s. per lb d/d.
Acetanilide	.. 2s. 3d. per lb. for quantity. Stocks are small.
Amidopyrin	. 13s. 6d. per lb. Neglected. Stocks low.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. per oz. for English make.
Barbitone .	. 15s. 6d. per lb. Quiet market.
Benzonaphthol .	. 5s 6d. per lb. Small inquiry.
Bismuth Salts .	.. A steady market. Prices according to quantity:
Bismuth Carbonate	.. 12s. 9d.- 14s. 9d. per lb.
„ Citrate .	.. 11s. 4d.- 13s 4d. „
„ Salicylate	. 10s. 2d. 12s. 2d. „
„ Subnitrate	.. 10s. 9d.- 12s. 9d. „
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides – .	.. Fluctuating market. Continental prices decidedly firmer.
Potassium ..	.. 11d. per lb.
Sodium .	.. 1s. „
Ammonium ..	.. 1s. 1d per lb.
Calcium Lactate..	.. Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate ..	.. 3s. 10d. per lb., duty paid. Advanced. Higher prices are quoted from the Continent.
Chloroform ..	.. 2s. per lb. for cwt. lots. Market more active. Makers busy.
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Formaldehyde ..	.. £57 per ton, *ex* works. English make.
Glycerophosphates –	Fair business passing.
Calcium, soluble and citrate free .	. 7s. per lb.
Iron .. .	. 8s 9d. per lb.
Magnesium ..	.. 9s per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. „
Guaiacol Carbonate	.. 12s. per lb for cwt lots Supplies not plentiful.
Hexamine ..	.. 3s. 9d. per lb. for English make. Market dull.
Homatropine Hydrobromide	.. 30s. per oz.
Hydroquinone ..	.. 4s. 3d. per lb. in cwt. lots. Foreign make.
Hypophosphites –	
Calcium .	3s. 6d. per lb., for 28-lb. lots.
Potassium .	. 4s. 1d per lb.
Sodium .	4s. „
Iron. Ammon. Citrate B.P.	2s. 1d 2s 5d. per lb, according to quantity. Advanced by 2d. per lb.
Magnesium Carbonate –	
Light Commercial	.. £36 per ton net.
Magnesium Oxide –	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £26 per ton, less 2½%.
Heavy Pure .	. 2s 2s. 3d. per lb., according to quantity. Steady market.
Menthol –	
A B.R. recryst. B P.	.. 60s. per lb. Weaker.
Synthetic ..	. 26s. 35s per lb., according to quantity. English make. Steady demand.
Mercurials	. Market firm.
Red oxide	.. 5s 3d. 5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d. 3s. 7d. „
White precip.	.. 4s. 7d.—4s. 8d. „
Calomel ..	. 3s. 11d. - 4s. „
Methyl Salicylate	.. 2s. 3d. 2s. 9d. per lb. for carboys. A slightly better market.
Metol ..	. 11s. per lb. British make.
Paraformaldehyde	.. 3s 6d. per lb. Better inquiry.
Paraldehyde	.. 1s. 4d - 1s. 6d. per lb. in free bottles and cases. Better demand.
Phenacetin .	. 6s per lb.
Phenazone .	. 7s 3d. per lb. for cwt lots. Quiet.
Phenolphthalein	.. 6s. 9d. 7s. 3d. per lb. In more plentiful supply.
Potass. Bitartrate 99/100% (Cream of Tartar) ..	.. 88s. per cwt, less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate ..	. 1s. 10d.—2s. 2d. per lb. Dearer.
Potass. Iodide	.. 16s. 8d. 17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	. 7½d per lb., 1 cwt. kegs included.
Potass. Permanganate	
B.P. Crystal ..	.. 8¾d. -9d. per lb. carriage paid.
Commercial .	.. 8d. 8¼d. per lb. carriage paid.
Quinine Sulphate	.. 2s. 3d. 2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin .. .	.. 5s. 6d. per lb
Saccharin. ..	.. 63s. per lb., in 50-lb. lots.
Salol .. .	.. 3s. 6d per lb. Very quiet.
Silver proteinate..	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	..2s. 6d. per lb. In steady demand for good qualities.
Sod. Citrate, B P.C., 1923	2s.- 2s. 2d. per lb., according to quantity. Much firmer in common with other citrates. Prices advanced by 2d. per lb.

Sod. Hyposulphite Photographic .	£13 £15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst	37s. 6d. 60s per cwt nett cash, according to quantity.
Sod. Nitroprusside .	16s. per lb. Less for quantity.
Sod. Potass Tartrate (Rochelle Salt)	77s 6d. 81s 6d per cwt , according to quantity. Market quiet.
Sod. Salicylate	Market easier. Powder 2s. 3d. - 2s. 6d. per lb. Crystal at 2s. 5d. 2s. 8d. per lb. Flake 2s. 9d.– 2s. 10d. per lb.
Sod. Sulphide Pure recryst . .	10d.- 1s. 2d. per lb., according to quantity.
Sod Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol . ..	15s. per lb. for good white crystal from ajowan seed. Very firm and scarce.

PERFUMERY CHEMICALS

Acetophenone .. .	12s. 6d per lb.
Aubepine .	14s. 6d ..
Amyl Acetate	2s. 9d. ..
Amyl Butyrate .	6s. 9d ..
Amyl Salicylate	3s. 3d. ..
Anethol (M P 21 22 C)	1s. 6d. ..
Benzyl Acetate from Chlorine free Benzyl Alcohol	3s. 3d. ..
Benzyl Alcohol free from Chlorine .	3s. 3d. ..
Benzaldehyde free from Chlorine .	3s. 6d ..
Benzyl Benzoate .	3s. 6d. ..
Cinnamic Aldehyde Natural .	15s. 6d. ..
Coumarin	20s ..
Citronellol .	16s. ..
Citral ..	10s. ..
Ethyl Cinnamate	15s ..
Ethyl Phthalate	3s. 3d. ..
Eugenol . .	11s. ..
Geraniol (Palmarosa)	35s ..
Geraniol .	11s -18s. 6d per lb.
Heliotropine . .	6s 6d per lb.
Iso Eugenol .	15s. 9d ..
Linalol ex Bois de Rose	28s. 6d. ..
Linalyl Acetate . .	28s 6d. ..
Methyl Anthranilate .	9s 6d. ..
Methyl Benzoate .	6s. ..
Musk Ambrette	48s. 6d. ..
Musk Xylol .	16s 6d. ..
Nerolin	4s. ..
Phenyl Ethyl Acetate	12s 6d ..
Phenyl Ethyl Alcohol	16s. ..
Rhodinol .	57s. 6d. ..
Safrol	1s 10d. ..
Terpineol	2s 9d ..
Vanillin	25s 3d – 26s 6d. per lb.

ESSENTIAL OILS

Almond Oil. Foreign S.P.A. ..	15s 6d per lb.
Anise Oil .. .	3s per lb
Bergamot Oil .	18s 6d per lb.
Bourbon Geranium Oil .	36s. 6d. ..
Camphor Oil .. .	75s. per cwt.
Cananga Oil Java ..	10s. 6d. per lb.
Cinnamon Oil, Leaf .	6½d. per oz.
Cassia Oil, 80/85% ..	9s. 3d. per lb.
Citronella Oil—	
Java 85/90% .. .	6s. per lb.
Ceylon	3s. 9d. per lb.
Clove Oil	7s. 6d. per lb.
Eucalyptus Oil 70/75%..	2s. 2d. per lb.
Lavender Oil	
French 38/40% Esters	27s. 6d. per lb.
Lemon Oil	3s. 2d. per lb.
Lemongrass Oil .	3d. per oz.
Orange Oil, Sweet .	13s. 9d. per lb.
Otto of Rose Oil -	
Bulgarian	27s. 6d. per oz.
Anatolian .	23s. 6d. per oz.
Palma Rosa Oil .	19s. per lb.
Peppermint Oil–	
Wayne County ..	21s. 6d. per lb.
Japanese . ..	16s. 3d. per lb.
Petitgrain Oil ..	10s. per lb.
Sandal Wood Oil -	
Mysore .. .	26s. 6d. per lb.
Australian . ..	21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than Aug . , they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. on June 19.

I.—Applications

Baker, Perkins, Ltd , and Head. Mixing apparatus 13,239. May 29.

Hailwood. Furnaces. 13,038, 13,039. May 28.

Hess. Regenerative furnaces. 12,988. May 27.

North British Diesel Engine Works (1922), Ltd., and Holloway. Centrifugal separators. 12,854. May 26.

Raymond Bros. Impact Pulverizer Co. Grinding or pulverizing apparatus. 13,265, 13,266. May 29. (U.S., 25-26.6 23.)

Rheinische Maschinenfabrik. Crushing mills. 13,112 May 28. (Ger , 28.5.23.)

I.—Complete Specifications Accepted

5108 (1923). Minimax Ges. Manufacture of foam for fire-extinguishing. (197,295.)

17,871 (1923). Carrier, and Carrier Engineering Co Drying and conditioning materials. (216,381.)

II.—Applications

Baird and Corthesy. Distillation of liquid hydrocarbons 13,261 May 29.

Calvert. Synthetic production of liquid hydrocarbons 13,374. May 31.

Davidson, Mielne, and Electrical Improvements, Ltd Fuel distillation 13,143. May 28.

Gregson, and Spencer-Bonecourt, Ltd. Installations for carbonising coal etc. 13,135 May 28.

Internationale Bergin-Compagnie voor Olie- en Kolen-Chemie. Process of treating carbon and hydrocarbons 13,095. May 28. (Ger., 31.5.23.)

King. Binder for manufacture of briquettes. 12,897 May 26.

Kung. Generating heating flames. 13,336. May 30

Marks (Carbide and Carbon Chemicals Corporation) Partial oxidation of gaseous hydrocarbons. 12,915. May 26

Raymond Bros. Impact Pulverizer Co. Pulverizing, feeding, and burning fuel. 13,264. May 29. (U.S., 8.3 24.)

Toogood. Carbonising plant. 13,170. May 29.

Wade (Streppel). Ovens for distillation of coal etc 13,094. May 28.

II.—Complete Specifications Accepted

35,310 (1922). Terrisse. Preparation of a carburetting fuel-mixture for internal-combustion engines. (216,169.)

722 (1923). Koppers Co. Vertical retort furnaces. (201,130.)

13,000 (1923). Comp. de Bethune. Recovery of the by-products of the distillation of coal. (209,703.)

17,665 (1923). Sutcliffe. Production of carbonised fuel. (216,378.)

19,963 (1923). Cabrier. *See* VII.

20,018 (1923). Fajole. Apparatus for producing semi-water-gas. (202,303.)

25,292 (1923). Barrett Co. Purifying hydrocarbons. (206,481.)

30,644 (1923). Crasoli. Water gas generators. (216,456.)

III.—Application

Baird and Corthesy. 13,261. *See* II.

III.—Complete Specifications Accepted

19,963 (1923). Cabrier. *See* VII.

25,292 (1923). Barrett Co. *See* II.

IV.—Application

Soc. of Chemical Industry in Basle. Manufacture of substantive azo dyestuffs. 13,360. May 30. (Switz., 27.7.23.)

IV.—Complete Specifications Accepted

5465 (1923). Meister, Lucius, u. Bruning. Manufacture of azo dyestuffs. (193,866.)

5731 (1923). Meister, Lucius, u. Bruning. Manufacture of azo dyestuffs. (195,600.)

14,945 (1923). Imray (Soc. Chem. Industry in Basle). Manufacture of naphthoindoxyls. (216,347.)

25,182 (1923). Meister, Lucius, u. Bruning. Manufacture of condensation products of the anthraquinone series. (205,502.)

V.—Applications

Courtaulds, Ltd., and Weyenbergh. Preparation of alkali celluloses. 13,331. May 30.

Courtaulds, Ltd., Bayley, and Hegan. Manufacture of viscose threads etc. 13,335. May 30.

Ges. fur Mechanische Zellulose. Manufacture of unbleached paper, cardboard, etc. 12,882. May 26. (Ger., 25.5.23.)

Ges. fur Mechanische Zellulose. Production of a half-stuff for cellulose manufacture. 12,883. May 26. (Ger., 25.5.23.)

Greenwood and Batley, Ltd., and Holt. Apparatus for spinning artificial silk. 13,383, 13,384. May 31.

Lilienfeld. Manufacture of artificial materials. 13,353, 13,354, 13,356, 13,359. May 30. (Austria, 4.4.24.)

Lilienfeld. Manufacture of cellulose derivatives. 13,355, 13,357, and 13,358. May 30. (Austria, 4.4.24.)

VI.—Application

Beckett, Thomas, and Scottish Dyes, Ltd. Dyeing. 12,914. May 26.

VI.—Complete Specifications Accepted

31,078 (1922). Moseley. Agents or assistants for detersive, scouring, bleaching, dyeing, and like operations. (215,880.)

22,314 (1923). Schlumpf. Apparatus for dyeing, bleaching, etc. (216,415.)

VII.—Applications

Jorgensen. 13,093. *See* IX.

Synthetic Ammonia and Nitrates, Ltd. (Collett). Catalysts for synthesis of ammonia. 13,167. May 29.

Synthetic Ammonia and Nitrates, Ltd. (Collett). Production of hydrogen. 13,168. May 29.

VII.—Complete Specifications Accepted

4873 (1923). Lamoreaux. Making sulphuric acid. (216,192.)

1983 (1923). Marks (Nitrogen Corporation). *See* X.

5286 (1923). Lamoreaux. Manufacture of sulphuric acid. (198,332.)

14,941 (1923). Urfer. Manufacture of catalysts for the synthesis of ammonia. (199,030.)

19,963 (1923). Cabrier. Distillation of ammoniacal liquids, tars, oils, and other liquids obtained in gas-works. (201,935.)

1644 (1924). Kautny. Devices for regulating the evaporation of liquid oxygen and the like. (216,463.)

19,834 (1923). Bass Akt.-Ges. Apparatus for producing anhydrous tin chloride. (201,927.)

IX.—Applications

Campbell, and Hardman and Holden, Ltd. Bituminous preparations, and their use in road making etc. 13,181. May 29.

Hay. Bituminous emulsions. 13,424, 13,425. May 31.

Jorgensen. Process of burning cement, lime, etc., and rotary kiln therefor. 13,093. May 28.

Mulligan. Manufacture of hydraulic cement etc. from gypsum. 13,048. May 28.

IX.—Complete Specifications Accepted

6966 (1923). Meadows. Composition for making or waterproofing roads. (216,245.)

21,391 (1923). Winqvist. Rotating kilns for burning cement etc. (203,673.)

X.—Applications

Baker. Electroplating. 12,917. May 26.

Baker. Method of determining boric acid in nickel-plating solutions. 12,918. May 26.

Brown and Wellesley. Alloys. 13,028. May 27.

Campbell. Manufacture of alloy steels. 13,361. May 30.

Campbell. Heating metal having magnetic properties. 13,362. May 30.

Hedges. Process of educting valuable ingredients from ores etc. 12,914. May 26.

Jackson (Stroman). Method of refining tin etc. 13,216. May 29.

MacKay. Electrochemical treatment of copper ores etc. 13,253. May 29.

Marks (Electro Metallurgical Co.). Welding and brazing copper etc. 12,916. May 26.

Seaton. Protection of metallic surfaces against corrosion. 13,315. May 30.

X.—Complete Specifications Accepted

31,843 (1922). Eureka Metallurgical Co. Flotation processes of recovering values from ores. (194,260.)

35,221 (1922). Edwards and Durant. Treatment of oxidised ores or other oxidised compounds of copper. (216,162.)

1983 (1923). Marks (Nitrogen Corporation). Manufacture of steel and fixation of nitrogen. (216,198.)

5702 (1923). Gordon and Keith. Treating ores etc. (216,228.)

19,283 (1923). British Thomson-Houston Co., Ltd. (General Electric Co.). Alloys. (216,389.)

XI.—Applications

Baker. 12,917. *See* X.

Baker. 12,918. *See* X.

Brown, and Telegraph Condenser Co., Ltd. Insulating and di-electric materials. 13,226. May 29.

Ellis (Roessler and Hasslacher Chemical Co.). Electrolysis. 13,140. May 28.

Jones (Manhattan Electrical Supply Co., Inc.). Dry cells. 13,017. May 27.

MacKay. 13,253. *See* X.

Rennerfelt. Electric arc furnaces. 13,129. May 28.

XIV.—Application

Traube. Production of rubber from latex. 13,267. May 29.

XV.—Complete Specification Accepted

32,214 (1923). Elektro Osmose Akt.-Ges. Manufacture of gelatin suitable for emulsions. (210,748.)

XIX.—Applications

Milner and Munroe. Methods of sterilising and preserving foods. 13,074, 13,075, and 13,076. May 28.

XIX. Complete Specification Accepted

1988 (1924). Thésée. Sterilising-medium. (216,464.)

XX.—Application

Carpmael (Chemische Fabrik auf Actien vorm. E. Schering). Manufacture of compounds of 4 amino-2 argentomercapto-benzene-1-carboxylic acid and alkali salts thereof. 13,345. May 30.

XX.—Complete Specifications Accepted

16,587 (1923) Imray (Meister, Lucius, u. Brüning). Manufacture of ethyl chloride. (216,368.)

26,163 (1923) Poulenc Frères, and Oechslin. Manufacture of oxyethylarsinic acid. (206,143.)

XXI.—Application

Thornton. Non inflammable kinematograph films. 13,192. May 29.

XXI.—Complete Specifications Accepted

21,898 (1923). Kalmus, Comstock, and Wescott, Inc. Photographic developing processes. (204,034.)

32,214 (1923) Elektro Osmose Akt Ges. *See* XV.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific number:— *Argentina*: Artificial silk (646); *Austria*: Steel (625); White lead, pig lead, oil, chemicals (627); *Belgium*: Phosphor bronze cable (B.X. 1009); *British India*: Lead, steel (Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); *Canada*: Silk (618); Leather (621); *Chile*: Steel (648); *Damascus*: Silk (643); *Denmark*: Iron and steel (630); *Dominican Republic*: Silk (649); *East Africa*: Agricultural implements (622); *Netherlands*: Sugar (634); *New Zealand*: Hardware (623); Electrically-driven centrifugal pump (A.X. 1001); *Norway*: Leather (638); *South Africa*: Electric lamps (B.X. 1011); *United States*: Hardware (645); *Uruguay*: Copper wire (B.X. 1005).

Further enquiries are as follows: *Argentina*: Tinplate (669); *British India*: Steel, brass (The Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); *France*: Copper sulphate, sulphur (656); *Morocco*: Hides, skins (665); *Poland*: Perfumes (660); *Rumania*: Galvanised iron wire (A.X. 1025); *Switzerland*: Aluminium (A.X. 1031); *South Africa*: Silk (652); *Turkey*: Agricultural machinery (A.X. 1028); *Venezuela*: Earthenware (673).

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during May, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 596, of which 491 were from merchants or importers. To these should be added 32 cases outstanding on May 1, making a total for the month of 628. These were dealt with as follows:—

Granted—476 (of which 429 were dealt with within 7 days of receipt).

Referred to British makers of similar products—136 (of which 117 were dealt with within 7 days of receipt).

Referred to Reparation Supplies available—7 (all dealt with within two days of receipt).

Outstanding on May 31, 1924—9.

Of the total of 628 applications received, 553 or 86 per cent. were dealt with within 7 days of receipt.

Trade Information

The Dorr Company, Engineers, of New York, announces that its continued growth has required a further expansion of the Executive Department. Mr. J. V. N. Dorr, President and General Manager since the foundation of the company, has appointed Dr. R. B. Moore, at present head of the Development Department, as General Manager. Mr. H. N. Spicer, of the Executive Staff, will sail on June 4 to London, as the first step of a tour of Europe that will take from four to six months, and will cover practically every important industrial section of the Continent. Mr. Spicer will make a special business survey, both in a general way and in connexion with the Dorr Company's European business. He will make his headquarters in London, at 16, South Street, E.C., but will spend most of his time in Spain, Italy, Austria, Czechoslovakia, Poland, and Germany.

French Company News

The Société des Mines de Dourges lit two new batteries, each of 42 coke ovens in August and October, 1923, and a third battery of 50 ovens is now ready, and a fourth of 50 ovens is under construction. To ensure complete use of by-product gas and tar the company has acquired interests in the Société Ammonia and in the Société Huiles, Goudrons et Dérivés, and will shortly begin to build a synthetic-ammonia plant. The company will also share the use of a tar distillery at Vendin le Vieil, which will be provided with ample plant for the manufacture of a range of tar products.

The Société de Pechelbronn is now producing at the rate of 3600 metric tons of crude oil a month. The company's refinery is working satisfactorily, and the more valuable products are now being obtained in larger proportion.

PUBLICATIONS RECEIVED

The Specific Heats of Gases. By J. R. Partington, M.B.E., D.Sc., and W. G. Shilling, M.Sc. Pp. 252. London: Ernest Benn, Ltd., 1924. Price 30s.

A Short History of Chemistry. By Rose Stern, B.Sc. Pp. viii+149. London: J. M. Dent and Sons, Ltd., 1924. Price 2s. 6d.

Mechanical Refrigeration. By Hal Williams. A practical study of cold storage and ice making in all their aspects. Revised edition. Pp. x+501. London: Sir Isaac Pitman and Sons, Ltd., 1924. Price 20s.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

Vol. 43 NEW SERIES LONDON, JUNE 20, 1924 No. 25

EDITORIAL

WE have received from Prof. Bancroft a reprint of a paper on the Action of Metals on Nitric Acid, published in the *Journal of Physical Chemistry* in May this year. This gives copious extracts from the statements in sundry books and papers on this topic, and a critical examination of them. Different writers have considered the reduction of nitric acid by metals, by hydrogen and by metallic nitrates, without arriving at unanimity. Although the main features are known to all chemists, the principles are only now being made clear and a survey of the work is of great value. Prof. Armstrong about forty-seven years ago made some experiments on the effect of metals on nitric acid: he concluded that these formed nitrates in the usual manner and that the hydrogen produced by the change reduced the nitric acid to nitrous acid, hyponitrous acid, hydroxylamine and ammonia, or some of these, in proportions depending upon the metal employed and other circumstances. Several years later came the theory of ionic dissociation, and the suggestion by Ostwald that nitric acid in presence of a metal splits up into the ions $\cdot$HO and NO_2, and that the various products obtained when a metal is dissolved in nitric acid are the secondary compounds resulting from the interaction of these ions and others. Armstrong's views about the dissociation hypothesis are well-known; how often has he told us, "I know not if in others' eyes it seem'd almost divine, but far beyond a doubt it lies that it did not in mine." Thereafter many experiments were made on metals and nitric acid, but according to Bancroft, each chemist merely used to "smile and look politely round to catch a casual suggestion, but made no effort to propound any solution of the question." Bancroft has long pondered over the problem, and with the assistance of Mr. Milligan he thinks he has got on the right track: new methods of analysis have been devised, and we are promised shortly an account of the reactions which indeed are complex and affected by a number of variables. Already he confirms Armstrong's 1877 account, and his full memoir will be awaited with interest. Does not this piece of work show how many opportunities for research are close at hand, and "what man might be, would he but do the duty that lies near, and cut clubs, cards, champagne, balls, billiard-rooms and beer?" This quotation would perhaps make a suitable motto for No. 2, Whitehall Court.

There are many other problems concerning the commonest reagents awaiting explanation. Does ammonium hydrate exist? The statements about this material are singularly conflicting, and an exact knowledge of the behaviour of such substances as nitric acid, ammonia and water would be of the greatest benefit to us all.

* * *

The Annual Meetings of the International Union of Pure and Applied Chemistry have been so delightful and valuable that those who have participated in them have hitherto avoided any criticism. A correspondent who has attended several of these meetings directs the attention of chemists to some matters which require serious thought. We well remember the early meetings in Paris and London which laid the foundations of the International Union, and we think the most sanguine of those who were present did not expect the steady and rapid success which has been attained. A constitution and a method of conducting the business of the Union were devised, admirable for a young society whose numbers were comparatively small. Prof. Moureu, the first president of the Union, worked so hard during his term of office that the Union has now become large, expensive, important and cumbrous. Sir William Pope, now president, is proceeding along the path marked out by his predecessor and, in the opinion of some, it will

only be a question of a few months or possibly a couple of years before the Union Internationale will begin to pay the penalty for rapid and abundant success. An army cannot march with the speed and ease of a regiment or a squadron. It must be content with many restrictions; nevertheless, it goes further and accomplishes more. The importance of its decisions are so great and the consequences so serious that many must be consulted and much time spent. The little squadron which Moureu commanded has already grown to the dimensions of a brigade and threatens to become a division. It may be worth while to consider whether its original conception is still adequate for effective working and we have heard from two or three chemists whose opinions are of value that the time is ripe for an effort to make its organisation and methods more suitable to its present dignity and importance. That such opinions can be held so soon after the foundation of the Union is a striking testimony to the sturdiness of its growth and to the tact and enthusiasm displayed by the Bureau and officials of the Union.

* * *

A teacher criticises the price of "Chemistry in the Twentieth Century." This book is a handsome production of some 280 pages, well written, well printed, and with some excellent illustrations; it costs 15s. net. We have compared it with some recent chemical and engineering books published by Messrs. Blackie and Son, Sir Isaac Pitman and Sons, Ltd., Messrs. Charles Griffin and Company, Ltd., John Wiley and Sons, Inc., Messrs. Longmans, Green and Co., and Macmillan and Co., Ltd., and think that taking everything into consideration this is a cheaper book than the average high-class scientific book published during the last two years. We are informed, and verily believe, that the contributors to this book did their work gratuitously, that knowledge might be increased, and that if they had been paid for their contributions, either what these are worth, or what it is usual to pay Fellows of the Royal Society and Knights of the Shire, the cost of the book would have considerably exceeded the 15s. fixed by the publishers in consultation with the Association of British Chemical Manufacturers. This Association is composed of acute business men, and it is quite possible that no other organisation could have made so satisfactory a bargain. The book, admirable as it is, is not intended for the junior members of the chemical fraternity; for these a set of pamphlets has been prepared at the price of sixpence each, and a considerable number has been sold at Wembley and elsewhere. The Association of British Chemical Manufacturers has catered for two important classes, there is, we admit, an intermediate class for which many books are published at different prices. During the last few years several chemical treatises have been published at prices between a shilling and ten shillings. Why—to travesty Courteline—should anyone pay seven or eight shillings for an umbrella when he can get "Chemists and Their Work" or *Chemistry and Industry* for sixpence!

A SIMPLE DEDUCTION OF THE LAW OF SOLUBILITY PRODUCT

By J. A. V. BUTLER, M.Sc.

The old deduction of the law of solubility product which is given in practically all textbooks of physical chemistry rested on the application of the law of mass action to two equilibria. In the first place it was assumed that the concentration of undissociated salt in solution was proportional to the "active mass" of the solid, *i.e.*, that the undissociated molecules had a definite solubility. Secondly the law of mass action was applied to the equilibrium between the undissociated salt and its ions. Thus representing concentrations in square brackets,

$$[MX]=k_1\,[MX]_{solid}$$

$$\frac{[M^{\cdot}]\times[X']}{[MX]}=k_2$$

$$\text{Therefore } [M^{\cdot}]\times[X']=K.$$

The incorrectness of both of these applications is now beyond dispute. The extensive researches of Noyes and others (*J. Amer. Chem. Soc.*, 1911 *et seq.*) proved that the concentration of undissociated salt (as determined by conductivity measurements) is certainly not constant. It was realised almost from the first that the law of mass action does not apply to the equilibrium between a salt and its ions.

Most teachers have probably felt the unsatisfactory nature of this treatment. But the relation had to be deduced somehow even if the inadequacy of the proof was so glaring as to make it necessary to apologise for it in elementary classes. It is scarcely productive of a proper respect for a subject to have to make apologies of this sort and it is thought that a simple deduction which is free from these objections and sufficiently elementary for beginners may be of interest.

This deduction is based on the more elaborate statistical treatment recently given by the writer (*J. Phys. Chem.*, 28, 438, 1924). It assumes that the ions of a simple salt take part independently in the process of solution at the crystal surface. Modern knowledge makes this conception inevitable. If the salt is almost or entirely dissociated into ions in solution, and if the solid crystal is rightly regarded as a lattice structure built up of positive and negative ions, there is no reason to postulate the appearance of the molecule at any stage in the process of solution.

An ion leaves the surface and passes into solution when it has acquired by thermal agitation sufficient energy to carry it out of the range of the attractive forces at the crystal surface. An ion becomes deposited when it reaches the surface from solution at a place at which it can become permanently attached. In the simplest case of a cubic lattice a positive ion must be deposited above a negative one and *vice versa*, in order to continue the crystal lattice. It follows that the rate at which an ion leaves the surface is proportional in the first place to the number in the surface layer, whilst the rate of deposition of an ion is proportional to its concentration in solution and to the number of places at the surface at which it can become attached.

Equilibrium is attained when equal numbers of both kinds of ions are dissolved and deposited in the same time.

Now consider the state of the crystal surface in contact with the solution. Take the case of a crystal normally containing equal numbers of positive and negative ions in its surface layer. In contact with solution there may be a greater tendency for the one ion to leave or to become deposited at the surface than the other. The facility with which precipitates of insoluble salts adsorb a common ion is well known. Fajans and Frankenburger (Z. phys. chem., **105**, 255, 1923) have recently determined the amount of silver ion adsorbed by silver bromide crystals and found for one particular dilute solution an adsorption of one silver ion for every four to ten bromide ions of the exposed surface.

The result may be roughly illustrated as follows: I shows a cross-section of the two layers next to the surface of a complete crystal; II the same for a crystal with an incomplete surface layer which has lost more positive than negative ions.

I

− + − + − + − + − +
+ − + − + − + − + −

Exposed, 5 +, 5 −.

II

− +   + − + − + − +
− + −   −

Exposed, 3 +, 5 −.

It is evident that the loss of a positive ion exposes a negative ion and *vice versa.*

Suppose that at equilibrium Nx positive ions and N (1 − x) negative ions are exposed at the surface. Then we can write the following proportionalities:—

Rate of solution of positive ions = k_1Nx,
Rate of deposition of positive ions = $k_2N(1 - x).C_1$,
Rate of solution of negative ions = $k_3N(1 - x)$,
Rate of deposition of negative ions = k_4NxC_2;
where C_1 and C_2 are the concentrations of the positive and negative ions in solution.

For equilibrium

$$k_1Nx = k_2N(1-x)C_1$$

and

$$k_3N(1-x) = k_4NxC_2$$

whence

$$C_1 \cdot C_2 = \frac{k_1k_3}{k_2k_4} = K$$

which is the law of solubility product.

It is evident that if the addition of electrolytes whether containing a common ion or not causes any change in the conditions of solution (*e.g.*, by affecting the attraction of the solvent for the ions), the quantities k_1, k_2, etc., will not remain constant. The fact that the "law" is at best an approximation need cause no surprise. Some of the factors affecting the solubility product have been discussed from this point of view in the paper referred to.

Chemistry Department,
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ABSORBENT AND DECOLORISING CARBONS

By E. R. SUTCLIFFE, Wh.Ex., A.M.I.M.E.

In view of the interest now being taken in absorbent materials generally the following notes on carbons made at Leigh will be of interest.

These carbons are a development of work done during the war when it was found necessary to have some more highly active material than the charcoal then in use, and, furthermore, to render the country less dependent upon expensive foreign carbons.

It was then found that by the briquetting and carbonisation of coal a special structure could be produced, and that by suitable slow oxidation this structure could be deepened and rendered quite as active for absorbent purposes as any of the then known absorbent carbons, so material was then produced and supplied to the Anti-Gas Department of a power some seven or eight times more active than that then in general use.

On the termination of hostilities a large installation for the production of this highly active material was in course of construction, and it is in adapting this plant and invention to peace purposes that Sutcliffe, Speakman and Co., Ltd., have now turned their energies.

Further research showed that the carbon manufactured under the process was not only of high absorptive power, but that by modifying the process the highest qualities of carbon for decolorisation could be made, and in recent developments carbon has been made equal and in some respects superior to the highest quality of zinc-activated foreign carbon.

Absorbent Carbons

Absorbent carbons are made in many forms and qualities, and the development of grading and quality will depend largely upon demand and the purposes that open up for their use. An advantage in the carbon made under the process is that it can be made in any grade from sizes 2½ in. to the familiar 6 to 12 in. mesh, or if required special shapes of block carbon can be made.

No universal standard for absorptive power is adopted at present, but the highest qualities are quite equal to the highest quality of activated coconut char, and in small quantities material of super-activity has been made. The highest quality is suitable for gas masks, and for an absorbent for the more expensive solvents. A lower grade is more suitable, say, for benzol recovery at gas works or oil works. Other grades of less costly carbons are available for use in treatment for water purification, such as treating chlorinated water, or for extracting naphthalene.

Decolorising Carbons

These are made in granular form or as powders. One form of granular carbon possesses about three to four times the decolorising power of animal charcoal. Another type, of harder quality but less power when compared with animal charcoal, gives the following comparison:—

It possesses less power than animal char in taking out up to 50 per cent. of the colour of a raw sugar solution. It possesses equal power to animal char in taking out up to 75 per cent. When used for a finisher for extracting say the final 25 per cent. of the colour, it possesses about five times the power of animal charcoal. In general, these carbons are inferior for taking out heavy colours, but possess many times the power for taking out light colours, as compared with animal char. It would appear that where possible an economic use could be found for treating sugar and similar solutions, first by animal char for extracting heavy colours, and using these granulated carbons as a finisher, for which purpose they are superior to animal char.

Finely ground carbons are made in a number of qualities. The lowest quality is equal to most of the imported foreign carbons. A second grade is a very high-quality carbon, having roughly twice the decolorising power of the lowest quality, and is very suitable for glycerin, oils and fats. There is another carbon about equal to the second quality, but only of use for oils and fats.

A special, very powerful carbon which is only available in limited quantities has about three times the decolorising power of the lowest quality. A further special carbon, also available in very limited quantities, is the most powerful known decolorising carbon for taking out final traces of colour; it surpasses any other quality of carbon.

It cannot be said that the above exhaust the qualities available, for constant research is being carried out on uses to which these substances may be put, and the possibilities are by no means yet exhausted.

Strange to say, the absorbent and decolorising powers do not seem to have any direct relationship; this may only be due to the difficulty in arranging a comparative test, absorption being usually measured by taking the time that a given carbon will hold back a given vapour and permit none to pass, whereas in decolorisation the percentage of colour removed is determined, and this involves a condition of equilibrium.

Absorptive and Decolorising Power

It would appear that the absorbent and decolorising power depend upon the dimensions of the minute pores that the carbon possesses, and these dimensions evidently vary, depending on the way in which the carbon is made.

Professor Williams in his recent paper describes the pores in silica gel as being probably long wedge-shaped capillaries. This explanation of a material in which the pores are formed by slow drying and by the application of heat from the exterior seems an excellent one. In carbon the porosity is produced first by slow evolution of the primary volatile matter, which no doubt produces or forms similar tapered capillaries as the substance contracts. The final evolution of the residual volatiles, however, does not cause a contraction, and it might be assumed that the secondary capillaries are parallel and will vary in dimensions and number depending upon the shrinkage the carbon first undergoes in its primary treatment.

The final activation by slow oxidation is an action upon the surfaces of these capillaries, leaving them in a lace-like formation presenting an enormous surface.

Assuming the above explanation to be the true one, then there is evidence to show that :—

1 High vapour absorption is associated with small primary capillaries.

2 High decolorising power is associated with larger primary capillaries.

3 Too great a development of the primary capillaries reduces the value of the carbon for both purposes.

Generally speaking, the highest absorption carbon possesses low decolorising power when measured by standard laboratory decolorising tests, and this applies equally to coconut and other shell charcoal on the other hand, a high decolorising carbon possesses fair absorption powers for vapours.

There is an enormous field open for absorbent materials, particularly for solvent recovery. There are undoubtedly many works in this country to-day where recovery of the solvent wasted would pay for the installation of plant to recover it in one year's work.

It is not generally appreciated that, for benzol recovery at coke ovens, in most works the use of carbon following the present oil washers would result in the recovery of a further half gallon of oil per ton of coal.

ISOTOPES

Dr. Aston announced in last week's *Nature* the results of further work on isotopes. He confirms the existence of an isotope of iron of mass 54. Strontium has two isotopes of masses 88 and 86. Barium is a simple element of mass 138; lanthanum is a simple element of mass 139; praseodymium is probably simple and has a mass of 141, neodymium gives an indistinct band 142 to 150 suggesting several isotopes and erbium seems to contain isotopes from 164 to 176.

It is interesting to find that the elements whose atomic numbers are 57 and 59 are simple and their masses differ by two units only. The isotopes which have odd atomic numbers have nearly always isotopes whose masses are all odd numbers; lithium, boron and nitrogen are the exceptions. In almost every case there is an isotope which differs from an isotope of the adjacent odd numbered element by four units. The rare earths in this respect also seem to be nonconformists. There is hardly yet absolutely conclusive evidence to prove whether there are two concurrent lines of elements, the odd and the even, differing from each other by four units at least or one line with a difference of two units at least. Dr. Aston will some day clear up this point. For the convenience of our readers we append a list of the isotopes now known, mainly

taken from Dr. Cranston's book on "The Structure of Matter."

Element	At. number	At. weight	Masses of isotopes in order of intensity of spectral lines
H	1	1·008	1·008
He	2	4	4
Li	3	6·94	7, 6
Be	4	9·1	9
B	5	10·9	11, 10
C	6	12·005	12
N	7	14·008	14
O	8	16	16
F	9	19	19
Ne	10	20·2	20, 22
Na	11	23	23
Mg	12	24·32	24, 25, 26
Al	13	27	27
Si	14	28·1	28, 29, (30)
P	15	31·04	31
S	16	32·06	32
Cl	17	35·46	35, 37
A	18	39·9	40, 36
K	19	39·1	39, 41
Ca	20	40·07	40, (44)
Sc	21	45·1	45
Ti	22	48·1	48
V	23	51	51
Cr	24	52	52
Mn	25	54·93	55
Fe	26	55·84	56, 54
Co	27	58·97	59
Ni	28	58·68	58 60
Cu	29	63·57	63, 65
Zn	30	65·37	64, 66, 68, 70
Ga	31	70·1	69 71
Ge	32	72·5	74, 72, 70
As	33	74·96	75
Se	34	79·2	80, 78, 76, 82, 77, 74
Br	35	79.92	79 81
Kr	36	82·92	84, 86, 82, 83, 80, 78
Rb	37	85·45	85 87
Sr	38	87·63	88 86
Y	39	89·33	89
Ag	47	107·88	107 109
In	49	114·8	115
Sn	50	118·7	120, 118, 116, 124, 119, 117, 122, (121)
Sb	51	121·77	121 123
I	53	126 92	127
X	54	130·2	129, 132, 131, 134, 136, 128, 130, (126), (124)
Cs	55	132·81	133
Ba	56	137·37	138
La	57	138·9	139
Pr	59	140·9	141
Nd	60	144·3	142—150
Er	68	167·7	164—170
Hg	80	200·6	(197—200) 202, 204

The isotopes of the first thirty-nine elements are now known; the next three are zirconium, niobium and molybdenum: Dr. Aston has more than once tried to record their isotopes but, so far, without success. The next element, whose atomic number is 43, has not been discovered. A number of isotopes of lead, bismuth, radium, thorium and uranium have been identified but there may be other isotopes of these elements of whose existence we are as yet ignorant. It will be interesting when Dr. Aston investigates the isotopes of lead, a metal which occupies a prominent position in the history of isotopy.

ASCARITE

An Absorbent used in the determination of Carbon in Steel by the direct combustion method

By JAMES B. STETSER

During the progress of the world war the enormous expansion of the steel industry of the United States caused a great increase in the amount of analytical work to be done in the laboratories of the various steel plants of that country. This increase was caused not only by enlarged tonnage, but also by more rigid specification both physically and chemically for the steel produced for the allied armies. While the work was increased, there was an actual decrease in the number of qualified laboratory men, due to the great need for chemists in the various wartime chemical industries. It became necessary under these circumstances, not only to increase the accuracy of the tests in order to meet specifications, but also to simplify methods to such a degree that the test could be run accurately by partially-trained men.

It will be easily understood then why it became necessary for the writer, during the early years of the war, while connected with the Penn Seaboard Steel Corporation as metallurgist, to turn his attention to the problem of determining the percentage of carbon in steel, in order to simplify if possible the methods then in use. The Eggertz or colour method, based on the assumption that the carbon in steel when dissolved in dilute nitric acid will give a depth of colour that varies almost directly as the percentage, had to be entirely abandoned. The results obtained by this method on normalised or slowly-cooled steels were reasonably accurate, provided the usual precaution was observed of having the standard and the sample of the same type of steel and the carbon contents approximately equal. However, it took a man with a well-trained eye to use this method even when the carbon content was not over 0·50 per cent. The main difficulty was experienced with the quickly-cooled furnace preliminaries, even when these samples were cooled with compressed air. As the Eggertz method gives a different depth of colour according to the form in which the carbon exists, large errors were found in the results on these furnace tests, due to the fact that the carbon might exist in any form from sorbite to martensite. It proved impossible to cool each test in practice so that the carbon was always in the same form, and hence it was useless to try to provide a standard of like heat-treatment.

Although the combustion method was accurate, it was found necessary to reduce the time taken to run the test, as the method then in use required from ten to twenty-five minutes for each test. When the time necessary to take the test, prepare the sample and report the tests was added to this, it was found that a test could not be reported in less than fifteen minutes from the time it was taken. This interval was too great, as furnace changes took place which might cause a variation from the desired carbon content, and costly delay was sometimes caused by waiting for laboratory results when the furnaces were ready for additions.

Experiments showed that the carbon in a steel sample could be completely burned to carbon dioxide in less than two minutes after it was introduced into the furnace, provided there was free access of oxygen and the furnace temperature was around 950° C. This fact was of little value due to defects in the absorbents then in use. In using the Vanier bulb, the most efficient of the potash bulbs, it was found that at least six minutes were required to wash all carbon dioxide from the train, and even then there was some time lost due to escape of water. Gas could be passed through soda-lime at a rate sufficient for our requirements. This absorbent, however, had other defects—it required phosphorus pentoxide as a dryer which had a tendency to channel and lose water. This was a serious defect as furnace preliminaries were not checked and an error in one of them, if undetected, could cause considerable loss. Also the more efficient soda-limes contained from 5 to 15 per cent. of moisture, which increased the liability of loss. The necessarily heavy weight of absorbent and absorption vessel caused difficulty in weighing as the balance decreased in sensitiveness.

Up to this time, all use of caustic soda or caustic potash as an absorbent had been in the form of a solution in some type of potash bulb. We now experimented to see if these reagents could not be used in some solid form which would probably have little need of an extra dryer. Mixtures with asbestos gave some promise, and a type was finally evolved which needed no drier whatever, and at the same time was marked by the rapidity with which it absorbed carbon dioxide. At the same time, it had another peculiar property that was of considerable value: namely, that the absorbent changed in colour as it became saturated with carbon dioxide. On account of the sharply-defined division of the used and unused portions, it was easy to determine when it was necessary to recharge the absorption bottle. This material, being ideal for our purpose, was put into use in the laboratory using a modified train of our own design, and methods of procedure which had been simplified and standardised.

In estimating the speed with which carbon determinations might be made with this absorbent, standard steels from the U.S. Bureau of Standards were checked in an actual running time of two minutes, but the method adopted allowed a running time of three and one-half minutes, a measured amount of oxygen being used to sweep all carbon dioxide from the train.

When this absorbent had been in use in the laboratory for about one year, an article was published in the *Iron Age* of August 22, 1918, describing our method of determining carbon in the hope that it might prove of interest and value to other steel works chemists. There being numerous requests for the absorbent, it was put on the market under the trade name of "Ascarite," and its use spread so rapidly that it is now used in the majority of the steel laboratories of the United States. Ascarite is distributed by the Arthur H. Thomas Co., West Washington Square, Philadelphia, U.S.A., and supplies can be obtained in Great Britain from the District Chemical Co., Ltd., 1, Fenchurch Avenue, London, E.C. 3.

NOTES FROM WEMBLEY

A collection of apparatus and research chemicals from the University of Birmingham has now been added to the scientific exhibit in the chemical section of the Palace of Industry, in the British Empire Exhibition. Autoclaves, furnaces, turbines and an electric control for vacuum distillation are among the apparatus shown, and the research chemicals include a number of interesting complex salts of cobalt, trimethylstibine, and other specimens illustrating the chemistry of selenium, tellurium, molybdenum and zirconium. Visitors will find many chemicals of topical interest.

Another noteworthy exhibit in the scientific exhibit is to be found in the exhibit of explosives, collected by Sir R. Robertson. This is Dr. B. Flürscheim's exhibit of tetranitroaniline (TNA), which he discovered. Tetranitroaniline is the most powerful solid explosive which has yet been manufactured. The reactions by which the explosive is produced, and those by which it is transformed into other substances, are shown, together with a table giving the relative strengths of TNA and other nitro-compounds.

One is accustomed to the appearance of rubber in the most unexpected places and forms, but a garden made entirely of rubber is a novelty that suggests great possibilities when one considers the "standard" weather. Those who wish to see this "rubber garden," must go to the stand of the North British Rubber Co., Ltd., in the Rubber Section in the Palace of Industry, where they will find an old-world garden with a "crazy" paving path through a lawn, with borders of flowers, with rambler roses and clematis climbing up a loggia, and a fountain, complete with water-lilies and goldfish. Everything—earth, grass, flowers, foliage, crazy paving, fountain, lilies and goldfish—all made of rubber, and very effective, too.

Mention should be made of an artistically-produced booklet illustrating the products of the Washington Chemical Co., Ltd., Washington Station, County Durham, the manufacturers of the well-known "Pattinson's" magnesia. This company, which is not far short of its centenary—it was founded in 1840 by two Fellows of the Royal Society, H. L. Pattinson and R. S. Newall—describes the various kinds of magnesia and magnesium carbonate that it makes in the booklet, which contains illustrations of the firm's works, quarries, laboratory, and provides much interesting, as well as useful information for buyers. It is worth noting that the Washington Chemical Co. invites correspondence regarding new or extended uses for its products in industry or pharmacy.

Those who wander in other parts of the Exhibition should not fail to visit the stand of the Non-Ferrous Metal Trades Joint Committee, on which the Institute of Metals has a remarkable display, illustrating the corrosion of condenser tubes. Diagrams and actual specimens are provided to illustrate each type of corrosion, and the formation of scale. Of great interest is the series of specimens of aluminium treated so as to be resistant to sea-water. A means has now been found of not only making aluminium

resistant to corrosion, but of colouring it. Indeed, it is suggested that coloured aluminium could be used in thin sheets for decorative panelling and even as wallpaper. It should be noted that the Institute of Metals has prepared a booklet admitting visitors to the meetings and library of the Institute during the period of the Exhibition. These booklets can be obtained either from the Institute, 36, Victoria Street, S.W. 1, or from Stand 237, Palace of Engineering.

Agriculture does not lend itself very well to exhibition, but the display provided by the Ministry of Agriculture in the Government Pavilion is worth a lengthy visit. Rothamsted, of course, looms large, with an excellent exhibit designed to illustrate the properties of the soil and some of the methods used for its improvement, but there are also displays relating to plant and animal health and improvement, diseases and pests of animals and plants, farm engineering and agricultural economics. There are kinematograph films and a useful guide-booklet to help the visitor.

FORTHCOMING EVENTS

June 25 BRITISH EMPIRE EXHIBITION. Conferences on "Heredity as the Basis of National and Industrial Efficiency," to be held in Conference Hall 3, at Wembley.

July 9–12 SOCIETY OF CHEMICAL INDUSTRY, Annual General Meeting to be held at Liverpool

July 15. THE INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (LONDON). Visit of Chemical Students to Wembley. At 9.45 a.m. an Inaugural Meeting will be held at University College, Gower Street, W.C. 1, at which the President of the Institute, Prof. G. G. Henderson, LL.D., F.R.S., will take the chair. Mr. W. J. U. Woolcock, C.B.E., General Organiser of the Chemical Section of the Exhibition and President-elect of the Society of Chemical Industry, will explain the objects of the exhibits and the special features of interest. Prof. W. P. Wynne, C.B.E., F.R.S., President of the Chemical Society, hopes to support the speaker at the meeting. The cost of the visit, including return ticket to Wembley, entrance to the Exhibition, and ticket for luncheon, will be 5s. Further information can be obtained from Mr. G. S. W. Marlow, 30, Russell Square, London, W.C. 1, and applications should be made not later than June 23.

Sept 8 to 11. INSTITUTE OF METALS. Annual Autumn Meeting, to be opened at the Institution of Mechanical Engineers, when W. M. Corso, S.B., will deliver the third annual Autumn Lecture. On September 9 the morning will be devoted to reading and discussion of papers, followed by luncheon at the Connaught Rooms, Kingsway, the afternoon to be spent at the British Empire Exhibition. On September 10 further papers will be presented for discussion, the afternoon being devoted to visits to works. A reception will be held in the evening at the National Physical Laboratory, Teddington. A detailed programme will be issued in August.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

The Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 10.30 a.m.

The following is the Programme :—

Tuesday, July 8, 9.0 p.m. Informal Reception by the President and the Local Committee at the Midland Adelphi Hotel.

Wednesday, July 9, 10.30 a.m. Annual General Meeting in the Arts Theatre, The University, and Presidential Address, "A Neglected Chapter in Organic Chemistry: The Fats." 2.30 p.m. Visit to White Star Liner, "Cedric," and tea on board, by invitation of the White Star Line. 8.30 p.m. Reception and Dance in the Town Hall, by invitation of the Rt. Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.).

Thursday, July 10, 9.45 a.m. Messel Memorial Lecture by the Rt. Hon. Viscount Leverhulme, in the Arts Theatre, and presentation to the Lecturer of the Society's Messel Medal for 1924. 11.30 a.m. Visit to the Works of Messrs. Joseph Crosfield and Sons, Ltd., Warrington. Luncheon by invitation of the Directors. Inspection of the Works of Messrs. Joseph Crosfield and Sons, Ltd. Cost of travelling, 5s. 7.30 p.m. Annual Dinner, in the Midland Adelphi Hotel. Tickets, exclusive of Wines, 12s. 6d.

Friday, July 11, 10.0 a.m. Business Session in the Physics Lecture Theatre, The University. 1.0 p.m. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of The United Alkali Co., Ltd., followed by visit to Works of The United Alkali Co., Ltd. Cost of travelling, 3s. 6d. 7.30 p.m. Dinner at Port Sunlight, by invitation of the Chairman and Directors of Messrs. Lever Bros., Ltd. Cost of travelling, 2s. 6d.

Saturday, July 12. About 9.30 a.m. (details later). Visit to Lake Vyrnwy. Inspection of the Liverpool Corporation Waterworks (limited to 150). Luncheon and tea, by invitation of the Water Committee of the Corporation of Liverpool. Arrive Liverpool about 9.30 p.m. Cost, dinner on train included, 25s.

Unofficial Excursions. Tickets to be booked in Liverpool at Reception Room:—Chester, River Dee and Eaton Hall; Isle of Man; Llandudno and Beaumaris (sea); Lake District (two days).

Members intending to attend the meeting are requested to send their applications, accompanied by the appropriate remittance not later than the 28th June to Mr. E. Gabriel Jones, City Laboratories, Mount Pleasant Liverpool, to whom all inquiries relating to private hospitality, railway travelling and other matters connected with the meeting should be addressed.

J. P. LONGSTAFF,
General Secretary

MEETING OF COUNCIL

The monthly meeting of Council was held on June 13, 1924, the President (Dr. E. F. Armstrong, F.R.S.) in the Chair.

It was unanimously resolved to confer the Honorary Membership of the Society on Monsieur Ernest Fourneau, of the Pasteur Institute, Paris, and on Monsieur Armand Solvay, President of the Société Solvay et Cie, Brussels.

The President reported that he had been elected Chairman of the Committee appointed by the Federal Council to carry through the Scheme for obtaining a Central House for the various Chemical Societies.

The Accounts and Balance Sheet for 1923, and the Annual Report of Council were approved. The Treasurer pointed out that during the first five months of 1924 a considerable reduction has been effected in the cost of printing and publishing the *Journal* by the introduction of certain economies.

A cordial invitation was received from the Yorkshire Section to hold the Annual General Meeting in Leeds in July, 1925, and it was unanimously agreed to recommend its acceptance to the Annual Meeting.

Reports of various Committees were submitted and 18 members were elected:—Home 15; Overseas 3.

The arrangements for holding the Autumn Dinner of the Society in London were remitted to the House Committee, and the Committee was given executive powers during the vacation.

The next meeting of Council will be held on Wednesday, July 9, at 10 a.m., in the University, Liverpool.

LIST OF MEMBERS ELECTED, June 13, 1924

Allibone, Bernard C., 109, Sunderland Road, Forest Hill, London, S.E. 23. Chemist.

Anderson, James T., 6, Sycamore Grove, Rugby. Analytical Chemist.

Byrne, George T., 21, Alexandra Road, Ansdell, Lytham, Lancs. Professor of Chemistry.

Griffin, Kenneth M., High Street, Auckland, New Zealand. Government Analyst.

Guthrie, Francis C., Lyndhurst, Mossley Hill, Liverpool. Lecturer in Chemistry.

Guttin, Henry, Titusville, Poughkeepsie, New York, U.S.A. Engineer Counsellor.

Hamilton, Charles H., c/o Messrs Wm. Gossage and Sons, Ltd., Widnes. Chairman.

Holliday, George C., Reydon Hall, Wanstead, London, E. 11. Research Chemist.

Keyworth, Charles M., 39, Rosslyn Street, Aigburth, Liverpool. Chemist.

Lescher, T. Edward, 56, Hanover Street, Liverpool. Managing Director.

Maurer, Edward, St. Thomas' Laboratories, Commercial Road, Portsmouth. Research Chemist.

Merchant, Douglas J., 64, Newbridge Road, Bath. Chemist.

Moors, Albert E., "Brookside," Norman Road, Runcorn. Tanner.

O'Sullivan, Daniel J., c/o Public Analyst, Eglinton Street, Cork. Analytical Chemist.

Read, Douglas E., Box 161, East Angus, Que., Canada. Chemist.

Roberts, Miss Muriel, 36, The Judges Drive, Newsham Park, Liverpool. Analyst.

Towers, John S., Laurel Bank, Woolton Road, Wavertree, Liverpool. Laboratory Furnisher.

Turner, Charles F., 27, Elsmere Avenue, Aigburth Road, Liverpool. Analyst.

CHEMICAL SOCIETY

At an ordinary scientific meeting held on Thursday, June 5, the President announced that an extraordinary general meeting would be held on Thursday, June 19, at 7.45 p.m., and would be followed by an ordinary scientific meeting.

Mr. H. Burgess read the following paper :—

Studies in dynamic isomerism. Part XVI. Mutarotation of beryllium benzoylcamphor. Formation of an additive compound with chloroform. The optical activity of beryllium. (With T. M. Lowry.)

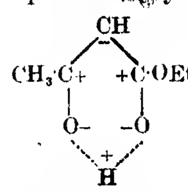
(*a*) BERYLLIUM benzoylcamphor, $Be(C_{17}H_{19}O_2)_2$ is a colourless crystalline compound melting at 208°. It is remarkable for showing a slow mutarotation, *e.g.*, from 490° to 443° in benzene. The material can be recovered, and after slow crystallisation exhibits the same high initial rotation and subsequent mutarotation as before. The mutarotation can be catalysed by piperidine, but benzoic acid produces also a permanent decomposition. Measurements of solubility, with and without a catalyst, have given the proportion of the initial form in the final equilibrium-mixture in alcohol and in acetone, whilst from concurrent measurements of the optical rotatory power of the saturated solutions the specific rotation of the unknown labile isomeride in these two solvents has been deduced.

(*b*) Beryllium benzoylcamphor unites with two molecular proportions of chloroform to produce the additive compound $Be(C_{17}H_{19}O_2)_2,2CHCl_3$. This crystallises in prisms instead of in discs; but these gradually become opaque by loss of chloroform. When dissolved in benzene or acetone, the additive compound gives at once the *final* rotatory power of beryllium benzoylcamphor in these solvents; but when dissolved in chloroform the last stages of a rapid mutarotation were observed. The free beryllium compound also exhibits a very rapid mutarotation in chloroform, which appears therefore to have a definite catalytic action on the mutarotation.

(*c*) The cause of the mutarotation is not certain, but it is attributed provisionally to the opening out and closing again of the ring-system of a co-ordinated complex of the cyclic type.

Dr. N. V. Sidgwick remarked that the isolation of a compound with chloroform was unusual, although the solubility of these substances was usually greater in chloroform than in benzene.

Prof. C. K. Ingold recalled that failure to isolate two enolic forms (and their metallic derivatives) of ethyl acetoacetate: $CH_3{\cdot}C(OH):CH{\cdot}CO_2Et$ and $CH_3{\cdot}CO{\cdot}CH:C(OH)OEt$, had previously been quoted by Prof. Lowry as proof of the cyclic polar structure:



although the speaker had pointed out that due consideration had not been given to such success

in the cases of ethyl formylphenylacetate and ethyl *s*-diacetylsuccinate. The new evidence for the existence of two series of metallic derivatives in the case of benzoylcamphor was at variance with this untenable hypothesis; isolation of the unstable free enol of benzoylcamphor would decide the point. Further, it seemed that the co-ordination of the metal required proof; solubility in organic solvents was inconclusive evidence since many salts of the simple fatty acids, *e.g.*, copper butyrate, are freely soluble in organic media.

Prof. Lowry said that an unexpected discovery was that metallic derivatives exhibit mutarotation at all: chloroform stopped the rotation of nitrocamphor but was a catalyst of the mutarotation of the metallic derivative. It must be admitted that the co-ordination compounds of beryllium are tetrahedral, and the evidence showed beryllium benzoylcamphor to be a co-ordination compound. His own explanation of the phenomenon was fundamentally that of Prof. Morgan in the case of basic beryllium acetate. The speaker had obtained new evidence, based mainly on absorption spectra, that the copper salts of the higher fatty acids are probably co-ordinated.

Prof. Lowry then read the following paper:—

Studies of valency. Part IV. Absorption spectra of camphor, benzylidenecamphor and camphorquinone. (With Miss H. S. French.)

(*a*) A SOLUTION of camphor in alcohol shows a band at log $\epsilon=1{\cdot}57$, λ 2880 A.U. In benzylidenecamphor the band is moved to log $\epsilon=4{\cdot}32$, but the wave-length is practically constant at 2900 A.U. In camphorquinone the wave-length is altered to 4650 A.U., but the intensity remains practically constant at log $\epsilon=1{\cdot}46$.

(*b*) The bearing of these observations on the origin of visible colour, and on the theory of rotatory dispersion is discussed.

Mr. J. E. Purvis said that the use of the iron arc for the study of absorption spectra is defective on account of its irregularity, whereas the radiations of the spark are regular and constant within the usual allotted time. Benzaldehyde in alcoholic solution gives bands at λ 2850 and λ 2456; the camphor band is at λ 2880 (Lowry) or λ 2850 (Purvis). The benzylidenecamphor band at λ 2900, with its greater intensity, might therefore be caused by the overlapping of the bands still present in the two different systems; no mention had been made of the fate of the benzaldehyde band at λ 2456. Again, the camphor band shows no resolution into a series of narrower vapour bands; the benzaldehyde band at λ 2850 is resolved into a number of finer bands when in the vaporous condition, but the band at λ 2456 undergoes no such resolution. The camphorquinone solution band also splits up into a number of narrower bands in the vaporous condition. Mr. Purvis suggested the desirability of a comparison of the vapour of benzylidenecamphor with those of benzaldehyde, camphor, and camphorquinone, and in fact an extension of such comparisons to all observations of absorption spectra.

Replying, Prof. Lowry expressed the opinion that the source of light was, in these experiments, of no consequence.

Dr. J. Kenyon then described:

The resolution of α-terpineol (with A. T. Fuller).

dl-α-TERPINEOL has been resolved into its optically active components by the fractional crystallisation of its hydrogen phthalic ester with four different alkaloids. The α-terpinyl hydrogen phthalates thus obtained show $[\alpha]_D \pm 36{\cdot}7°$ in ethyl alcoholic solution, and on hydrolysis with alcoholic potash give optically active α-terpineols of $[\alpha]_D^{20} \pm 100{\cdot}5°$ in the homogeneous state.

d-Terpinyl hydrogen phthalate, when heated with aqueous potash, gives *d*-limonene of $[\alpha]_D^{20}+107{\cdot}8°$. The formate, acetate, propionate, *n*-butyrate and *n*-valerate of the active terpineols have been prepared. The rotatory powers of these esters lie on a smooth curve except in the case of the propionate which shows a slight exaltation; the latter effect is enhanced when the rotatory powers are determined in solvents.

Dr. R. H. Pickard congratulated the authors on the first complete resolution of a tertiary alcohol in bulk, and on the successful application of the phthalic ester method in such a case. The use of four different alkaloids practically excluded the possibility of formation of mixed crystals.

Prof. C. S. Gibson, also extending his congratulations, said that in similar work he had experienced difficulty with mixed crystal formation. It was specially interesting that resolution was obtained equally well by brucine and strychnine.

The twelfth Faraday Lecture was delivered on Thursday, June 12, at the Royal Institution by Prof. R. A. Millikan, of the California Institute of Technology, Pasadena. In introducing the lecturer the President, Prof. W. P. Wynne, observed that by a happy chance the first lecture since 1914 was to be delivered by a citizen of the great nation across the Atlantic; a man whose researches on the electron were as highly appreciated here as in his own country.

Prof. Millikan commenced his discourse by saying that he would present an account of the present status of the "discrete" and "continuous" points of view in the consideration of electrical and optical phenomena and would endeavour clearly to differentiate between fact and fancy. After a reference to Maxwell's repudiation of the atomic view of electricity, he began with the assertion that the electron is no longer an hypothesis, and described his "oil-drop" experiments to prove that an electric charge can be varied only by definite stages. The dimensions of positive and negative electrons might for practical purposes be ignored, although it was an unexplained fact that the former has a mass 1845 times as great as that of the latter. Among the "agreed facts, free from fancy," were mentioned the concentration of positive electricity in the nucleus of an atom, and its equality in amount to the negative electricity; the variation of the unneutralised electrons by unit stages from 1 to 92 (tribute being paid to Moseley's

work in this direction); the significance of atomic weight and atomic number; radiation of the outer electrons by falling from an outer to an inner energy-level; and the confirmation of the Planck-Einstein-Bohr law of radiation.

Remarking that these facts were proof enough of the amazing advances made during the past fifteen years, the lecturer admitted, amid laughter, that knowledge was now desirable of "how the electrons spend their leisure time when not radiating: whether they should be regarded (as by the physicist) as active, or (as by the chemist) as loafing around on the corners of dry goods boxes." While not entirely admitting their applicability, he mentioned the assumed validity of the electromagnetic laws, and the existence of localised valencies, as representing the chief opposition to the former view, and then proceeded to describe the quantitative successes of the orbit theory, with incidental reference to his own experimental work on "stripped atoms," whereby the precise effect of the two close-in electrons in screening the other electrons could be computed. If the test of truth was the accounting for old relationships and the successful prediction of new ones, then the orbit theory must be accepted, and the stationary electron theory rejected. The electronic and sub-atomic world was being revealed to the modern physicist with consistency and definiteness; the theory, like that of the atom itself, would in its evolution admit of addition, but not of subtraction.

Maxwell's dielectric theory was then subjected to criticism, rather from the point of view of the situation created by modern discoveries regarding electromagnetic wave phenomena than that of its original foundations.

Although Einstein's equation had met with general acceptance, the idea of light quanta was still viewed with suspicion; Prof. Millikan, however, described new experiments which had produced unambiguous evidence for the reality of the Compton effect, so that not merely the equation but also the Einstein conception is having new successes. In fact, atomic conceptions in the field of ether waves seem at the moment to hold the master-key to progress.

The President then invited Prof. Millikan's acceptance of the Faraday Medal, the highest honour which the Society could bestow in appreciation of his wonderful discoveries.

A vote of thanks was proposed by Prof. F. G. Donnan, who said that the Faraday Lectureship had enabled them to bring to London many of the greatest men in the scientific world, among whom the present lecturer held a very high place. The speaker's own experience was that among the great things for which the United States of America were justly renowned, the greatest was their science; there had always been great American scientists, but the last seven years were specially marked by their "red-hot" enthusiasm.

Sir Oliver Lodge, seconding, congratulated the Society on being able to hand the Faraday Medal, in Michael Faraday's own Lecture Theatre, to a worthy successor, and testified to the brilliant scientific results being achieved in America. Personally, he agreed with Prof. Millikan in accepting the orbital atom, but he was not surprised that chemists were inclined to "shy" at it.

The vote having been carried with acclamation, Prof. Millikan said that he was deeply touched by the heartiness of the welcome accorded to him; the medal and its associations were to him an exceedingly precious honour. Moreover, the medal was presented in the Royal Institution, where Faraday worked, by people of that stock whom he regarded with the affection which exists between children and their parents, and he assured them that in his country the sentiment was widespread and controlling. It was not, after all, so much a question of where one lived; the development of science diminished the importance of geographical position. Nevertheless, the future of the Anglo-Saxon race was one with the future of England.

A vote of thanks to the members and managers of the Royal Institution terminated the proceedings.

THE SOCIETY OF DYERS AND COLOURISTS

The annual dinner was held in the Hotel Victoria, Northumberland Avenue, London, on June 11. The guests included Dr. E. F. Armstrong, F.R.S., president of the Society of Chemical Industry; Dr. C. Doree, Chairman of the London Section of the society; Mr. W. J. U. Woolcock, of the Association of British Chemical Manufacturers; Mr. W. W. Leuchars, Renter Warden of the Dyers' Company, and Sir Max Muspratt, Chairman of the Council of the Association of British Chemical Manufacturers.

Dr. E. F. Armstrong, in proposing the toast of the Society of Dyers and Colourists, said they had succeeded in spite of the politician in producing a big proportion of the colours used in Britain and in building up an industry of which they were very proud. The President (Mr. S. J. Pentecost), in responding said the past ten years had justified the optimism of those who desired to see Britain once again produce the colours needed for her textile industry. It was the duty of the Government of the day to foster and maintain the dyestuffs industry of the country and to encourage research in the coal-tar industry in every way. Mr. L. J. Hunt, Prime Warden of the Dyers' Company, in proposing "Allied Industries," said his company was the oldest connected with the industry, their records going back to the 13th century. Mr. H. J. Holroyd, Chairman of the National Federation of Dyers and Cleaners, responded.

Dr. H. A. Wilson, professor of physics in the Rice Institute, Houston, Texas, U.S.A., has been appointed to the chair of natural philosophy in the University of Glasgow. Born in Yorkshire, Prof. Wilson studied at Leeds, Berlin and Cambridge (where he was Clerk Maxwell student in the Cavendish Laboratory) and became professor of physics in King's College London, in 1901. In 1909, he occupied the chair of physics at McGill University, Montreal, and in 1912 he went to the Rice Institute.

CORRESPONDENCE

A NEW HOT-AIR BATH

Sir,—Perhaps some of your readers will be interested in the hot-air bath here described. When distilling or heating inflammable liquids in a flask, the flask may crack and the liquid spill over the bench and cause a serious fire.

The heater here described is so formed as to minimise this risk of fire, and to enable one to recover a large proportion of the contents of the flask.

Further, when subjecting a valuable substance (*e.g.*, Menthylamine) to steam distillation, should the flask break, the heater will retain the aqueous mixture which can be poured into another flask. The small hole, X, is for pouring off any liquid not got away through holes D. X is plugged with asbestos fibre when heater is in use.

The heater is made up of: (i) a cone, B, well made and watertight, with eight ⅜ in. holes, D, punched as near as practicable to the common seam of A, B

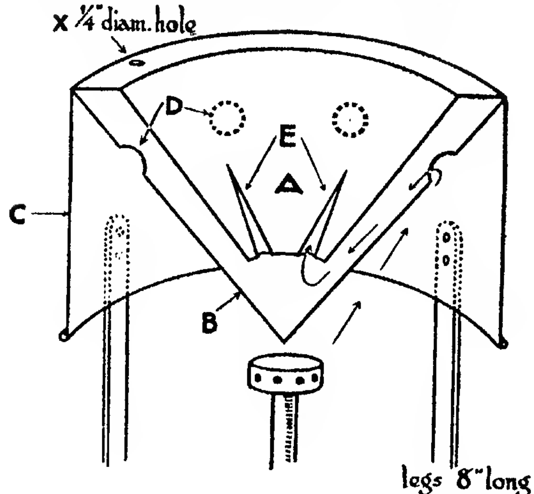


Fig. 1

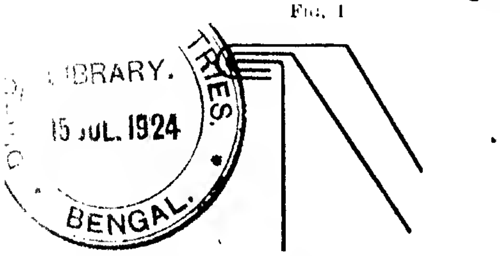


Fig. 2

and C: (ii) a cone, A, with the apex cut away, and having half-a-dozen serrations, E; (iii) a cylinder, C, of depth equal to depth of cone B.

A, B and C are lap-jointed, as shown in Fig. 2. The flask sits snug in the cone A, and is subject to heating by hot-air and conduction, eliminating trouble due to local heating.

Dimensions are: Cone B, 8 in. diam. × 4 in. deep. The diagrams will explain the rest. Three legs can be rivetted to the cylinder walls (C), which will then make the heater self-contained, to be used in conjunction with a Bunsen burner. The heater is very satisfactory for temperatures up to 140° C.—I am, Sir, etc.,

G. A. Collinson

Organic Laboratory,
The University, Leeds

WHAT A MEMBER THINKS

Dear Mr. Editor,—Your issue of March 21 has just reached here. Now, about your articles written for the non-technical reader. Quite frankly, the technical man who is so absorbed in his technicalities that he cannot convert his knowledge into common-sense language is one of the chief enemies of science. It should be possible to state scientific truth in such language and in such a manner that an ordinary well-educated non-technical person should be able to comprehend it. I do not necessarily say use it. I, for one, am glad to tell you that your articles on elementary things are very welcome indeed to a busy man down under. Many thanks for your articles on Evaporation; they are just what I want.—I am, Sir, etc.,

Harry Williams

Botany,
New South Wales
May 5, 1924

CHEMISTRY IN THE 20th CENTURY

Sir,—I have read the review of "Chemistry in the Twentieth Century," and your comment thereon in the current number of your *Journal*. I am not sure whether the Reviewer "damns with faint praise," but I, and many other teachers, will feel inclined to damn the publisher, and whoever else is responsible for the preposterous price at which the book is published. Fifteen shillings for VIII+281 pages!! A book of this kind surely should be sold at a price low enough to bring it within the reach of schoolboys and schoolgirls. A really interesting book of this type is simply invaluable to the teacher. Cannot something be done to bring such a story of real scientific achievement into the hands of those to whom it would be useful?—I am, Sir, etc.,

Teacher

COULD NOT A CHEMOR PRACTISE CHEMISTRY?

Sir,—I am not willing that the Canadian-born suggestion to coin the word "Chemor" as a designation for members of the chemical profession should be dismissed with so shallow a witticism as concludes the letter of Mr. John S. Bousfield of Cambridge in the issue of April 25.

Mr. Bousfield asks whether I would say, "I am a chemor and I practice chemorry." Certainly not. Mr. Bousfield might provide himself an idle hour's amusement by applying his surely original principle of word formation to the designation of the occupations of the actor, auditor, author, doctor, pastor, proctor, procurator, tutor, etc. To add zest to his pursuit I challenge him to produce a single parallel to the form he creates to ridicule.

So far as I am aware no one has felt the need of a new word for our occupation. "Chemistry" serves the purpose quite well. But the actual need of a word to distinguish the "qualified chemist" from the man who revels in the various designations of apothecary, chemist, chimist, dispensator, dispenser, dispensing chemist, druggist, druggister, drugster, pharmaceutist and pharmacist is the very occasion for all our discussion. To Mr. Bousfield's suggestion of "Chartered Chemist" it may be objected that (1) if institute diplomas are "charters," so also are the diplomas or licences of the pharmacists; (2) this designation occupies seventeen letter spaces, against six for "chemor"; (3) its inevitable abbreviation to "C.C." diminishing to "c.c.," may furnish more justifiable grounds for mirth than even the curious word "chemorry," which my learned colleague "wishes on" me.—I am, Sir, etc., J. F. Snell

Macdonald College, Que.

THE INTERNATIONAL UNION OF CHEMISTRY

Sir,—This last week, on opening the just issued Part II. of Dr. Böeseken's "Configuration of the Saccharides," my eye was caught by the following footnote on page 1: "The Conference on organic chemical nomenclature, held at Cambridge in June, 1923, decided that substances which until then had been called glucosides, should in future take the general name *glucide*."

The reference is to the International Union I assume, at which I was present. There was no such Conference, nor was the subject ever before the meeting. I learn, however, on enquiry, that a committee discussed matters of nomenclature *in camera*, and I suppose this is the "Conference" to which reference is made. No committee should have plenary powers to deal with such problems, nor should such decisions be taken at the meeting at which they are proposed. The Geneva Conference should be a warning to us. To abolish a term so time-honoured, useful and significant, and substitute one that is meaningless would be absurd.

The Union is about to meet in Copenhagen. Thus far it has acquired no legislative authority. The question to be decided in the near future is, whether it can be made acceptable to chemists and popular; whether, and to what extent it shall be authoritative. Probably most will say: "The less the better; let its position be, in the main, to bring men together from different nations, so that they may learn to know one another and form some common opinion of the needs and possibilities in chemistry, so that they may co-operate in giving value to our science in the different countries represented." The body must be organised upon more simple lines, and its aims and object carefully defined. At present far too much is being attempted and too many questions which are not of international importance are being considered. It is unfortunate that the beginning made last year at Cambridge, when several monographs in which important issues were discussed, were presented, is not to be followed up this year. There is no agreement between chemists upon matters of general theory, so that we are little short of empirics in far too many of our dealings. We greatly need t discuss these. At present, not only is the represen tion of this or that country more or less a matter chance, but the committees appointed are in no w sufficiently representative of the subjects considere I have enough experience of International Organis tions to know how difficult it is to make them effe tive, even when the task is a simple one. Certainl it will only be by making the task of the Internation Union a simple one that it can be made effective the way many of us desire it should be. Fraterni will not be encouraged in any body which seeks compel—so until more united in our outlook, we sha do well to confine ourselves mainly to the task of promoting International understanding and amity. I am, Sir, etc., Henry E. Armstrong

THE HISTORY OF THE GAS PROCESS

Sir,—We note, in the number of *Chemistry and Industry* for June 13, 1924 (p. 614) your remarks as to the evolution of "accepted scientific facts," in which you refer more especially to the history of the gas process. In reference thereto you mention the contribution of Mr. D. Brownlie (*Chemistry and Industry*, June 6, p. 601). "a correspondent who has evidently been at great pains to authenticate his facts." Brownlie states: "Murdoch described this installation in the most lucid and detailed manner before the Royal Society *of Arts* in 1808 and the account can of course be read in *their journal* whilst at the same time he was awarded for this paper the Society's Rumford Gold Medal." And when the historical development of the gas process is referred to, this is the statement commonly made. What are the facts? Murdock read his paper before the Royal Society on February 25, 1808, was awarded the Rumford medal of the *Royal Society* (consisting of a *gold medal and silver replica*) in 1806, and "the account can of course be read in the Philosophical Transactions of the Society." I am, Sir, etc., D. Chandler

J. S. G. Thomas

South Metropolitan Gas Co.,
London
June 14, 1924

PERSONAL AND OTHER ITEMS

Mr. J. E. P. Wagstaff, M.A., has been appointed professor of physics in the University of Durham and not in the University of Leeds, as was wrongly stated in the issue of June 13. The Cavendish professor of physics in the University of Leeds is, of course, Prof. R. Whiddington.

Dr. R. F. Ruttan, Macdonald professor of chemistry in McGill University, Montreal, has been appointed Dean of the Faculty of Graduate Studies. Dr. G. Stafford Whitby has been appointed to a chair of organic chemistry, and Dr. O. Maass to a chair of physical chemistry in the same University. It is understood that Prof. Whitby will visit England during the summer.

Mr. G. M. Bennett, M.A., M.Sc., late fellow of St. John's College, Cambridge has been appointed lecturer in organic chemistry in the University of Sheffield.

On June 13, the gold medal of the Royal Astronomical Society was presented to Prof. A. S. Eddington, F.R.S., for, amongst other reasons, his work on the internal constitution of a star, and for his expositions of relativity.

Mr. B. T. Bush has become president of the Synthetic Organic Chemical Manufacturers' Association of the United States.

Mr. W. M. Corse, who is to deliver the Autumn Lecture of the Institute of Metals on September 8, is a member of the U. S. National Research Council.

Sir Max Muspratt, chairman of the United Alkali Co., Ltd., is now back in Liverpool, after spending some time investigating the company's mines in Spain.

We regret to announce that Mr. Charles Lorleberg a director of R. W. Greeff & Co., Ltd., of London, and Manchester, died suddenly from heart failure on June 11.

The Discovery of Benzene

Benzene, the material from which the host of dyestuffs manufactured to-day is primarily derived, was first prepared in the Royal Institution laboratory by Faraday, who announced his discovery to the Royal Society on June 16, 1825. The Managers of the Royal Institution, in association with the Chemical Society, the Society of Chemical Industry, and the Association of British Chemical Manufacturers, have decided to celebrate the event on June 16 next year. The arrangements are in charge of a joint Committee of the four bodies.

Thermal Properties of Methyl Chloride

The Food Investigation Board of the Department of Scientific and Industrial Research has published in Special Report No. 19, by the Engineering Committee of the Board (Pp. 16, Price 1s.), an account of the thermal properties of methyl chloride, by D. N. Shorthose, M.A. The Report is supplementary to the report on ethyl chloride (No. 14), by Prof. C. F. Jenkin. Measurements are given of the specific heat, total heat, saturation specific volumes, latent heat, vapour density, and vapour pressure curve, figures being given both in tables and in charts. The data, though prepared with the object of constructing charts for the use of refrigerating engineers, will be found of interest to chemists, especially as the methods used in determining the data are described in detail.

Canadian Mineral Resources

The Dominion Department of Mines has sent Mr. W. Malcolm, M.A. (Geological Survey) and Dr. A. W. G. Wilson (Mines Branch) to London. These officers will be available, either at the Canadian Pavilion at Wembley or at the office of the High Commissioner for Canada, Kinnaird House, Pall Mall East, London, S.W. 1, to furnish authoritative information on Canadian mineral resources and on the utilisation of the mineral products found in Canada.

REVIEWS

A Short History of Chemistry. By R. Stern, B.Sc. Pp. viii+149. London: J. M. Dent and Sons, Ltd. 1924. Price 2s. 6d.

Some little light is thrown upon our methods of teaching chemistry in schools by the fact that Miss Stern's book is the first history of chemistry to be written primarily for boys and girls. From personal experience I can vouch for the fact that, until recently, there was no book on the history of chemistry in two of our public schools and one of the largest day schools in the country, in all of which chemistry had been taught for at least twenty-five years. I have no reason to believe that these schools were in any way exceptional, and I have wondered how far Prof. Smithell's recent complaint about the lack of scientific knowledge among the general public, in spite of the intensive work of a generation of science teaching in schools, may have been caused by too great an insistence upon the practical side of science and too little upon its human aspect.

It is indisputable that science has found it difficult to win regard as an essential part in a general education, and that it is still often considered to be a professional and specialist section of the curriculum, even when it is studied by the whole school. Something of this attitude towards science is reflected in the remark of a boy to a predecessor of mine at Clifton: "I didn't know you were writing a book, sir. Is it an intellectual book or a book on chemistry?" I believe that the chief aim of those who teach chemistry in schools should be to instil into the minds of their pupils (and of their colleagues) that chemistry—as typical of science—is primarily a philosophy, a method leading to a definite outlook on life, rather than a craft. That it has features characteristic of the latter, and those, too, of such a kind that only a child whose intelligence is distinctly below the normal can fail to gain some profit from them, is, of course, a great additional advantage, and renders chemistry, when properly taught, an ideal means of education. But it is, so I think, a serious mistake to pay so much attention to technical matter and methods and so little to those essentials which chemistry has in common with the humanities. A formidable protagonist of the heuristic method has remarked that when boys and girls begin the study of chemistry they should be shut up in a laboratory by themselves for a year and left to find out what they can. To my mind it would be equally useful to shut a novice at classics into a library with Homer in Greek and Vergil in Latin. To introduce the element of danger in order to make the parallel complete, one might add translations of Martial and Petronius.

The easiest and most satisfactory way of making chemistry in schools a living thing—for science specialist and unspecialist alike—is the adoption of the historical method. That there are other ways I should be the last to deny, but I know of no other of such general application or production of such good results. Miss Stern may therefore be congratulated on having made a valuable contribution

to the progress of this method, for there can be little doubt that her attractive and inexpensive little book will meet with widespread approval. The weakest part of the book is that dealing with alchemy and iatrochemistry, with which the author has obviously very little acquaintance. It is to be hoped that in the next edition these twelve pages will be rewritten. For the rest of the book the reviewer has nothing but praise. Miss Stern's style is simple and straightforward; her matter is interesting, and her perception of vital facts is sure. Those for whom the book is intended will enjoy reading it, and those chemists who have left their schooldays far behind may spend a pleasant evening with it refreshing their memories of giants of the past.

E. J. HOLMYARD

THE TEXTILE FIBERS: THEIR PHYSICAL, MICROSCOPICAL AND CHEMICAL PROPERTIES. By J. MERRITT MATTHEWS, Ph.D. Pp. xviii + 1053. Fourth Edition, revised and enlarged. New York: John Wiley and Sons, Inc., and London: Chapman and Hall, Ltd., 1924. Price 50s.

The author mentions that so much new matter has appeared on textile fibres of recent years that he has found it necessary to re-write and re-arrange the book. He has done this in a very thorough manner, in fact in a manner which has also distinguished his other books. Attempts have been made to find omissions of references to important researches, but little success has been achieved, and the importance of such an admission is realised when one considers the enormous amount of work which is being turned out by the staffs of research institutions and by other workers. It may be argued, in fact, that the research institutes are creating a new science relating to textile fibres and publications of the nature of the one under review will have to realise that position. Whether it is better to consider research in periods and give, say, ten yearly digests of different branches of research, or to review the whole field in one volume, is open for argument, but certain it is that the author, by adding new matter to his previous compilation, and then rewriting the whole, has produced an excellent book, and one which should be on the shelves of all engaged in the treatment of textile fibres. Illustrations are given of apparatus and machinery and a number of fibre micrographs.

The information given is in some cases so complete that one wonders whether one is reading a book dealing generally with textile fibres or with some special branch of the treatment of those fibres. For instance, the chapter on the mercerising of cotton is large enough for a book on finishing, and it is difficult to reconcile a full discussion of the recovery of caustic soda from mercerising liquors with inclusion in such a volume. A sense of proportion seems to be lacking, but the inclusion of such matter is for the good from the point of view of the purchaser. Artificial silks are thoroughly treated, but flax hardly receives attention commensurate with its importance. Perhaps this is, however, because the literature relating to it is scant and not always reliable. All the fibres used in commerce from asbestos to nettle fibre are considered. The analysis of textile fibres and yarns and tests for distinguishing different fibres are treated at length, but the matter, on the testing of yarns and fabrics for strength, is split up into different sections of the book. A critical comparison of the different methods of testing would be useful in the light of modern work on this subject. In discussing cellulose the author dwells at length on the chemical constitution, a matter which is out of place in a volume of this kind, but he gives little space to recent work on the fundamental natures of the celluloses contained in all vegetable fibres. One school of chemists regards the celluloses of all vegetable matters as identical, and this is an important point with which the author could have dealt.

Omissions in the bibliography are noticed; in one case a book mentioned in the text is not included.

S. H. HIGGINS

REPORT

REPORT ON THE ECONOMIC, FINANCIAL, AND INDUSTRIAL CONDITIONS OF THE NETHERLANDS, TO FEBRUARY, 1924. By R. V. LAMING. Department of Overseas Trade. Pp. 69. H.M. Stationery Office, 1924. Price 2s.

The occupation of the Rhine area by the French has had a big detrimental effect on the economic situation of the Netherlands, principally on account of the dislocation of transport.

In agriculture the sugar crop was disappointing, a yield of 210,000 t. on the year's working being expected, against 250,000 t. in 1922, on 20 per cent. less acreage. The potato crop was also reduced, though good in quality.

The production of coal in 1923 amounted to 4·85 million t., and of lignite, 41,000 t.; prospecting has shown seven new coal-beds suitable for exploitation. The production of salt amounted to 26,393 t., against 25,810 t. in 1922.

Dutch industries appear to have got over the worst of the depression. The textile industries are still in difficulties, but margarine and incandescent lamp manufacturers are prospering. Labour difficulties have had to be faced all round, principally on account of the stringent legislation regulating employment. The cessation of supplies of raw materials from the Ruhr was also felt severely at first, but has been countered, with some benefit to British trade.

In 1923 the value of imports was 2009 mill. fl. (£1 = fl. 12·10 at par; 11·38½ to 11·90 in 1923), and of exports 1303 mill. fl., imports having decreased by about 19 mill. fl. from 1922, and exports increased by 82 mill. fl. One of the principal reasons for the increased exports was the demand for Dutch coal, whilst exports of earth, clay, and sand were also important. Some of the principal items of export other than foodstuffs were coal, 2,034,557 t.; coke, 561,718 t.; incandescent lamps, 4678 t.; linseed oil, 52,761 t.; artificial silk yarns, 1754 t.; plantation rubber, 6809 t.

PARLIAMENTARY NEWS

Australian Zinc Concentrates

Mr. A. V. Alexander informed Sir F. Wise that 1,298,489 tons of zinc concentrates, including slime concentrates, had been delivered to the British Government under the contract with the Zinc Producers' Association Proprietary, Ltd. Regarding the prospects there was very little change in the situation.—(June 16.)

COMPANY NEWS

W. J. BUSH & CO., LTD.

The gross profit for 1923 was £249,885 and the net profit to £48,109, to which £18,197 brought forward must be added. A final dividend of 7 per cent. is recommended on the ordinary shares, making 10 per cent. for the year and leaving a carry forward of £35,056.

BOOTS PURE DRUG CO., LTD.

The net profit for the year ended March 31 last was £628,620. The preference and preferred dividends absorb £96,750, leaving £531,870. Dividends for the whole year have been paid on the ordinary shares totalling 36 per cent., less tax, requiring £360,000, the balance remaining being £171,870. The amount brought forward was £138,682, and out of the total of £310,552 it is proposed to transfer £100,000 to reserve, carrying forward £210,552. At March 31, 1923, the reserve amounted to £1,303,989, since when £900,000 has been capitalised, leaving £403,989, which is increased to £503,989 by the addition now proposed. The profit and loss account shows that before computation of the net profit £56,412 has been set aside for repairs, renewals, etc., £41,437 for taxation, and £35,291 for depreciation, whilst £20,000 is allocated for staff pension fund, making a total allocation to that fund of £40,000. The balance sheet totals £3,982,838.

DUNLOP RUBBER CO., LTD.

At the annual general meeting it was not found possible to proceed with the scheme of capital reconstruction which had been put forward by the board, owing to the opposition of the Parent Tyre Co. In consequence, representatives of the various classes of shareholders were appointed to consider the scheme with the board.

LANTARO NITRATE CO., LTD.

A second interim dividend on account for the year 1924 is announced of 5 per cent., or 5s. pre share, less tax, payable on July 8.

The New Brunswick Power Commission has surveyed and proposes developing the Grand Falls, on the St. John River. The falls are located in a well settled district, and the electricity can be easily distributed within small radius of the plant. The initial development is placed at 50,000 h.p.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.
Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

All grades of boric acid have been reduced by £3 per ton as from June 11. Borax prices are unchanged. Prices generally remain steady.

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial	
Cryst.	£45 per ton.
Powder	£47 per ton.
Acid Hydrochloric ..	3s. 6d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder ..	Spot £11 d/d., Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial	3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised	4s. 2d.—4s. 6d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¼d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic, solid ..	Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton, carr. paid.
Sod. Bichromate	4¼d. per lb.
Sod. Bisulphite Powder	
60/62%	£18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst. ..	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.

Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow 1s. 11d. per lb.
Barytes .. .. .. £3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide .. 3s. 9d. per lb.
Carbon Bisulphide .. £24—£26 per ton according to quantity.
Carbon Black .. 6¼d. 6¾d. per lb. Market firmer.
Carbon Tetrachloride .. £56 per ton, drums free.
Chromium Oxide, green .. 1s. 3d. per lb.
Indiarubber Substitutes, White and Dark } 4¾d.—6¼d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black .. .. 45s. per cwt., barrels free. Dearer.
Lead Hyposulphite .. 7½d. per lb.
Lithopone, 30% .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. .. £15 10s. per ton f.o.r. London.
Sulphur .. .. .. £10—£12 per ton, according to quality.
Sulphur Chloride .. 3d. per lb., carboys extra.
Thiocarbanilide .. .. 2s. 9d. per lb.
Vermilion, pale or deep .. 4s. 10d. per lb. Easier.
Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All prices keep fairly stable, but there is room for improvement in business.

Acetate of Lime—
Brown .. .. .. £14 10s. per ton d/d. Demand active.
Grey .. .. .. £19—£20 per ton. Fair demand.
Liquor .. .. .. 9d. per gall. 32° Tw.
Charcoal .. .. .. £7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. ,, ,, 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 7d. per gall. Unrefined.
Wood Naphtha—
Miscible .. .. 5s per gall. 60% O.P. Market dull.
Solvent .. .. 5s 6d. per gall 40% O.P. Fairly good demand.
Wood Tar .. .. £5 per ton.
Brown Sugar of Lead .. £46 per ton.

TAR PRODUCTS

Acid Carbolic—
Crystals .. .. 6½d.—7d. per lb. Demand quiet.
Crude 60's .. .. 1s. 9d.—1s. 10d. per gall. Market flat. Only odd lots being offered.
Acid Cresylic, 97/99 .. 2s 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95% .. .. 1s. 10d.—1s. 11d. per gall. Steady demand.
Dark .. .. .. 1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—
Strained .. .. 9½d. per gall. Very quiet.
Unstrained .. .. 8½d.—9d. per gall.
Benzole—
Crude 65's .. .. 10½d. 1s. per gall. ex works in tank wagons.
Standard Motor .. 1s. 4½d. 1s. 6d. per gall. ex works in tank wagons.
Pure .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.

Toluole—90% .. .. 1s. 5½d. per gall.
Pure .. .. 1s. 10d.—2s. per gall.
Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 9d.—9½d. per gall. Few inquiries.
Middle Oil .. } 7d.—9d. per gall. according to
Heavy .. .. } grade and district. Demand
Standard Specification } not so strong.
Naphtha—
Solvent 90/160 .. 1s. 4d.—1s. 5d. Market steady.
Solvent 90/190 .. 1s. 1d.—1s. 2d. Fair business passing.
Naphthalene Crude
Drained Creosote Salts £6—£6 10s. Demand falling off.
Whizzed or hot pressed £9—£12 per ton. Little business.
Naphthalene—
Crystals and Flaked .. £16—£17 per ton.
Pitch, medium soft .. 52s. 6d.—57s. 6d. per ton. Market steadier. Few inquiries for forward delivery. Very little business for prompt.
Pyridine—90/160 .. 21s. 6d.—22s. per gall. Demand well maintained.
Heavy .. 12s.—12s. 6d. More business passing.

INTERMEDIATES AND DYES

Business in dyestuffs has been fairly good and seems again to be on the upward move.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. .. 4s. 4d. per lb. 100% basis d/d
Acid Naphthionic .. 2s. 4d. per lb. 100% basis d/d
Acid Neville and Winther 5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 2d.—1s. 3d. per lb. Steady
Acid Sulphanilic .. .. 10d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 7¾d.—8¼d. per lb. naked at works.
Aniline Salts .. .. 7¾d.—9d. per lb. naked at works
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 3d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 19/31° C. .. 4¾d.—5¼d. per lb. Demand moderate.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethylaniline .. .. 2s. 4d. per lb. d/d. Drums extra
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works
66/68° C. 1s. 2d. per lb. naked at works
Diphenylamine .. .. 3s. per lb. d/d
Monochlorbenzol .. £63 per ton.
β-Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. 1s. 4½d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 5s. 3d. per lb. d/d.
p-Nitraniline .. .. 2s. 4d. per lb. d/d.
Nitrobenzene .. .. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol .. 2s. per lb. 100% basis d/d.

Nitronaphthalene	..	11¾d. per lb. d/d.
p-Nitrophenol	..	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol		4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	..	4s. 2d. per lb. d/d.
p-Phenylene Diamine	..	10s. 3d. per lb. 100% basis d/d.
R. Salt	..	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	..	2s. 5d. per lb. 100% basis d/d.
o-Toluidine	..	8½d. per lb.
p-Toluidine	..	3s. 6d. per lb. naked at works.
m-Toluylene Diamine	..	4s. 6d per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The demand is steady for the small quantities required for home consumption, but export inquiry for larger bulk is wanting.

Acid, Acetic 80% B.P.	..	£48 per ton.
Acid, Acetyl Salicyclic	..	3s. 3d.—3s. 5d. per lb. Market rather weak, but fair demand.
Acid, Benzoic B.P.	..	3s. 9d. per lb. Larger supplies available.
Acid, Boric B.P.	..	Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain. Prices reduced by £3 per ton.
Acid, Camphoric	..	19s.—21s. per lb.
Acid, Citric	..	1s. 6½d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	..	3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst.	..	7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic	..	Prices quoted from 2s. per lb. down to 1s. 8d. for ton lots. Market weak.
Acid, Tannic B.P.	..	3s. per lb. Market quiet.
Acid, Tartaric	..	1s. 1½d.—1s. 2d. per lb. less 5%. Better tone but not yet very active. Cheap offers of second hand parcels of foreign acid. Higher prices expected in view of firmness of raw materials.
Amidol	..	9s. per lb. d/d.
Acetanilide	..	2s. 3d. per lb. for quantity. Demand slow. Prices shaded to secure large orders.
Amidopyrin	..	13s. 6d. per lb. Neglected. Stocks low.
Ammon. Benzoate	..	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.		£37 per ton.
Atropine Sulphate	..	12s. 6d. per oz. for English make.
Barbitone	..	15s. 6d. per lb. Quiet market.
Benzonaphthol	..	5s. 6d. per lb. Small inquiry.
Bismuth Salts	..	A steady market. Prices according to quantity:
Bismuth Carbonate	..	12s. 9d.—14s. 9d. per lb.
„ Citrate	..	11s. 4d.—13s. 4d. „
„ Salicylate	..	10s. 2d.—12s. 2d. „
„ Subnitrate	..	10s. 9d.—12s. 9d. „
Borax B.P.	..	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	..	Fluctuating market. Continental prices decidedly firmer.
Potassium	..	11d. per lb.
Sodium	..	1s. „
Ammonium	..	1s. 1d. per lb.
Calcium Lactate	..	Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate	..	3s. 10d. per lb., duty paid. Advanced. Higher prices are quoted from the Continent.
Chloroform	..	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	..	6s. 6d. per lb. Little demand.
Formaldehyde	..	£57 per ton, *ex works*. English make.
Glycerophosphates—		Fair business passing.
Calcium, soluble and citrate free	..	7s. per lb.
Iron	..	8s. 9d. per lb.
Magnesium	..	9s. per lb.
Potassium, 50%	..	3s. 6d. per lb.
Sodium, 50%	..	2s. 6d. „
Guaiacol Carbonate	..	11s. 3d. per lb. for cwt. lots. Export orders small.
Hexamine	..	3s. 6d. per lb. for English make. Market dull.
Homatropine Hydrobromide	..	30s. per oz.
Hydrastine hydrochlor	..	English make offered at 120s. per oz.
Hydroquinone	..	4s. 3d. per lb. in cwt. lots. Foreign make.
Hypophosphites—		
Calcium	..	3s. 6d. per lb., for 28-lb. lots.
Potassium	..	4s. 1d. per lb.
Sodium	..	4s. „
Iron. Ammon. Citrate B.P.		2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—		
Light Commercial	..	£36 per ton net.
Magnesium Oxide—		
Light Commercial	..	£75 per ton, less 2½%.
Heavy Commercial	..	£26 per ton, less 2½%.
Heavy Pure	..	1s. 6d.—2s. per lb., according to quantity. Steady market.
Menthol—		
A.B.R. recryst. B.P.	..	55s. per lb. Weaker.
Synthetic	..	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	..	Market firm.
Red oxide	..	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	..	3s. 6d.—3s. 7d. „
White precip.	..	4s. 7d.—4s. 8d. „
Calomel	..	3s. 11d.—4s. „
Methyl Salicylate	..	2s. 1d.—2s. 6d. per lb. for carboys. Not much demand.
Metol	..	11s. per lb. British make.
Paraformaldehyde	..	3s. per lb.
Paraldehyde	..	1s. 4d.—1s. 6d. per lb. in free bottles and cases. Better demand.
Phenacetin	..	6s. per lb. Very slow.
Phenazone	..	7s. 3d. per lb. for cwt. lots. Quiet.
Phenolphthalein	..	6s. 6d. per lb. Weaker.
Potass. Bitartrate—99/100% (Cream of Tartar)	..	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	..	1s. 10d.—2s. 2d. per lb. Dearer.
Potass. Iodide	..	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	..	7½d. per lb., 1-cwt. kegs included.
Quinine Sulphate	..	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	..	5s. 6d. per lb.
Saccharin	..	63s. per lb., in 50-lb. lots.
Salol	..	3s. 6d. per lb. Very quiet.
Silver proteinate	..	9s. 6d. per lb.
Sod. Benzoate, B.P.	..	2s. 9d. per lb. In steady demand for good qualities.
Sod. Citrate, B.P.C., 1923		1s. 11d.—2s. 2d. per lb., according to quantity. Firm in common with other citrates.

Sod. Hyposulphite—		
Photographic ..	.. £13—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.	
Sod. Metabisulphite cryst.	37s 6d.—40s. per cwt. nett cash, according to quantity.	
Sod. Nitroprusside	.. 16s. per lb. Less for quantity.	
Sod. Potass. Tartrate (Rochelle Salt)	.. 77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.	
Sod. Salicylate ..	.. Market easier. Powder 2s. 3d.—2s. 6d. per lb. Crystal at 2s. 5d.—2s. 8d. per lb. Flake 2s. 9d.—2s. 10d. per lb.	
Sod. Sulphide		
Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.	
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.	
Thymol	.. 15s.—15s. 6d. per lb. for good white crystal from ajowan seed. Very firm and scarce.	

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.	
Aubepine .	. 11s. 6d ,,	
Amyl Acetate .	.. 2s 9d. ,,	
Amyl Butyrate .	.. 6s. 9d. ,,	
Amyl Salicylate .	. 3s 3d ,,	
Anethol (M.P. 21 22 C.)	4s. 6d ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. ,,	Cheaper
Benzyl Alcohol free from Chlorine ..	.. 3s ,,	Cheaper.
Benzaldehyde free from Chlorine .	.. 3s. 6d. ,,	
Benzyl Benzoate	.. 3s 6d. ,,	
Cinnamic Aldehyde .. Natural ..	. 15s 6d. ,,	
Coumarin ..	.. 20s. ,,	
Citronellol ..	.. 16s. ,,	
Citral .. .	.. 10s ,,	
Ethyl Cinnamate	.. 15s ,,	
Ethyl Phthalate ..	. 3s. 3d. ,,	
Eugenol	.. 10s 6d. ..	Cheaper.
Geraniol (Palmarosa)	.. 35s. ,,	
Geraniol	.. 11s. 18s. 6d per lb.	
Heliotropine ..	.. 6s 6d. per lb.	
Iso Eugenol ..	.. 15s. 9d. ,,	
Linalol ex Bois de Rose	28s. 6d. ,,	
Linalyl Acetate .	.. 28s. 6d. ,,	
Methyl Anthranilate	.. 9s. 6d. ,,	
Methyl Benzoate	.. 6s. ,,	
Musk Ambrette ..	.. 48s. 6d. ,,	
Musk Xylol ..	.. 16s. 6d. ,,	
Nerolin	.. 4s. ,,	
Phenyl Ethyl Acetate	.. 12s. 6d. ,,	
Phenyl Ethyl Alcohol	.. 16s. ,,	
Rhodinol . ..	. 57s. 6d. ,,	
Safrol . ..	.. 1s. 10d. ,,	
Terpineol . ..	.. 2s. 9d. ,,	
Vanillin	.. 25s. 3d.—26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. .. .	.. 15s. 6d. per lb.	
Anise Oil	.. 2s 10d. per lb.	Cheaper.
Bergamot Oil ..	.. 19s 6d. per lb	Dearer.
Bourbon Geranium Oil	.. 36s. 6d. ,,	
Camphor Oil ..	.. 75s. per cwt.	
Cananga Oil Java	.. 10s. 6d. per lb.	
Cinnamon Oil, Leaf	.. 6½d. per oz.	
Cassia Oil, 80/85%	.. 9s. 3d. per lb.	
Citronella Oil—		
Java 85/90% ..	.. 6s. per lb.	
Ceylon	.. 3s. 9d. per lb.	
Clove Oil	.. 7s. 6d. per lb.	
Eucalyptus Oil 70/75%	.. 2s. 2d. per lb.	
Lavender Oil—		
French 38/40% Esters	27s. 6d. per lb.	
Lemon Oil ..	.. 3s. 2d. per lb.	
Lemongrass Oil	.. 3d. per oz.	
Orange Oil, Sweet	.. 13s. 9d. per lb.	
Otto of Rose Oil—		
Bulgarian ..	.. 27s. 6d. per oz.	
Anatolian ..	.. 23s. 6d. per oz.	
Palma Rosa Oil	.. 19s. per lb.	
Peppermint Oil—		
Wayne County	.. 20s. 9d. per lb.	Weaker.
Japanese ..	.. 15s. 6d. per lb.	Weaker.
Petigrain Oil ..	.. 10s. per lb.	
Sandal Wood Oil—		
Mysore	.. 26s. 6d. per lb.	
Australian ..	.. 21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents, those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before August 11, they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court Chancery Lane, London, W.C. 2, on June 26th.

I.—Application

Gelder. Grinding and pulverising machines. 13,593 June 4.

I.—Complete Specifications Accepted

73 (1923). Mewes. Separating and utilising the constituents of gases. (216,545.)

5838 (1923). Reavell, and Kestner Evaporator and Engineering Co. Rotary drying-machines. (216,577.)

5976 (1923). Kucher. Refrigeration. (195,943.)

6293 (1923). Thompson and Henshalwood. *See* VI.

12,122 (1923). Bennis. Furnaces. (216,666.)

12,394 (1923). Thomson and Nisbet. Apparatus for filtering dust-laden gases. (216,675.)

16,565 (1923). Schmies, and Deutsche Luftfilter-Bauges. Removal of constituents from gases. (216,708.)

24,037 (1923). Fasting. Rotary kilns. (205,796.)

27,876 (1923). Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges. Akt.-Ges.). Apparatus for the electrical precipitation of suspended particles from gaseous fluids. (216,789.)

31,348 (1923). Kucher. Refrigeration. (208,547.)

II.—Applications

Banner. Preparation of emulsions of oil and water. 13,546. June 4.

Frey. Fuel compact, and manufacture of same. 13,79[illegible] June 5. (U.S., 5.6.23.)

Heyl. Distillation of oil shale etc. 13,891. June 6.

Humphreys and Glasgow, Ltd., and Stelfox. Manufacture of gas. 13,616. June 4.

Jackson (Koppers Co.). Eliminating hydrogen sulphide etc. from fuel gases and air. 13,781. June 5.

Nicklin. 13,694. *See* III.

Soc. Anon. des Pétroles Houilles et Dérivés. Treatment of hydrocarbons. 13,626. June 4. (Fr., 11.11.23.)

Soc. Anon. des Pétroles Houilles et Dérivés. Production of coke etc. 13,731. June 5. (Fr., 28.11.23.)

II.—Complete Specifications Accepted

5868 (1923). Jackson (Koppers Co.). Coking ret[illegible] oven batteries. (216,579.)

9505 (1923). Soc. Anon. de Construction de Fours à Coke Simplex. Gasifying coal, lignite, and bituminous fuel. (196,599.)
13,966 (1923). Beaudequin. Manufacture of artificial coal or coal-like substances. (216,691.)
16,565 (1923). Schmios, and Deutsche Luftfilter-Bauges. See I.
23,231 (1923). Johnson (Badische Anilin und Soda Fabrik). Manufacture of active carbon. (216,761.)

III.—Applications

Nicklin. Recovery of creosote oil from crude coal gas. 13,694. June 4.
Soc. Anon. des Pétroles Houilles et Dérivés. 13,626. See II.

IV.—Application

Eberlein. 13,907. *See* XIII.

IV.—Complete Specifications Accepted

8837 (1923). Ransford (Cassella und Co.). Manufacture of alkylated and aralkylated derivatives of vat-dyestuffs. (216,622.)
13,120 (1923). Durand und Huguenin Akt.-Ges. Manufacture of mordant dyestuffs. (197,940.)

V.—Applications

Calico Printers' Association, Ltd., and Dawson. 13,788. See VI.
Hartogs. Spinning viscose. 13,898. June 6 (Holland, 25.7.23).
Hartogs. Spinning viscose. 13,899. June 6.
Hartogs. Manufacture of viscose solutions. 13,900. June 6.
Kirschbraun. Paper manufacture. 13,886. June 6.
Rinman. Dry distillation of alkalized waste liquor from soda-cellulose manufacture. 13,798. June 5.

V.—Complete Specifications Accepted

26,467 (1923). Bocken. Obtaining fibres from the leaves of agaves etc. (216,777.)
31,362 (1923). Vams. Continuous chlorination of raw cellulose. (208,551.)

VI.—Applications

Cadgene. Printing of textile fabrics. 13,553. June 4 (U.S., 15.2.24).
Calico Printers' Association, Ltd., and Dawson. Scouring and bleaching textile fibres etc. 13,788. June 5.
Johnson (Badische Anilin- und Soda-Fabrik). Treatment of cellulose esters for dyeing. 13,503. June 2.
Lepine. Desulphurizing, bleaching, etc. fibres etc. 13,820. June 6.
Livsey, and Worrall, Ltd. Method of obtaining effects on textile fabrics. 13,729. June 5.

VI.—Complete Specifications Accepted

2833 (1923). Mitchell and Wordsworth. Dyeing and like machines. (216,556.)
6293 (1923). Thompson and Henshulwood. Dye vats, tanks, and like receptacles. (216,595.)
6683 (1923). Lord. Apparatus for treating hanks of yarn with liquids. (216,598.)

VII.—Applications

Blumenfeld and Weizmann. Titanium compounds. 13,446. June 2.
Jackson (Koppers Co.). 13,781. *See* II.
Soc. Anon. d'Eclairage et d'Applications Electriques. Extracting krypton and xenon from the atmosphere. 13,925. June 6. (Fr., 29.6.23.)

VII.—Complete Specifications Accepted

12,660 (1923). Akt. Dansk Svovlsyre- & Superphosphat Fabrik, and Dansk Akt. Siemens-Schuckert. Automatic regulation of the supply of oxidising agents, nitric acid, nitrate solution, or others in the manufacture of sulphuric acid. (199,004.)
19,229 (1923). Michael. Processes for making potassium nitrate. (208,114.)

VIII.—Applications

Eggimann and Perea. Translucent materials. 13,674. June 4. (Fr., 12.6.23.)
Tams. Semi-porcelain body for pottery. 13,711. June 5.

VIII.—Complete Specification Accepted

4897 (1924). Michaelis. Manufacture of high-grade plate glass. (212,250.)

IX.—Applications

Keay. Cementing pulp stones. 13,478. June 2.
Keay. Abrasive cement. 13,479. June 2.
Peace. Manufacture and hardening of concrete products. 13,534. June 4.

IX.—Complete Specification Accepted

6967 (1923). Meadows. Compositions for making or waterproofing roads. (216,602.)

X.—Applications

Aciéries Réunies de Burbach-Eich-Dudelange Soc. Anon. Treatment of molten slag, metals, etc. 13,697. June 4. (Luxembourg, 16.10.23.)
Ashanti Goldfields Corporation, Ltd., and Rhodes. Ore-roasting furnaces. 13,686. June 4.
Chemische Fabrik Griesheim-Elektron, and Beielstein. Recovery of light metals from scrap. 13,939. June 6. (Ger., 20.7.23.)
Helfenstein. Metallurgical etc. hearth furnace. 13,518. June 2.
Vincent. Soldering process, and composition therefor. 13,599. June 4.

X.—Complete Specifications Accepted

5886 (1923). Marks (American Smelting and Refining Co.). Extracting tin from its ores. (216,580.)
14,577 (1923). Ashcroft. Treatment of zinc-lead sulphide ores, mattes, and the like. (216,695.)
24,313 (1923). Billington. Ferrous alloys. (216,766.)

XI.—Application

Pehrson and Prentice. Electric furnaces. 13,508. June 2.

XI.—Complete Specifications Accepted

8334 (1923). Ridoni, and Soc. Talco e Grafiti val Chisone. Manufacture of electrodes from natural graphites. (216,617.)
11,442 (1923). Ziegenberg. Galvanic cells. (216,659.)
22,007 (1923). Metropolitan-Vickers Electrical Co. (Westinghouse Electric and Manufacturing Co.). Electric furnaces. (216,756.)
27,876 (1923). Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges. Akt.-Ges.). *See* I.

XII.—Application

Banner. 13,546. *See* II.

XIII.—Applications

Bamber. Manufacture of paints, varnishes, etc. 13,790. June 5.
Eberlein. Production of colour lakes. 13,907. June 6.

XIV.—Application

Bamber. 13,789. *See* XX.

XV.—Application

Bray. Treatment of hides, skins, etc. 13,796. June 5.

XV.—Complete Specification Accepted

91 (1923). Le Petit, Burns, and Blanke. Treatment of hides, skins, etc. (216,546.)

XVI.—Complete Specification Accepted

5746 (1923). Harnist. Manufacture of disinfecting-fertilisers from sulphur or metallic sulphides. (194,289.)

XIX.—Application

Bergeret and Dorignac. Preservation of organic or vegetable substances. 13,868. June 6.

XX.—Applications

Bamber. Manufacture of crude dipentene from crude rubber etc. 13,789. June 5.

Coke and Maxted. Oxidation of derivatives of aromatic hydrocarbons. 13,507. June 2.

Coke and Maxted. Oxidation of alcohols and aldehydes. 13,555. June 4.

Coke and Maxted. Oxidation of toluene. 13,634. June 4.

XX.—Complete Specification Accepted

5958 (1923). Holzverkohlungs-Industrie Akt.-Ges. Manufacture of hexamethylenetetramine. (195,602.)

XXI.—Application

Kodak, Ltd. Photographic reversal processes. 13,595. June 4. (U.S., 5.7.23.)

XXIII.—Application

Roberts. Viscosimeters. 13,734. June 5.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific number: *Australia:* Silk, (675); Pottery, glassware, (676); hardware, aluminium and enamelled ware, (679); *British India:* Metals, hardware, paint, (680); cable varnish, white enamel, (Director General, India Store Department, Branch No. 10, Belvedere Road, S.E. 1); *Italy:* Silk, (687); *Netherlands:* Leather, (688); stationery, (689); silk, (691); *New Zealand:* Iron, (A.X./1038); hardware, (A.X./1039); *Peru:* Tableware, earthenware, (701); *South Africa:* Steel, (A.X./1047); copper, (A.X./1048) & steel roofing, (A.X./1042); *South Latin America:* Earthenware, (699); *Spain:* Tinplate, (695); silk, (696).

Trade Information

Briquetting is of great importance in that it enables the "smalls" produced in the mining of coal and ore, and the manufacture of coke to be utilised, thereby eliminating loss and the cost of storage or removal. A firm that has specialised in briquetting coal, coke, ore, or cement, potassium cyanide, calcium carbide and many other materials is that of Wm. Johnson and Sons (Leeds), Ltd., Castleton Foundry, Armley, Leeds. The brochure "BM2" devoted to briquetting machinery manufactured by this firm illustrates an interesting variety of standard briquetting plant, such as the "Eggette," or "Ovoid" plant for fuel, and plants for peat, lignite, and ore. In addition, recognising the important part played by moisture in briquetting, Messrs. Johnson have evolved, as the result of forty years' experience, a series of horizontal rotary, multitubular, cascade, spiral, and vertical table dryers, as well as calciners, for drying the materials before briquetting. For each class of material, a special dryer is provided, and every attention is paid to suitability and economy of use. Other plant made at the Castleton Foundry includes pitch crackers, mixers and measurers, disintegrators, vertical heaters or cookers and various types of briquetting plant to suit every need. As an illustration of Messrs. Johnson's experience, it is interesting to note that they have supplied briquetting plant to a number of foreign governments. Amongst other specialities of this firm are mining, cement-making, elevating, conveying, drying and washing plant, crushing and grinding machinery, clay-working and concrete-mixing machinery and many other types of plant. Catalogues illustrating these products can be obtained from Messrs. Johnson and Sons on application, and the firm is glad to submit plans and estimates to deal with any proposition.

The Reproduction of Colour in monochrome by means of photography presents hosts of fascinating problems. Despite the voluminous literature, however, evidence is not wanting that the virtues and limitations of photographic reproductions are imperfectly appreciated. For this reason, a welcome must be given to a booklet on the "Wellington Spectrum Plate," issued by Messrs. Wellington and Ward, Ltd., of Elstree. In plain, clear language, the booklet sets out to show what can and what cannot be expected of a panchromatic plate, and gives notes on development, the use of light and contrast filters, desensitisers and desensitising that are both sound and very much to the point. The Spectrum panchromatic plate, the subject of the booklet, is used for the reproduction of landscapes, coloured objects, pictures and portraiture, and recognition is given to the aid which such a plate can render to the microphotographer in the rendering of minute structures by the inclusion of a list of micro and contrast filters with their respective spectral transmission. A useful booklet that combines interest and instruction.

PUBLICATIONS RECEIVED

THE STRUCTURE OF MATTER. By J. A. Cranston, D.Sc., A.I.C. Pp. xv+196. London: Blackie and Son, Ltd., 1924. Price 12s. 6d.

CHEMICAL SYNTHESIS: STUDIES IN THE INVESTIGATION OF NATURAL ORGANIC PRODUCTS. By H. Hepworth, D.Sc. Pp. xx+243. London: Blackie and Son, Ltd., 1924. Price 20s. net.

COMPLEX SALTS. By W. Thomas, B.A., M.Sc., Ph.D. Manuals of Pure and Applied Chemistry. Edited by R. M. Caven, D.Sc. Pp. xi+122. London: Blackie and Son, Ltd., 1924. Price 10s.

ELEMENTS OF WATER BACTERIOLOGY, WITH SPECIAL REFERENCE TO SANITARY WATER ANALYSIS. By S. Cate Prescott and C. E. A. Winslow. Fourth edition, rewritten. Pp. ix+211. London: Chapman and Hall, Ltd., 1924. Price 11s. 6d.

THE ACTION OF METALS ON NITRIC ACID. By W. D. Bancroft. Reprinted from the *Journal of Physical Chemistry*. Vol. XXVIII. Pp. 475—493, May, 1924.

A TEXT-BOOK OF INORGANIC CHEMISTRY. Edited by J. Newton Friend, D.Sc., Ph.D. Vol. II. The Alkali-Metals and their Congeners. By A. J. Walker, Ph.D., B.A. Pp. xxvi+379. London: Charles Griffin and Co., Ltd., 1924. Price 20s.

THEORETICAL METALLURGY. By R. Scott Dean. Pp. vii+246. London: Chapman and Hall, Ltd., 1924. Price 15s.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council of Pure and Applied Chemistry

which consists of Representatives from

The Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Institute of Brewing, the Society of Dyers and Colourists, the Society of Glass Technology, the Iron and Steel Institute, the Ceramic Society, the Institution of Gas Engineers, the Society of Leather Trade Chemists, the Royal Photographic Society, the Mineralogical Society, the Biochemical Society, the Institute of Metals, and the Royal Agricultural Society.

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EDITORIAL

OUR readers continue to devote their attention to the problem of an accurate designation for the chemist and for his work. We hope that they will succeed to the satisfaction of everyone, but our hopes are not very sanguine. The subject is so vast, the interests so many and varied, and the psychological reactions so deeply seated, that even an approach to unanimity seems remote. It is no cause for regret that opinions on chemical topics are so varied; it is rather a reason for congratulation, for it shows how vital the science, how keen its votaries, how much work still remains to be done. Indeed, it is not an unfair question to ask: What is a chemist? We all know chemists whose work lies, so to speak, within the covers of Roscoe and Schorlemmer or Cohen, but we know of many others who rejoice in the title, but yet never approach chemistry much nearer than physics and mathematics, though by intransigents these may be considered as branches, humble, but necessary, of our science. On more than one occasion chemists have been trounced because they have become, or so style themselves, gas chemists, brewery, metallurgical, water, industrial or pure chemists. What is a chemist, and what, indeed, is chemistry? These are questions that we shall not attempt to answer: States and Sciences alike have their "terre irredente," their unredeemed territories, containing subjects belonging to other States and Sciences, and it passeth the wit of man to find a solution that shall be universally acceptable. The human instinct for classification is irrepressible, so we suppose—indeed, hope—that more of our readers will give their opinions when they feel so disposed.

* * *

We have been wondering, despite the heat and the tempting cool of greenery, how a definition of a "chemist" could be worded. But Prof. Drummond, in the letter which we print in our correspondence columns, raises a far more fundamental question; that of the training of the chemist. It was recently reported that Sir Edward Elgar has been studying chemistry. No doubt he has made great progress, but one may doubt whether he would be asked to referee a paper on stereo-isomerism for the Transactions. Yet the chemist is constantly asked to become expert in harmonies other than his own; and last week Prof. Ellis showed the difficulties that arise when he is expected to become a bacteriologist. It all seems to lead back to the question: What is a chemist, for, obviously, his training would not be a matter of controversy were a stricter definition possible. Knowledge is increasing so rapidly, "labels" are coming into use so profusely, that it is well for Prof. Drummond to remind us that the real function of the university is to educate the student, and to give him a knowledge of the fundamental principles

of science. Specialisation is now a commonplace, but it will be readily admitted that a student who has begun to study the carbohydrates in detail before he has mastered his general organic chemistry would make a very strange chemist. Yet, in effect, the student who graduates in chemistry without having some knowledge of general scientific principles is in a very similar position. The problems of the living cell and its activities pervade the whole of chemistry and but few chemists can avoid some contact with them. To look at the question from a standpoint still more utilitarian, might not biochemical knowledge have been in a very different position to-day had the early workers possessed a sound acquaintance with the technique of the microscope? And even to-day, how many chemists are really familiar with the beauty of microchemical methods? Specialisation is inevitable in a vast domain such as that of chemistry, but at least let us have specialists who will erect their own soaring dream pinnacles from foundations set in that fair champaign which is common to all science

* * *

Some of the common misconceptions about chemists and their work are due, without a doubt, to neglect of the philosophic aspects of chemistry, especially its history. And how fascinating does the science become when it is expounded by means of the historical method. It is surprising that one of the modern psychoanalysts has not yet made a study of the reasoning that led Prout to believe that all heavier atoms are simply aggregations of atoms of hydrogen. How one would like to know how Newton became a "firmly convinced atomist," as Prof. Richards calls him. But how much delving remains to be done before we have accurate records on which to build our histories of chemistry. Mr. Holmyard, whose interesting article on Béguin will be found on another page, has laboured greatly to establish some of the data of chemical history, and future historians will be very grateful to him. If the proposal now before the Senate of the University of London is accepted, we shall enter on a new stage in scientific teaching. In brief, the proposal is to establish post-graduate course of study in the history, principles and methods of science, and an important feature is that all students, whether in chemistry, physics or biology, will be required to study the early history of *all* science, and only later the history of their special branch. Further information will be awaited with much interest. This will hardly satisfy Prof. Drummond, however, as reform seems to be most needed in the early undergraduate stages General scientific principles, and of course their history, should be taught, and when they are taught chemistry will benefit greatly. Misconceptions will have to be cleared away: use of Bentham and Hooker does not make a botanist any more than Mellor's treatise will make a chemist. And it is appropriate, when we are beginning to celebrate the centenary of Lord Kelvin, to quote his declaration that all science is one science and any branch of science that places itself outside the pale of the other branches ceases for the time being to be a science.

ATOMS AND ETHEREAL RADIATIONS

A series of three lectures on "Atoms and Ethereal Radiations" was delivered at University College, London, by Prof. R. A. Millikan on June 16, 17 and 19. The chair was taken by Prof. A. W. Porter.

The first lecture, "Bridging the Gap between X Rays and Light," was largely a description of work done in Millikan's laboratory to get beyond the Schuman region. The method consists of obtaining spark spectra in high vacua. The vacuum is maintained with a battery of mercury diffusion pumps. The spark is obtained from a number of Leyden jars charged from a small transformer. The spectra are analysed with metal gratings. The first gratings were ruled to throw as much energy as possible into the first order; but later some were ruled with special sets of spacings so that the high orders, even up to the tenth, were strong. In 1919 Millikan and Sawyer reached 600A, and their latest limit is 136A. Millikan showed a historic slide made by Schuman reaching 1220A. Lyman's limit is 510A. From the other end of the gap Seigbahn has now reached 18A. The gap is thus about 7 octaves.

The gap no longer exists theoretically, as was shown by Millikan in part of the first and the whole of the second lecture. Because of the simplicity of X-ray spectra, it was natural to try, first of all, to apply the methods by which the K, L and M series are arranged to the new region. The effort was entirely successful. Millikan showed fine Moseley diagrams connecting his strong lines, and some excellent slides indicating the progression of these lines with atomic number, like de Broglie's slides for the X-rays. The high resolution was necessary to pick out the doublets and triplets, and track down the lines corresponding to different stages of ionisation of the atom involved: this was similar to the work done in the visible region by Fowler and Paschen. The regular doublet separation can, in all cases, be accounted for by Sommerfeld's fourth power law. For the irregular doublets the linear progression of wave number difference with atomic number was found. The screening constant of the Moseley equation was calculated, and the progression of this factor and its approach to assigned limits were verified. A definite conclusion is reached that the electrons possess coulomb fields, the electrons in the K shell acting, as a limit, as if situated at the nucleus, the screening effect for any set decreasing with increase of atomic number. The laws of X-ray spectra can thus be applied right into the visible spectrum. There is no gap. But Millikan points out a tremendous difficulty. In X-ray spectral laws the doublet separation is calculated from the change of mass with speed of the electron in an elliptic orbit of equal energy to an alternative circular orbit. In the visible region the separation has been accounted for by assuming some undefined assymmetry, which necessitates an energy difference of the circular orbit with the inclination of its normal to unspecified structured axes, resulting in the introduction of the azimuthal quantum

number. Both assumptions have served us well in obtaining large numbers of numerical agreements. Millikan has proved beyond doubt that they are mutually exclusive. Which we must choose, Millikan leaves open. Our consolation, as he points out, is that we have a check on our postulates.

The last lecture was on the penetrating radiations of the upper atmosphere. Kohlhörster has concluded that there is a radiation in the atmosphere for which the absorption coefficient of water is 0·0025, whilst the hardest rays from Th. D. have a coefficient 0·033. Millikan finds a radiation which is very probably that observed by Kohlhörster. However, he finds that the rays are only slightly harder than the most penetrating γ-rays. Millikan also finds that the rays are of local origin. A heavy snowstorm causes their disappearance, and they are cut down to nearly half by 0·3 inches of lead. Millikan puts forward an explanation that the rays are due to radioactive dust of cosmic origin settling slowly through the atmosphere, the decay being rapid enough to account for the diminishing intensity of the rays approaching the earth's surface.

JEAN BÉGUIN

By E. J. HOLMYARD, M.A., F.I.C.

The Science Library at Clifton College recently acquired a copy of "Les Élémens de Chimie," by Jean Béguin, "reveus, expliquez, et augmentez par Jean Lucas de Roy, Médecin Boleducois," Rouen, MDCXXXXVII. Little seems to be known of Béguin. Kopp and Meyer barely mention him, but a few details are given by the omniscient Ferguson in his wonderful "Bibliotheca Chemica," vol. 1, pp 93-94. "Beguinus," he says, "was a native of Lorraine, and flourished at the beginning of the seventeenth century. After studying chemistry and pharmacy at Sedan (?) he came to Paris, where he made chemical preparations, and opened a school for instruction in chemistry, pharmacy and metallurgy. He also visited foreign countries to see the mines and study mineralogy. His first publication was an edition of the 'Novem Lumen Chymicum' of Sendivogius with a preface, 1608. He had great reputation as a teacher, and was among the first to give practical instruction.

"At the instigation of a pupil, Jeremias Barth, he drew up a small manual entitled 'Tyrocinium Chymicum,' printed in 1610. It was meant for his own students 'to save him the trouble of dictating and them of writing' the methods he demonstrated, and it was not regularly published. A copy having got to Cologne, the tract was at once reprinted in 1611, in a tiny 16mo, much to his disgust, and he was thereby compelled to bring out a revised edition, which was published in 1612. A French translation by the author appeared in the same year. The 'Tyrocinium' afterwards became the most popular text book of its time, for between 1611 and 1669 it passed through some fifty editions. There is a list of these (says Ferguson) in my memoir of Beguinus, read to the Philosophical Society of Glasgow but not yet published. There are two translations into German. The English translation ['Tyrocinium Chymicum': or, Chymical Essays, acquired from the Fountain of Nature and Manual Experience. By John Beguinus, Almoner to the most Christian King of France. London: Printed for Thomas Passenger, at the three Bibles upon London-bridge, 1669] was made by Richard Russell [who is famous for his translation of Geber]."

"The book is merely an outline of certain pharmaceutical preparations, but incidentally there is some general chemistry, and it contains the description for the first time of certain substances, with the discovery of which the author is credited."

A careful study of the "Elémens de Chimie" has led me to place a considerably higher value on the book than that assigned to it by Ferguson, and it is scarcely doubtful that the great Lemery (1645—1715) must have been very much indebted to it. It has therefore seemed desirable to place on record some of its main characteristics, especially in view of the facts that copies are rare and that Béguin has never received his due share of attention.

The present copy is described as the fourth edition —which probably implies the fourth edition of the French translation with Lucas de Roy's commentary. The notes and additions made by the commentator are easily distinguishable from the text as they are printed in italic type. Béguin's object in writing the book was, he tells us, to maintain that the new "chemical" remedies, that is, metallic derivatives and the like, were more agreeable, more efficacious and less dangerous than the old vegetable potions. "Chemistry is an art which teaches how to dissolve the natural mixed bodies, and to coagulate [crystallise or precipitate] them when dissolved, in order to make more agreeable, salubrious and reliable medicaments. The word *Chymie* is Greek, signifying in French the art of making liquids, or to reduce solid bodies to a liquid. It is thus called, *par excellence*, inasmuch as it shows how to dissolve (which is more difficult) and also to coagulate. . . . If it is called the Distillatory Art, this is because distillation is its most beautiful and principal operation."

Chemistry is essentially a practical art, although there are people who are content with theory only, and never give themselves to the elegant operations of this art. The subject-matter of chemistry is the compound body, not as susceptible of motion, which is the province of physics, but in virtue of the fact that it may be dissolved and coagulated. Hence men who hear the name "Alchemist" should not immediately think of one who spends all his time in the transmutation of the metals, and dreams of nothing but the admirable mystery of the Philosophers' Stone.

The vulgar drugs and remedies are often useless and obnoxious, as well as difficult to make and not seldom dangerous in use. The patient, at the smell of some *syrop magistral*, "made by great labour according to some recipe I don't know how many feet long," is often "constraint de se vuider

haut et bas sans autre cérémonie." Chemical remedies have never been known to give rise to these unpleasant symptoms. Having elaborated this point in some 26 pages, Béguin winds up his introductory chapter by asserting that chemical medicines, principally those extracted from metals and minerals, will cure epilepsy, leprosy, gout, quartan fever, dropsy, and several other maladies regarded as incurable, and that with "toute douceur, vitesse et sureté."

The three chemical principles are mercury, sulphur and salt, but it must not be imagined that by a chemical resolution one can extract from all bodies the mercury, salt and sulphur sold in apothecaries' shops. The substances into which animal and vegetable bodies may be split up merely have such a resemblance to mineral mercury, salt and sulphur, having relatively the same differences in their essences, actions and properties, that one is justified in calling them by these names. Philosophers have, indeed, given these three principles many names, some of which are indicated in the following table :—

SALT	SULPHUR	MERCURY
Common salt	Saltpetre	Sal armoniac
Bitter	Sweet	Acid
Body	Soul	Spirit
Matter	Form	Idea
Patient	Agent	Informing and moving
Art	Nature	Intelligence
Sense	Judgment	Understanding
Material	Spiritual	Glorious

[Observe the influence of Paracelsan views.]

In illustration of his thesis, Béguin gives an example, since ocular experience is always better than mere reasoning. "If you heat green wood, first of all there is produced an aqueous vapour which is non-inflammable but which can be converted into water if it is collected. . . . This water is called mercury. Afterwards comes an oleaginous and easily inflammable vapour, which if collected becomes transformed into an oil, and is called sulphur. Finally, there is left in the cinders a dry earthy body, which can be extracted with water, and deliquesces in a cold and moist place. It can be converted into a solid by heat, and is called salt."

It should be noted that none of the three principles is free from more or less admixture with the other two. In addition, during chemical resolution, two other substances are commonly met with, which, however, are not to be regarded as "principles"; they are the *terre damnée* or *tête morte* and the *phlegme insipide*. It is customary to neglect them as they have no medicinal virtues.

In the chapters immediately following, Béguin describes the chief chemical operations and gives a table to show their inter-relationship :—

La Chymie a pour objet le corps mixte, duquel elle enseigne
- La solution, de laquelle y a deux especes
  - Calcination, qui se fait par
    - Corrosion par
      - Amalgamation
      - Precipitation
      - Stratification ou cementation avec laquelle a affinité la commixtion
      - Fumigation
    - Cinefaction
    - Ignition par
      - Reverboration, à laquelle se rapporte l'exsiccation de l'humidité native
  - Extraction qui se considere
    - Generalement quand elle est faite par
      - Ascension qui est
        - Seche, qu'on nomme sublimation.
        - Humide, qu'on nomme distillation.
      - Descension qui est
        - Chaude, ou distillation par descension
        - Froide, qui est double
          - Filtration
          - Deliquescence
      - moyen intermede qui se fait par
        - Digestion, qu'on nomme aussi maceration
        - Putrefaction
        - Circulation à quoi se peut rapporter la fermentation
    - Specialement qui se fait par separation de la teinture des corps par menstruè convenable.
- Coagulation laquelle bien qu'elle se trouve toujours avec les especes de solution, amalgamation, precipitation, sublimation, et distillation, toutesfois elle se fait particulièrement par
  - Exhalation
  - Coction
  - Congelation
  - Fixation

TABLE OF CHEMICAL OPERATIONS, SLIGHTLY ABRIDGED

He then proceeds to describe each of these operations in detail. *Calcination* is the reduction of a body to a calx, and is defined by Geber as the pulverisation of a substance by heat. By the word *calx* chemists mean any very fine powder, made by the dissipation of the humidity which bound its particles together; it is applied principally to minerals. When the powder or calx is rendered impalpable, like extremely fine flour, they call it *alcohol*, a word which they use also to express rectified spirit of wine or *alcohol of wine*. It is interesting to find this late survival of the word alcohol in its general mediæval sense; originally, as is well known, *al-kuhl* was the powdered lead or antimony sulphide used as a cosmetic in the East.

Corrosion is a calcination of the compound by corrosive substances, and is carried out in several ways, principally the following; amalgamation, precipitation, stratification and fumigation. Of these,

precipitation is a corrosion made by acids (aqua fortis, etc.), and is performed by plunging the body into the corrosive liquid. Then, after having been corroded or dissolved, it is reduced to a calx, either by separation of the aqua fortis or otherwise. Here Lucas de Roy adds :—" If after solution of the body the aqua fortis does not quit the calx, chemists are accustomed to add substances which will bring about this separation, viz., either plain water, so that by this means the aqua fortis, having lost its strength, leaves the said calx and allows it to *precipitate, i.e.*, to sink to the bottom ; or they add salt or hot salt water. But according to the diversity of material there is a diversity of separations ; thus to separate silver they place in the solution a sheet of copper, to which the silver calx joins and attaches itself by some occult property."

Sublimation is an extraction of most subtle dry parts, which become elevated by the fire and adhere to the vessel. It is carried out by placing the suitably prepared substance to be sublimed in a pot with a round or flat bottom, until the pot is half full. The latter is then placed in a furnace, and to it is luted an aludel, tall enough to reach above the furnace. On the aludel is fixed an alembic having no spout but provided with a small hole in the middle of the top to allow the humid spirits to escape. Afterwards the apparatus is gradually heated, and when all the humidity has been exhaled (which one recognises when, applying a piece of glass or sheet of well-polished iron to the hole, the vapour can no longer be detected), one stops the hole with luting-clay and increases the fire in order to drive up the dry spirits. Now since, according to Geber, sublimation is an elevation made by the fire of a dry body which adheres to the vessel,[1] it appears how *mal à propos* is the vulgar confusion of sublimation with distillation, and with how little reason distilled waters are called " sublimed waters " by some. Furthermore, it should be remarked that this chemical operation is not a new invention, but that it was known to the ancients. For according to Galen and Dioscorides cadmia is prepared in this fashion, and thence pompholyx and spode.[2]

" Distillation," says Béguin, " is an extraction of the humid parts of a body, which are attenuated and elevated as vapour by means of heat." Further details are given by Lucas de Roy in his note on this section : There are two kinds of distillation, viz., direct and oblique. While the oblique is carried out by ascension only, the direct may be *per descensum* as well. In direct distillation by ascension the vapours condense at the top of the alembic and the liquid falls back into the grooved rim, whence it passes into the tube leading to the receiver. " This resolution of the vapours is greatly improved if one pours cold water all round the alembic and its tube."[3] Direct distillation is related to distillation *par la campane*, by means of which oil of sulphur is prepared [*lit.*, by means of which the oil is extracted from sulphur.]

[1] *Summa perfectionis*, Book II, Part 4, Chap. 3 (Russell's translation, 1678, p. 88) : " Wherefore we say, *Sublimation* is the *Elevation* of a dry thing by *Fire*, with adherency to its Vessel."

[2] Cadmia, pompholyx and spodo are all varieties of impure zinc oxide. Under *spode*, Littré gives Oxyde de zinc obtenu par sublimation en calcinant la tuthie.

[3] For the history of the continuous cooling device in distillation see E. O. von Lippmann's *Beiträge zur Gesch. d. Naturw. und d. Technik*, Berlin, 1923, pp. 127 *et seq.*

Oblique distillation is that in which the spirits are made to emerge from the side of the vessel; it is principally used for the distillation of minerals. The vessel in which it is carried out is called the *retort*.

Filtration consists in passing the liquid through grey paper or through a small piece of cloth, so that the large particles are retained on the filter. Lucas de Roy adds, " There are certain things which need to be squeezed, but that which filters without pressure is clearer, and that which goes through under pressure is more turbid. There are also things which must be filtered more than once in order to clear them. Finally, if they are viscous, sticky and slowly running syrups, they must be heated as well."

Deliquescence is when impure calces, salts and similar liquefiable substances are placed uncovered upon a marble slab or sloping glass, or are hung in a bag in a vaporous air, where they yield their *humour* in a pure state. Nevertheless it sometimes happens that no separation of parts is made by deliquescence ; thus when certain salts are placed in a cellar or some other cold and damp place, the external humidity promptly insinuates itself into them and resolves them into a liquid, which may be collected in a vessel placed below to receive it.

Fermentation, although it does not make such an evident separation of the subtle parts from the gross, is nevertheless a way of extracting a very noble essence. Both liquids and solids may be fermented. Liquids which have the quality of hotness, such as the juice of pears and apples, will ferment spontaneously, but those which are of a cold quality, such as cold expressed juices, require the addition of some foreign substance to advance the ebullition and fermentation. Wine lees, yeast, or salt may be used for this purpose.

The two principal operations in chemistry are solution and coagulation. Various methods of solution have already been described, so that it only remains to speak of coagulation. *Coagulation* is that process by which soft and liquid bodies are rendered solid by privation of their humidity. It is brought about in four ways : (1) by exhalation, in which the humidity of the substance to be coagulated is evaporated ; (2) by decoction, in which liquid substances are reduced to a more solid consistency ; (3) by congelation, as when crystals are produced in cellars by the cold ; (4) by fixation, in which substances which are volatile and fly from the fire are rendered able to withstand the latter. It is carried out by addition of a fixative medicine, or by mixtion, sublimation, or cementation, or otherwise according to the nature of the substance dealt with. . . .

The remaining portion of the first part of the book is taken up with practical details concerning the apparatus of the laboratory. Lucas de Roy's note on cutting glass is of interest :—" Il faut quelquefois eslargir la bouche et entrée principalement des cucurbites, en couppant et comme attestant leur

plus haute partie, d'autant que par la faute des verriers, qui les soufflent, ils finissent en col estroit. Pour faire donc ledit attestement il faut avoir tout prest, et à la main des cercles de fer, attachez à des bastons longs ou manches, l'un desquels esgalement approprié en son interieure superficie à la partie et endroit du verre, qui doit estre couppée, sera mis au feu et rougi. Puis appliqué en le tournant doucement ou luy fera serrer le verre estroitement, et l'ayant osté quelque peu apres, il faut soudainement espancher sur le lieu eschauffé par le cercle quelque goutte de salive ou d'eau froide, et ainsi se coupera le verre. l'eschauffant avec méche d'arquebuse allumée par le bout, ou avec le bout d'une verge de fer rougie, la partie du verre ainsi eschauffée et touchée avec le doigt mouillé se fendra aussi tost, s'allongera et croistra la fente ou fissure en la façon que vous voudrez en movant et advançant peu à peu la méche ou verge, ce qui reüssira plus heureusement, si auparavant vous marquez l'endroit et le lieu à couper avec esmeril ou diamant."

Having explained in the first part the general methods of working, Béguin proceeds in the second to give particulars and details of the various operations He begins by sounding a note of warning against the use of leaden vessels in distillation. "Que les vases où on distille ne soient pas de plomb" for they impress a malignant quality on the liquids which are distilled in them, and render them vomitive, quite apart from the fact that the vessels themselves are corroded. It is a fact, he says, that addition of a drop or two of sulphuric acid to liquids which have been distilled in lead vessels will cause precipitation of *ceruse* [lead sulphate here]. He remarks also that care should be taken that the luting material employed to lute together the various parts of a distillation apparatus yields no vapour on heating, lest the liquid distilled should be infected by a foreign quality.

After more preliminary matter of this kind, Béguin gives practical details for the preparation of particular substances. Of these, many have little interest for us at the present day, but others are of importance. In all the instructions, however, it is easy to recognise the work of a man who always appealed to experiment rather than to authority: a characteristic by no means common at that period. A few of the preparations which are described may be noted here.

Eaux Fortes. "Strong waters," which are also called caustic, parting [separatoires], royal, and "de "Gehenne," are obtained by the action of great heat upon vitriol, saltpetre, sal armoniac, antimony, mercury sublimate, alum, cinnabar, and the like. The most caustic of them is *aqua regia*, which dissolves gold. Ordinary *aqua fortis* is prepared as follows. Take two pounds of dried vitriol and a pound of ordinary saltpetre. Grind or mix them together, then place them in a retort in a reverberatory furnace, and having adapted an ample receiver distil gradually for 20 hours. The *aqua fortis* which has distilled over is then purified by silver. A quarter of it is taken, and a dram of refined silver thrown in. When the latter has dissolved, the solution is poured into the remaining three quarters of the original distillate, which will become as white as milk. Let the precipitate settle, and pour off the clear supernatant liquid, which will now be pure. To make *aqua regia*, dissolve one ounce of sal armoniac, or of dried common salt, in four ounces of *aqua fortis*; it will then dissolve gold. Lucas de Roy adds, "It is called *aqua regia* because it dissolves gold, which is the king of metals. It is also called the *Water of the Two Champions*, because nitre and sal armoniac fight at their first meeting, like two sworn enemies. Sal armoniac is called the *Eagle*, because it carries off the gold as the Eagle carried off Ganymede.

Spirit of Common Salt.—The discovery of hydrochloric acid is often attributed to Glauber (1648), or to the pseudo-Valentine (probably about the beginning of the seventeenth century), but Béguin refers to "spirit of salt" as a substance already well known. "Les artistes ont inventé divers moyens pour tirer l'esprit de sel . . . mais moy, je le tire ainsi." "I take 2 lb. of calcined sea-salt and mix it with 6 lb. of brick dust or red earth or common clay. Then I put it in a large and strong retort, of such a size that a third part remains empty. I next adapt a large receiver, in which I put a pound of distilled water, and afterwards I distil for 30 hours, carefully regulating the fire as in the distillation of spirit of vitriol. Then, after having separated the water and the phlegm, I have left at least 20 ounces of spirit, which it is necessary to rectify." The last part of the description is not free from ambiguity, but it seems clear that he obtained a solution of hydrochloric acid. It is of interest to note that Béguin's method agrees almost word for word with that given in an Arabic MS. of about the same date, and of Syrian origin, preserved in the library of the Vatican.

Spirit of Nitre, which Béguin apparently distinguished from *aqua fortis*, is made in a similar way, viz., by heating a mixture of saltpetre with clay. Lucas de Roy notes that water distils over first, but that when the temperature is raised, deep red spirits (which are called *sang de Salamandre*) make their appearance. To separate the phlegm from the spirit (that is, to concentrate the acid) the crude product must first be heated in the water-bath, which removes most of the phlegm, and then redistilled. Care should be taken, he says, in working with the acid, never to mix it, when concentrated, with alcohol, "de peur que le esprits de vin et de nitre, estans meslez purs, ne viennent à causer quelque inflammation." According to Béguin, nitric acid is a useful medicine for colic, pleurisy, quinsy and the stone.

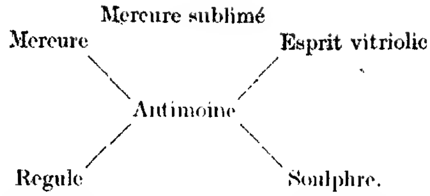
He next describes the preparation of an odoriferous liquid—presumably acetone—by the distillation of lead acetate. It is necessary to lute all the apparatus carefully, "autrement tout le laboratoire se remplira d'une si grande et si suave odeur, que je croy fermement qu'elle surpasse de beaucoup les odeurs de tous les vegetables odiferons mis ensemble."

Poudre Emetic d'Antimoine, ou Mercure de Vic.—Take four ounces of powdered antimony [sulphide] and eight ounces of mercury sublimate. Mix the two together and distil in a retort to which is fitted a

receiver half full of water. If the gummy, butter-like liquid [$SbCl_3$] sticks to the neck of the retort, melt it with a hot coal. When it falls into the water it will be precipitated as a white powder [$SbCl_3+H_2O=SbOCl+2HCl$]. Afterwards heat the retort very strongly and cinnabar will sublime into the neck [$Sb_2S_3+3HgCl_2=2SbCl_3+3HgS$.]. De Roy notes that the white precipitate obtained in the above operation is called *poudre emetique* or powder of Algeroth, "du nom de *Victorius Algerothus*, Médicin et Physicien de Verone, qui luy a donné vogue," or, again, *fleurs de beurre d'antimoine*.

Of especial interest is Béguin's explanation of the formation and constitution of this *poudre emetique*. It is so clear and logical that it appears desirable to quote it *verbatim*: "Je ne me peux toutes-fois assez estonner commes plusieurs doctes, mais peu experts, se sont laissez emporter à une opinion de croire que cette poudre emetique provient du mercure sublimé et non du regule d'Antimoine. Car j'ay assez fait paroistre cy devant à toutes sortes de qualitez de personnes et gens doctes, qui ont honoré mon petit laboratoire de leur presence, et ce par raison fondée sur l'experience (veu que je n'en admets point d'autre en cet art), que la poudre emetique n'est autre chose que le regule d'antimoine [*i.e.*, metallic antimony], dissout et calciné par l'esprit vitriolic du sublimé: duquel l'esprit elle retient d'autant plus ou moins qu'elle est beaucoup ou peu lavée . . . Et par ce que le regule d'antimoine approche plus de la nature metallique que le Mercure, voila pourquoy distilant le mercure sublimé avec l'Antimoine, l'esprit vitriolic du sublimé quitte le Mercure, et se joinct et attache au regule de l'Antimoine. Et se sentant pressé et chassé par la chaleur, dissoult et calcine le regule, et passe en liqueur gommeuse ou huileuse par le bec de la cornuë; et tombant goutte à goutte dans l'eau qui est dans le recipient, l'esprit de vitriol se dissoult dans l'eau, et le regule tombe en poudre blanche au fonds du recipient. Cecy se recognoist au goust de l'eau qui est impregnée de l'esprit vitriolic, et à la fusion de la poudre emetique à fort feu de soufflets, laquelle se tourne en vray regule d'Antimoine. Davantage apres que toute la liqueur gommeuse est distilée, ne reste plus dans la cornuë que le mercure du sublimé et le soulphre de l'antimoine. Et parce qu'ils ont une extreme sympathie par ensemble en donnant feu de suppression, ils se subliment par ensemble au col de la cornue en cinabre. Je concluds donc par ces experiences infaillibles, que la poudre emetique n'est autre chose que le regule d'antimoine calciné, par l'esprit vitriolic qui est dans le sublimé."

This remarkably penetrating explanation of the reaction between antimony sulphide and mercuric chloride, together with the observation of the hydrolysis of the antimony chloride by water, has—to the best of my knowledge—been overlooked hitherto. It says much for Béguin's chemical instinct, and at once reminds us of the careful theorising of Black a century later. It is certainly a pleasant relief from the vapourings of contemporary alchemists. Béguin completes his explanation by what I imagine to be one of the earliest graphical formulæ:—



This expresses the facts: (*a*) that mercury sublimate consists of mercury and an "acid radical," as we should say now; (*b*) that antimony (*i.e.*, stibnite, Sb_2S_3), consists of a metallic regulus and sulphur; and (*c*) that when the two substances are heated together the acid radical of the sublimate combines with the regulus of the stibnite, while the sulphur and mercury thus set free combine to form cinnabar. Béguin also observed that the antimony chloride lost more or less of its acid radical on treatment with water, and that the water itself became acid in the process.

White Precipitate.—Dissolve mercury in *aqua fortis*, and add a solution of salt. A white precipitate is obtained, which must be washed until free from acid, dried, washed with rose water and dried again.

Red Precipitate. Dissolve mercury in nitric acid and evaporate to dryness in a strong fire. A red precipitate will be left This is a very useful medicine, since it is a sovereign purgative in leprosy. It may be given without danger to women and young children, and the dose is six grains.

Space will not permit the description of Béguin's methods of preparing stannic chloride, yellow oxide of mercury, fulminating gold, and many other substances, but one cannot close this article without noting the fact that he describes for the first time the preparation of benzoic acid from gum benzoïn.* "Take benzoin coarsely powdered and put it in a round pot, which cover with a cornet of grey paper . . . then administer the sublimation fire, and collect at frequent intervals the flowers which have sublimed. They are white as snow, and are none other than the essential salt of Benzoin . . . they are a very proper remedy for pimples and redness of the face."

The book ends with the quotation, "L'homme brutal ne cognoistra point, et le fol n'entendra à ces choses."

* The origin of the word *benzoin* is interesting, especially since it is itself the root of those honoured words *benzene*, *benzoïc*, *benzoyl*, etc. Benzoin or benjoin is a corruption of *lubān jāwā*, which is the Arabic for *incense of Java*, the best sort of incense coming from Sumatra, which the Arabs erroneously called Java. When the name *lubān jāwā* reached Europe, the first syllable was mistaken for the definite article *al* and therefore dropped. The *bān jawā* thus left finally became converted into benjoin or benzoin

The late Mr. J. C. Hewlett, chairman of C. J. Hewlett and Son, Ltd., manufacturing chemists, and a fellow of the Chemical Society, left estate of the gross value of £144,711, with net personalty, £114,840.

CHEMICAL ENGINEERING AT THE BRITISH EMPIRE EXHIBITION

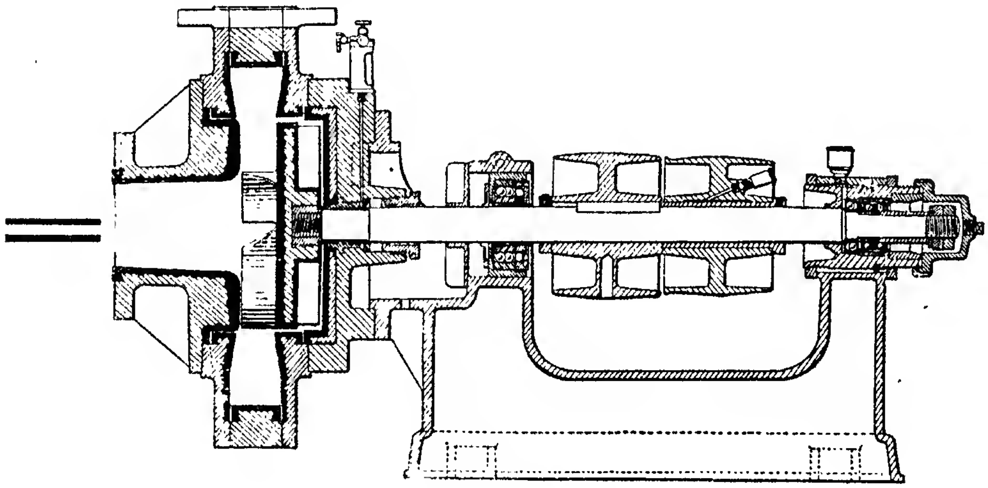
By Prof. J. W. HINCHLEY

(*Continued*)

The illustration (Fig. 7) of the "Resiline" Pump by the Pulsometer Engineering Co., Ltd., brings out the high standard of its design. Ball bearings support the spindle, and a ball thrust bearing maintains the exact position of the impeller to give the minimum "slip." The loose pulley is smaller than the fast one—a small matter, but a real economy in belting and power.

The "Reform" Dust Collector, which is shown at work by Henry Simon, Ltd., of Manchester, although designed for the flour-milling industry should prove an excellent air filter for use in many other dry grinding operations. The filter consists of a number of vertical cloth filter sleeves, arranged in a case in groups. By a simple mechanism the dust-laden air is shut off from each group of sleeves in turn, and a current of pure air drawn through them in a reverse direction. While this pure air is passing through, the sleeves are shaken vigorously several times to dislodge the dust clinging to their surface, which falls into a hopper below.

What may be considered a new process of separating particles according to size is shown, at work on grain, on the same stand. The "Carter" Separator consists of series of discs rotated together on the same horizontal shaft. Each disc is provided with depressions over its surface on both sides, and corresponding in size to the position of the disc on the machine, or rather, to the size of grain to be lifted at that position. It will be realised that if the grain is made to pass from one end of the machine to the other, the removal of grains according to size may be accomplished by the larger grains at any point failing to be lifted by the depressions in the disc provided. The efficiency of the machine on grain is remarkable, and apparentl much higher than would be possible by a siftin process.



The "Resiline" Pump

FIG. 7

The Peebles Sand Washer for the sand of filte beds should be examined. It consists of a series c hoppers and washing chambers through which th sand passes, and in which in turn it is submitte to the action of jets of water. The wash wate makes a complete cycle through the sections, an is effectively used before running to waste.

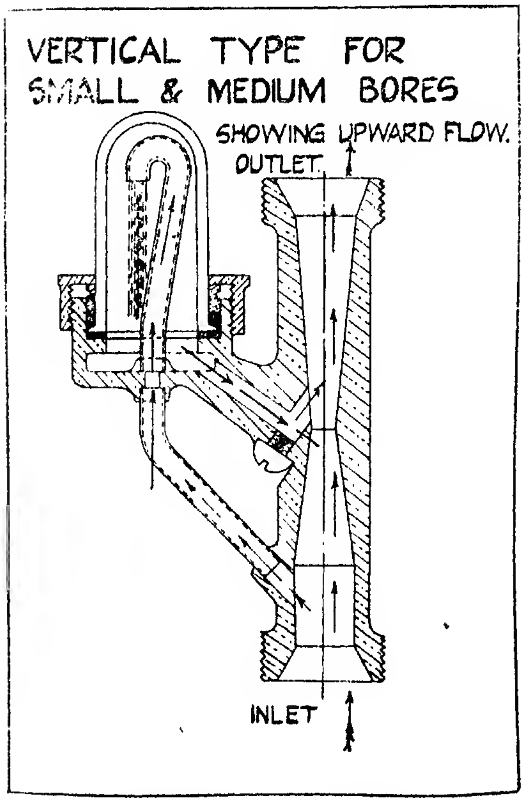
A simple sight flow indicator (Fig. 8) for liquids unde pressure is shown by R. and W. Hawthorn, Lesli and Co., Ltd., of Newcastle-on-Tyne. The apparatu is placed in the pipe line and consists of a Ventu tube, that is, the bore of the tube is gradually con stricted and over the tube a chamber with a vertica glass bell is provided. A small curved pipe lead from the inlet to the top of the glass bell, and a smal opening is made in the base of the glass bell chambe leading to the constriction. On account of the diffe ence in velocity produced the pressure at the constric tion is lower than at the inlet, and a portion of th liquid rises through the little tube leading to the to of the glass bell, and may be seen discharging. Th indicator is said to work effectively at velocitie as low as one foot per second.

The Howden-Ljungstrom Air Preheater shown b James Howden and Company, Ltd., of Glasgow, for use in boiler plants, introduces a new principle in continuous heat exchangers—discontinuous heat exchangers on similar lines are well known. Now, the problem of heat transmission between gases is a difficult one on account of the low rate of heat transfer. A notion of this difficulty will be realised when it is stated that heat transmission by saturated steam to water with the same temperature drop may be over five hundred times greater than between gases. This pre-heater avoids a large portion of this difficulty by using metal plate surfaces which are alternately carried into the currents of hot and cold gas, so that

in one part of the apparatus the gas heats the plates, and in another part the hot plates heat the cold gas. The metal plate surfaces are part of a cylindrical rotating member, carried in a vertical casing, divided vertically to form two conduits, one for the hot gases to heat one side, and the other for the cold air to be heated by the other side of the rotating member. The gas and air pass in opposite directions, *i.e.*, counter current heat transfer takes place.

Among the accessories exhibited, the level indicator of Dewrance and Co., London, ought to find many applications. A series of louvres are placed behind the ordinary gauge glass and an electric lamp is fitted near the bottom of the tube. The level of the liquid is seen by the meniscus being illuminated and appearing as a bright red glow.

Another device which is only novel in the excellent way in which the design is carried out is "Tompkins Tangential Drier" (Fig. 9) for steam. It consists of a compact box which may be placed in any pipe

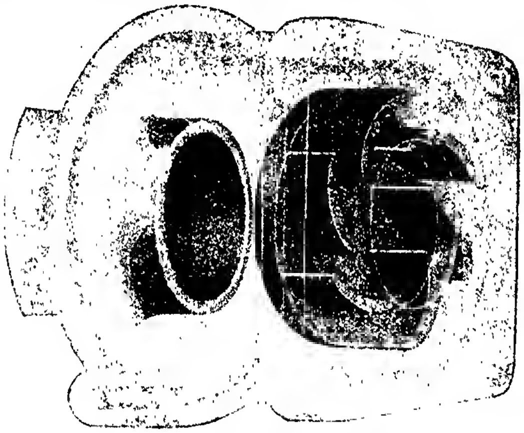


Hawthorn Sight Flow Indicator

FIG. 8

line. The box contains a fixed set of turbine blades which produce an energetic whirling of the steam by which the water is projected on to the inner surface of the box and flows away through the small pipe provided. It forms an excellent "save-all."

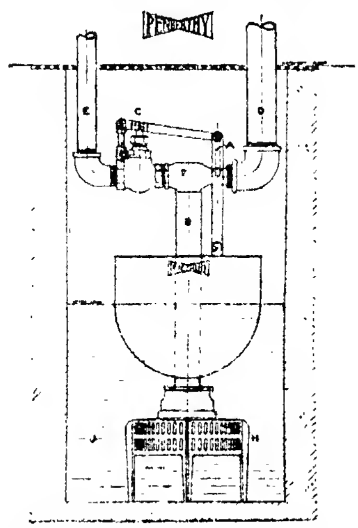
An automatic cellar drainer (Fig. 10) is shown at work by W. H. Willcox and Co., Ltd., London. It consists of a compact and well thought out arrangement of



Tompkins' Tangential Drier

FIG. 9

an ejector, a float and a valve with a strainer and foot valve. The float actuates the valve of the ejector in such a way that it is never partially open—always fully open or shut. Failure through corrosion or through deposits of slime etc. is prevented by the working parts being above the level of the liquid.

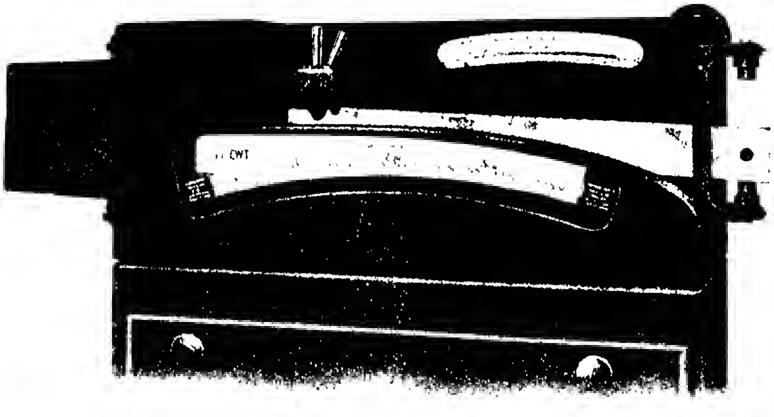


Penberthy Automatic Cellar Drainer

FIG. 10

The distribution of superheated steam is a more economical process than that of saturated steam. The heat losses are lower because the superheated steam acts as a permanent gas and a stationary somewhat non-conducting film is formed on the

inner surface of the pipe. With saturated steam on the other hand, the formation of a film is prevented by continuous condensation. Consequently, saturated steam is essential for economical heat transference, so that in many works superheated steam must



Avery's Platform Weighing Machine
Fig. 11

be converted into saturated steam at the plant where it is to be used. An interesting application of the "Area" regulator for this purpose is demonstrated by British Area Regulators, Ltd This regulator is well known for its precision in controlling the pressure, temperature, humidity or other physical condition in chemical plants. The regulator depends for its precision of action on a hydraulic relay device. The free flow of water from a small jet is affected by the movement of a lever. The difference of pressure produced actuates a pilot valve which in turn controls the supply of water to a hydraulic cylinder operating the regulating valve or other mechanism. For desuperheating steam, water is sprayed through a series of jets under the control of the regulator so as to reduce the temperature of the steam to the desired figure regardless of the quantity of steam passing.

Measurement in factories is the root of all sound commercial and technical control, and any improvement which renders mistakes difficult, increases accuracy, or saves time and mental worry should not be neglected

An improvement in platform weighing machines is shown by W. and T. Avery, Ltd., Birmingham (Fig. 11) On placing the goods on the platform an indicator shows the notch in which to place the poise for the hundredweights, and the minor reading, quarters, pounds, and ounces are shown by the indicating finger on the chart. If the poise is placed in the wrong notch, the indicator directs attention to the correction required. An improved protection bar, with Vee instead of square notches, is fitted to prevent wear and damage to the Vee notch on the steelyard.

In this respect it is a matter for comment that few firms adopt a single unit of weight in their works. The errors and loss of time which accrue from the use of 56, 28, 14, 7, etc. pound weights with ounces as sub-divisions are not appreciated, until one has realised the delightful simplicity of working with pounds only on a decimal system. Why do not firms who make weighing apparatus help manufacturers to adopt a method which is so advantageous?

(To be continued)

SMOKE POLLUTION IN FRANCE

A Police Ordinance of the Municipality of Paris, dated June 22, 1898, forbids the production of a thick and prolonged black smoke which might reach neighbouring habitations and vitiate the atmosphere of the streets of Paris. Using this Ordinance as a basis the Ministers of Commerce, Public Works, Interior Work, and Hygiene, have distributed throughout France a circular of which the following is a translation: "The Carbonisation Commission attached to the Ministries of Commerce and Public Works, has been struck, whilst studying means of favouring the development of the carbonisation of coal, with the necessity of restricting as far as possible the consumption of "fat" and "flaming" coals in a crude state, the scientific utilisation of these fuels consisting in previous carbonisation to remove volatile products and of burning them afterwards solely in the form of coke. An excellent method of obtaining this result would be to forbid the production of smoke in urban districts as has been done in Paris. In certain regions where special fuels are produced such as lignites or coals, with too high an ash content to be carbonised economically, and which will still have to be utilised in a crude state, measures of prohibition should be taken with precaution, and allowing sufficient time so that the adaptation of plant can be made progressively."

FORTHCOMING EVENTS

June 28. MINING INSTITUTE OF SCOTLAND. General Meeting, at City Chambers, Kirkgate, Dunfermline, at 3.30 p.m.

July 3. INSTITUTION OF CIVIL ENGINEERS, Great George Street, Westminster, S.W. 1, at 5 p.m. Joint Meeting with various Engineering Institutions and Associations, the Institute of Chemistry, the British Electrical and Allied Manufacturers' Association, and other bodies which are co-operating in the work of the Special Committee on Tabulating the Results of Heat-Engine and Boiler Trials. A paper will be presented by Capt. H. Riall Sankey, C.B., C.B.E., upon the General Scope and Objects of the Work of the Committee, and there will be a discussion.

July 5. INSTITUTION OF MECHANICAL ENGINEERS, Joint Meeting with the Institution of Civil Engineers, Storey's Gate, St. James's Park, London, S.W. 1, at 11.30 a.m. Discussion on "Draft Standard Test Code for Hydraulic Power Plants."

July 7–10. INSTITUTION OF SANITARY ENGINEERS International Conference at the Royal United Service Institution in Whitehall, S.W., at 10 a.m. and 2 p.m. On July 8 papers will be read on "Activated Sludge," and on July 9 on "Sewerage" and "Disposal of Sewage and Trade Wastes."

July 9–12. SOCIETY OF CHEMICAL INDUSTRY, Annual General Meeting to be held at Liverpool.

July 15. THE INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (LONDON). Visit of Chemical Students to Wembley. At 9.45 a.m. an Inaugural Meeting will be held at University College, Gower Street, W.C. 1, at which the President of the Institute, Prof. G. G. Henderson, LL.D., F.R.S., will take the chair. Mr. W. J. U. Woolcock, C.B.E., General Organiser of the Chemical Section of the Exhibition and President-elect of the Society of Chemical Industry, will explain the objects of the exhibits and the special features of interest. Prof. W. P. Wynne, C.B.E., F.R.S., President of the Chemical Society, hopes to support the speaker at the meeting. The cost of the visit, including return ticket to Wembley, entrance to the Exhibition, and ticket for luncheon, will be 5s. Further information can be obtained from Mr. G. S. W. Marlow, 30, Russell Square, London, W.C. 1, and applications should be made not later than June 28.

July 16. INSTITUTION OF CHEMICAL ENGINEERS, Annual Corporate Meeting, at the Hotel Cecil, Strand, London, W.C. 2, at 11 a.m. At 12 noon the presidential address will be delivered by Sir Arthur Duckham. After luncheon at 1 p.m. (price 6s., excluding wines) Sir F. Nathan will review the work of the Educational Committee on "The Training of a Chemical Engineer," and at 3.30 p.m. the following papers will be read:—(1) "Self balancing Centrifugals," by E. A. Alliott. (2) "Evaporation in Currents of Air," by G. W. Himus and J. W. Hinchley. After tea, at 5 p.m., members will proceed to the British Empire Exhibition, and a tour of the Chemical Hall will be made under the guidance of Mr. W. J. U. Woolcock.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

The Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 10.30 a.m.

A detailed programme with form of application for tickets has been sent to every member of the Society.

Attention is drawn to the following alterations:

Wednesday, July 9, 2.30 p.m. Visit to White Star liner *Celtic* (instead of *Cedric*), and tea on board by invitation of the White Star Line.

Thursday, July 10. The Messel Memorial Lecture will be given at 9.45 a.m. (not 10.30) in the Arts Theatre, The University, and the visit to the works of Messrs. J. Crosfield & Sons, Ltd., Warrington, will be at 11.30 a.m. (not 12.30 p.m.)

Delegates will be present at the Meetings from several of the Allied Societies at home and abroad. Among these will be Prof. Dr. C. F. Van Nieuwenburg of Delft, President of the Dutch Chemical Society.

Members intending to attend the Meeting are requested to send their applications, accompanied by the appropriate remittances to cover tickets and cost of travelling, at once to Mr. E. Gabriel Jones, City Laboratories, Mount Pleasant, Liverpool, to whom all enquiries relating to railway travelling and other matters connected with the Meeting should be addressed.

The Midland Adelphi and the North-Western Hotels are both very nearly full for the period of the meeting. Members intending to be present, and who have not yet booked Hotel accommodation, should therefore do this at once.

OFFICIAL NOTICES

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The eighth volume of these Reports is now ready. The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members, post free in each case.

A Member of the Society may purchase a set of Vols. II to VIII inclusive at the reduced price of £2 2s. 6d., and a Non-Member can procure a set at the reduced price of £3 15s., post free in each case.

CHEMICAL SOCIETY'S LIBRARY

Members are reminded that, in accordance with arrangements entered into by the Council, they are entitled to consult the Library of the Chemical Society, Burlington House, Piccadilly, W. 1, and to borrow books therefrom.

The Library is open daily from 10 a.m. to 9 p.m., Saturdays from 10 a.m. to 5 p.m. As hitherto the Library will be closed on Bank Holidays, the day following, and on other such occasions as the Council may direct.

CHEMICAL SOCIETY

At an extraordinary general meeting, held at 7.45 p.m. on Thursday, June 19, the President, Prof. W. P. Wynne, F.R.S., explained the policy reflected by the resolutions, which were all carried in the form in which they were circulated to Fellows.

The last ordinary scientific meeting of the session followed, when the President expressed appreciation of the honour done to the Society by the presence of Prof. R. Nasini: he also referred with deep regret to the death of Dr. R. M. Walmsley. It was announced that the list of Fellows would not be printed this year, that Vol. V. of the Collective Index would now be sold at the price ruling prior to January 1923, and that the charge for the Annual Reports would in future be:—to Fellows, 5s 6d. post free (second and subsequent copies 8s. 6d. post free); to others, 10s. 6d. plus postage.

Prof. D. R. Boyd discussed:—

Hydrolysis, and the theory of induced alternate polarities.

The theory of induced alternate polarities has recently been made the basis of a comprehensive generalisation with regard to the phenomena of hydrolysis:

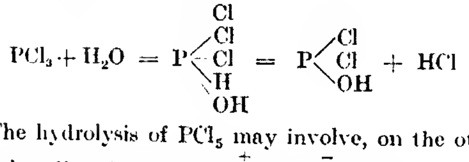
"The condition which facilitates the hydrolytic fission of a molecule —*ab*— into —*aH HOb*— is that *a* should be electronegative and *b* electropositive either because of their inherent character or as the result of an induced alternate polarity effect." (Robinson and Robinson, *T.* 1923, **123**, 533).

The application of this rule to compounds of the type RX, where X is a halogen, leads, however, to conflicting results. The hypothesis also fails to explain why compounds such as

$$(\overset{+}{C}_6H_5\cdot\overset{-}{O}\cdot\overset{+}{C}H_2)_2\overset{-}{C}H\quad\overset{-}{O}\cdot PHO(OH)$$

(Boyd, *T.* 1901, 79, 1223), are much more stable than $\overset{-}{C}H_3\ \overset{-}{O}\cdot PHO(OH)$; and why $\overset{+}{K}\cdot\overset{-}{SO_2}\overset{+}{O}\ \ C_2H_5$ is hydrolysed much more easily than $\overset{+}{K}O\cdot SO_2\cdot\overset{-}{O}\ \ C_2H_5$.

It is considered unlikely that the mechanism of hydrolytic fission is the same in all cases. The first step in the hydrolysis of PCl_3 probably consists in the formation of an additive compound:



The hydrolysis of PCl_5 may involve, on the other hand, a dissociation into $\overset{+}{P}Cl_4$ and $\overset{-}{Cl}$ ions:

$$\overset{+}{P}Cl_4+\overset{-}{Cl}+\overset{+}{H}+\overset{-}{O}H = PCl_4\cdot OH+\overset{+}{H}+\overset{-}{Cl}$$
$$PCl_4\cdot OH = POCl_3+HCl$$

It is not improbable that the first step in the hydrolysis of ethyl chloride is also an electrolytic discussion:—

$$C_2H_5Cl \rightleftharpoons C_2H_5^+ + Cl^-;$$
$$C_2H_5^+ + Cl^- + H^+ + OH^- \rightarrow C_2H_5OH + H^+ + Cl^-.$$

The hydrolytic fission of ethyl chloride is, on this view, closely comparable with the hydrolysis of sodium phenoxide:—

$$C_6H_5\cdot ONa \rightleftharpoons C_6H_5O^- + Na^+$$
$$C_6H_5O^- + Na^+ + H^+ + OH^- \rightarrow C_6H_5\cdot OH + Na^+ + OH^-$$

If, however, the Robinson rule is tested by reference to data with regard to the hydrolysis of the sodium tolyloxides (Boyd, *T.*, 1915, **107**, 1540), results are obtained which are in direct conflict with the views which have been developed by Lapworth and Shoesmith (*T.*, 1922, **121**, 1392) on the basis of the same experimental facts.

The discussion was opened by the Secretary reading the following contribution from Prof. Robinson:—

"The examples given by the author in the slip printed for circulation before the meeting are held to be wrongly interpreted. In the case of the diphenoxy*iso*propylphosphorous acid the effect of steric hindrance, always to be taken into consideration as an important factor, has not been mentioned, and is probably responsible for the stability of the compound. Even the polar effect would make it more stable than the methyl ester figured for comparison because of the powerful effect of the two oxygen atoms of the phenoxy-groups. Relatively to methyl, diphenoxypropyl must be a negative group.

The two mechanisms given for the hydrolysis of chlorides of phosphorus are obviously in agreement with the statement of the conditions of ready hydrolysis made by Robinson and Robinson. It is a confusion to include the phenomenon of the hydrolysis of salts of weak acids in this discussion."

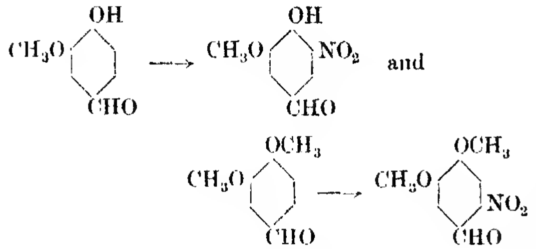
Prof. Lowry said that he saw no justification for the assumption of alternate polarities in the case of saturated compounds. The idea of ionic behaviour in organic reactions (the ions being formed in the course of the reaction) was put forward by Noyes in 1902; it was of interest to note that auric chloride formed not only the compound $AuCl_3$, HCl or $H^+[AuCl_4]^-$, but also one with phosphorus pentachloride which he was tempted to write $[PCl_4]^+[AuCl_4]^-$. If this formulation were acceptable, strong support would be afforded to Prof. Boyd's formulation $[PCl_4]Cl$.

Prof. G. T. Morgan said that it was difficult to get at close quarters with a theory the exponents of which continually shifted their ground. He considered the stability of the phosphorus compounds to be a question of their tetrahedral structure, in accordance with the characteristic co-ordination number 4 usually exhibited by phosphorus.

Dr. Flürscheim, who was in general agreement with Prof. Boyd's and Prof. Morgan's criticisms, said that in the triphenylmethyl halides Prof. Boyd had adduced especially important evidence. Ionisation, which alone involved proved electric charges on atoms, was pronounced in this case, where a central carbon atom, claimed to tend to assume an unproved negative charge, actually acquired a proved positive charge; it was negligible in carbon tetrachloride where carbon, with a postulated tendency to become positive, actually refused to acquire a *real* positive charge. Similarly, *p*-hydroxy-

cinnamic acid, with an enhanced "induced negative polarity" of carboxyl-oxygen, was weaker than cinnamic acid, whereas the meta-isomeride was stronger; a number of substituted benzoic and aliphatic acids behaved similarly. Here other factors, such as general polarity, could obviously not be invoked in explanation, and the facts must be unequivocally faced.

Dr. O. L. Brady referred to the two nitration effects :—



and enquired how these results could be reconciled with the polarity theory.

Prof. W. H. Perkin did not admit the reality of the difficulty, since unpublished work had shown that the nitro-group enters both positions to almost the same extent; separation had been effected by way of the *p*-toluidine compounds.

Prof. C. K. Ingold welcomed Prof. Boyd's paper as a much needed protest against *ex cathedra* utterances relating to the polarity theory, and the chosen evidence by which it was often upheld; moreover, the type of criticism employed was very widely applicable. If the phenyl group were, as had been stated, a key-position, the ambiguous polarity of an ethylene molecule should be determined by the introduction of a phenyl group in the direction $PhCH:CH_2$; the addition of $\overset{+}{H}-\overset{-}{Hal}$ and $\overset{-}{HO}-\overset{+}{Hal}$, replacement of H by NO_2, and replacement of H by OH then all proceed in a direction contrary to that indicated by the theory. The speaker protested against a series of reactions of no greater weight than these being "explained" in the Annual Reports on the assumption that the phenyl group is the key-position, and without reference to the adverse evidence.

In reply to Prof. Robinson, Prof. Boyd pointed out that the theory of induced polarities did not account for the extreme instability of methylphosphorous acid. It was difficult to understand how the processes of hydrolysis of the chlorides of phosphorus —assuming the mechanisms in the two cases to be essentially different in character—could both be conditioned by the same factor, namely, the polar differentiation between phosphorus and chlorine. Prof. Robinson's objection to the inclusion of cases of salt hydrolysis in the discussion was obviously unjustified if the hydrolysis of such compounds as ethyl chloride was preceded by an electrolytic dissociation.

Dr. O. L. Brady then spoke on :—

The isomerism of the oximes. Part XX. The isomeric p-*nitrobenzophenoneoximes and the four methyl ethers derived from them.* (With R. P. Mehta.)

THE stereochemical hypothesis of the isomerism of the oximes demands the existence of four isomeric ethers, an oxygen and nitrogen ether corresponding with each of the two isomeric oximes. Although two isomeric O-ethers had been obtained from certain aldoximes and ketoximes, until 1918 all attempts to obtain a second N-ether had been unsuccessful. Semper and Lichtenstadt (*Ber.*, 1918, **51**, 928), however, prepared two N-methyl ethers from phenyl-*p*-tolylketoxime, but, though they isolated two O-methyl ethers, one was an uncrystallisable oil and consequently of doubtful purity. The importance of this in relation to the structure of the oximes demanded confirmation and the isomeric *p*-nitrobenzophenoneoximes have now been prepared and from them four distinct, crystalline, methyl ethers. *anti*-*p*-Nitrobenzophenoneoxime (I) on methylation gives a yellow crystalline N-methyl ether m.p. 148° and a colourless crystalline O-methyl ether m.p. 94°. *syn*-*p*-Nitrobenzophenoneoxime (II) gives a yellow crystalline N-methyl ether m.p. 176° and a colourless crystalline O-methyl ether m.p. 97°.

$$\begin{array}{c} NO_2{\cdot}C_6H_4{\cdot}C{\cdot}C_6H_5 \\ \| \\ NOH \end{array} \qquad\qquad \begin{array}{c} NO_2{\cdot}C_6H_4{\cdot}C{\cdot}C_6H_5 \\ \| \\ HON \end{array}$$

(I) (II)

The constitution of the ethers was proved by the action of hydriodic acid, the O-ethers giving methyl iodide and the N-ethers methylamine. The molecular weights were normal in every case. The two N-ethers differ in crystalline appearance as do the two O-ethers; addition of a small quantity of one N-ether to the other lowers its melting point and the same is the case with the two O-ethers, a mixture of about equal quantities of the latter melting at 61-72°.

Prof. W. H. Perkin expressed his keen appreciation of the author's work on oximes. With reference to Dr. Brady's criticism of Meisenheimer's suggestion that the Beckmann change occurs across the molecule :—

$$\begin{array}{c} R{\cdot}C{\cdot}R' \\ \| \\ HON \end{array} \longrightarrow \begin{array}{c} R{\cdot}C{\cdot}OH \\ \| \\ NR' \end{array}$$

he had also come to the conclusion that the suggestion could not be accepted without much further work.

Mr. E. M. Richards read a paper on

The significance of simple rotatory dispersion. (With T. M. Lowry.)

THE phenomenon of simple rotatory dispersion is discussed in the light of new experimental data, with reference especially to camphorquinone, ammonium bromo-camphor-π-sulphonate and methyl*cyclo*hexylideneacetic acid.

Owing to the lateness of the hour, the communication of the latter portion of the paper was postponed.

At the President's invitation, Prof. Lowry rapidly summarised the paper, saying that it dealt with a new test for, and demonstrated the existence of, simple rotatory dispersion. If the two rectangular hyperbolas obtained by plotting α against λ^2 were averaged along a series of horizontal intercepts, the vertical asymptote of the resulting genuine hyperbola would be intermediate between those of the parent curves; the false hyperbola, obtained by averaging the parent curves vertically would, if treated as a genuine hyperbola, swing aside from the asymptote. The genuine hyperbola would always have as its asymptote the central line of a real absorption-band, whilst the false hyperbola would be directed into empty space.

Mr. H. Hunter offered his congratulations, but desired to withhold any further comment until he had seen the paper.

Dr. R. H. Pickard said that Mr. Hunter's papers had brought forward work giving proof of a point which had been dubious. It must, however, be remembered that the refinements of polarimetry were still not great, and the limit of work was at about λ3800. The experimental evidence showed that the overwhelming mass of organic compounds of "respectable" purity are of a nature expressed by one term of Drude's equation.

ACADÉMIE DES SCIENCES

At the meeting on June 2, L. Gentil communicated a further paper by M. Lazarev on the deposit of magnetic iron at Koursk, Russia, and estimated the quantity of iron in the northern belt at 34 milliard tons. M. D'Arsonval described, on behalf of M. Seillard, a new type of portable electrometer which could replace the dial electrometer in most of its applications. This new and delicate instrument allows measurements to be made without special plant or the use of high-tension batteries or reflected light, whether in the works or in the laboratory. The millionth part of a millionth of an ampere is indicated by a rigid needle on a fixed scale similar to an ordinary amperemeter and measurements impossible to the ordinary electrometer can be undertaken. During the meeting M. Charles Rabut was elected a member of the Académie des Sciences in the section of the applications of science to industry in place of the late Maurice Le Blanc.

On June 10, Monsieur Rateau communicated a note by M. Dumanois on "The use of light alloys for motor pistons," showing that the use of magnesium alloys might be useful in light engines, aluminium alloys being more suitable for larger engines on account of their heat conductivity.

Prof. Moureu gave an account of the rare natural gases, summarising the researches he has carried out on this subject with M. Lepape.

M. Haller showed that by the action of tetrachloroplatinic acid, turpentine combined directly with formic acid and with benzoic acid. This reaction led to the preparation of borneol and thence to synthetic camphor resembling natural camphor.

Prof. Le Chatelier drew attention to work on the lignites, showing that on distillation this fuel gives one and a-half times as much gas as does coal.

CORRESPONDENCE

BACTERIOLOGICAL TRAINING FOR CHEMISTS

Sir.—The article contributed to *Chemistry and Industry* (June 6) by Dr. David Ellis of Glasgow, on the training of chemists in bacteriology, should be read most carefully by all chemists, but more particularly by those who are seriously interested in the future of chemical training. There can be no question that we are rapidly approaching a stage in the history of chemical education in our Universities when drastic revision of the courses will be necessary. Parallel with the rapid advances in knowledge which have taken place in the many branches of chemistry during the past twenty-five years there has been in the majority, if not all, of our Universities so wide an extension of the syllabus, and so great an increase in the demands made on the candidate for Honours at the Final Examinations, that we may ask in all fairness whether the burden is not become already too heavy.

We must also recognise that the regrettable tendency to early specialisation which characterises much of our modern chemical training is undoubtedly largely responsible for the fact that the average graduate with Honours in Chemistry leaves the University at the end of three years with little or no education, apart from a knowledge of his chief subject; even those who spend a fourth year in study seldom devote the extra time to widening their outlook on science or on life.

Many will reply that the University courses in chemistry are already too short to enable a student to be trained adequately in that subject alone, and that attractive as schemes to introduce other subjects into the syllabus may be on paper, they are impracticable. I would remind such people that there is a tendency to forget that the real function of a University is to educate, and that three years should suffice to transmit to a student a knowledge of the fundamental principles of science. It is generally recognised that the graduate in chemistry on leaving the University is usually of very little use until he has acquired the special knowledge in the new field in which he is working; this period, probably the most humiliating in one's career, may be said to be in most cases about twelve months. Surely, then, if we accept the principle that specialisation should come after graduation, it is of the greatest importance that the short time at college should be occupied in planting fundamentals in the students' minds, and in developing that breadth of vision and power of thinking which are essential to their success in after life.

These general considerations bring me to the main point of my letter, which is concerned with Dr. Ellis' advice "Go and get a biological training, no matter what the means by which this training is obtained." It is probably true that an estimate that 1 per cent. of graduates in chemistry leave our Universities with any knowledge of biology would be generous, and yet at least ten times as many will within a few years be faced with problems demanding for their solution some knowledge of the living cell and its activities. Even if we ignore

this essentially practical aspect of the matter, there remains the equally important one, which concerns the educational value of a biological training.

Is there not cause for serious reflection on our modern system of education when we bear in mind that whereas one who is ignorant of the classics and of literature is rightly considered to be an uneducated person, no such description is applied to the individual who passes through life ignorant of the great fundamental principles that govern living organisms?

Two points should be clearly kept in mind. In the first place, there is no need, indeed it would obviously be impossible, to ask that every student should make a detailed study of biology during the years at college. But it is not too much to ask that our Universities should seriously consider whether it would not be advisable for all students in the Faculty of Science to take a course of general biology during their first year, *i.e.*, to take an examination in this subject at the stage corresponding in London, and certain other Universities, to the Intermediate Examination in Science.

I have carefully examined this question and have satisfied myself that the proposal is a practical one, for in the majority of cases it would only necessitate a condensation of the somewhat diffuse course in mathematics which now takes up so large a proportion of the student's first year.

The mention of the subject of general biology brings me to the second point, namely, that for the large proportion of students the existing courses of botany or zoology would not serve to satisfy my demands; such courses deal to a large extent with systems of classification and morphology; subjects which should occupy only a small proportion of the course which I wish to see taken by science students in general, and which should be built upon the lines laid down in the famous course given years ago by Huxley and Ray Lankester.

We must look in this country for a revival, such as is actively in progress in the United States of America, of the experimental method in biological science, if botany and zoology are to be raised from the lamentable position into which they have fallen in the last few decades; but here I digress. My last plea concerns my own subject, biochemistry. Prof Donnan once remarked to me that looking into the future of chemistry he could see only two paths which were likely to lead to the opening up of vast fields of knowledge. They appear at first widely divergent, but some day they will converge, and with startling results. The first is the investigation of the structure of the atom and molecule, and the second is the study of the chemical processes of the living cell.

At least two universities in this country, Cambridge and London, now have large, well-equipped biochemical departments, but, speaking at any rate for my own department, I can say that, with a few exceptions, the right type of material is not coming forward to be trained. The demand for biochemists from research departments and from industry is steady, and is greater in proportion than in any other branch of chemistry, but we are seldom able to supply the right type of man; the well trained chemist who not only has knowledge of the special field of biochemistry but who also has what can be termed the "biological" mind. By this one means that his training enables him to view a problem not only from the chemical or physico-chemical aspect, but also from the standpoint of the living cell. Biochemistry should, in my opinion, be a subject for post-graduate study, and I view as the most suitable raw material the good honours graduate in chemistry who already possesses a sound general knowledge of the general principles of biology. The strength of my feeling on these matters, Sir, must be my excuse for asking you to give me so large an amount of your space. I consider Dr. Ellis has rendered chemistry a great service in raising the matter in his pregnant article.

I am, Sir, etc., J. C. Drummond
Professor of Biochemistry

University College,
London

ALUMINIUM COOKING VESSELS

Sir,—One sometimes hears it stated that food cooked in aluminium vessels is injurious to health. How has this idea originated? There can be no disputing the fact that people have been taken ill and have died after partaking of food cooked in an aluminium pan and there are numbers of cases where the same result has followed the going to bed. It would be interesting to know which of these habits is the more dangerous. I am not going to accuse those people of ignorance or superstition who believe in the dangers of aluminium, and I should like to know if there is any ground whatever for their fear. Is the material of which "aluminium" pans are made all that it should be? I am, Sir, etc.,

Joseph Barnes

Arnside, Westmoreland
June 23, 1924

THE DESIGNATION OF THE CHEMIST

Sir,—Prof Snell, in support of the word "chemor," gives a list of words having the termination -or, and challenges me "to produce by my original system of word formation a parallel to the word (chemorry) which I create to ridicule." Now of the words he gives, actor, auditor, doctor, pastor, procurator and tutor are unchanged Latin words, proctor is a syncopated form of procurator, and author is a modified form of the Latin auctor. They therefore differ fundamentally from "chemor" as regards their derivation, and it is impossible to deal with them in the manner suggested. The true parallel is to be found in the word "chemistry" itself, the derivation of which is given in Murray's Dictionary as chemist + -ry.

A more formidable objection to the use of the word "chemor" arises from a consideration of the sister sciences. Thus physics is practised by a physicist, geology by a geologist, botany by a botanist, etc., and, if your correspondent has his way, chemistry by a "chemor." It does not seem logical and I do not think it is philologically sound. Is not the title

chemist too ancient and honourable to be mutilated in this arbitrary manner ? The profession of chemistry is the victim of faulty legislation, culminating in the final Pharmacy Act of 1869, which gave the title chemist to a section of the community, who are not, in the proper sense of the word, chemists. The only absolute remedy would seem to lie in fresh legislation. It is difficult to believe that the adoption of an hybrid word like "chemor" would improve matters to any material extent.—I am, Sir, etc.,

JOHN S. BOUSFIELD

Cambridge
June 23, 1924

PERSONAL AND OTHER ITEMS

Yale University has conferred the honorary degree of D.Sc. on Dr. Banting, the discoverer of insulin.

We regret to announce the death, in his 72nd year, of Sir James Johnston Dobbie, F.R.S. Born in Glasgow in 1852, Sir James Dobbie was educated at Glasgow High School and Glasgow University. After a period at Leipzig University he became lecturer in mineralogy, and subsequently assistant to the professor of chemistry in Glasgow University. After twenty years as professor of chemistry in the University College of North Wales, he was appointed in 1903 director of the Royal Scottish National Museum, and from 1909 he held the post of Government Chemist until his retirement in 1920. He had been elected a Fellow of the Royal Society in 1904 in recognition of his numerous researches on the chemical constitution of the alkaloids and the relation between the chemical constitution and absorption spectra of organic compounds. His services to science were recognised by the bestowal of a knighthood in 1915. Sir James Dobbie was President of the Institute of Chemistry from 1915 to 1918, and President of the Chemical Society from 1919 to 1921. He also served on the Royal Commission on awards to inventors. It is hoped to publish an extended obituary in a later issue.

Smithells Fund

Some time ago a movement was started through the University of Leeds for raising a Fund with the object of signalising the distinguished services which Prof. Arthur Smithells had rendered to the community in so many directions, and particularly to the science of Chemistry and the University of Leeds, during his thirty-eight years tenure of office as Professor of Chemistry, which terminated at the end of the session 1922-1923.

The Fund has been generously supported by the colleagues of Prof. Smithells on the Council and Staff of the University, personal friends, old students from all parts of the world, and by those connected with industries (notably the gas industry) who have desired to express in this practical way their appreciation of his sympathetic attitude and valuable assistance.

All who have interested themselves in the movement will be pleased to learn that the attainment of its object is now secured. Mr. Fiddes Watt, R.A., has undertaken the commission to paint a portrait of Prof. Smithells for presentation to the University, and a fund of at least two thousand pounds will remain for the endowment of a Scholarship in the University of Leeds, bearing the name of Prof. Smithells and instituted along lines approved by him.

Details will be notified to subscribers in due course, but as the fund will shortly be closed, any further subscriptions to increase the value of the Scholarship should be sent at once to the Treasurer, The Smithells Fund, at Beechwood, Roundhay, Leeds.

The Jacksonian Professorship at Cambridge

Since the death of Sir James Dewar, the Jacksonian professorship of natural philosophy at Cambridge has been suspended. According to "Nature," as the chair is only partly endowed and funds are not available to complete the stipend, the Council of the Senate has proposed that the professor shall not necessarily be required to reside and that the appointment shall be for one year, or a maximum of two successive years. The object of the suggestion is to attract a succession of distinguished scientists to Cambridge and, if adopted, it would probably result in a powerful stimulus to university research in chemistry, physics and their biological aspects, the subjects to which it is proposed to confine the chair.

A New Chemical Society

The announcement of the formation of the Indian Chemical Society, with headquarters at Calcutta, is of considerable interest, and the new body will have every wish for its success. The memorandum of association lays down a sound constitution for the Society, and the membership of the first Council gives every promise that the new body will do useful work. Sir P. C. Ray is the president, Dr. J. L. Simonsen and Prof. G. J. Fowler the vice-presidents, Prof. J. N. Mukhergee the secretary, Prof. P. C. Nutter the treasurer, and Dr. E. R. Watson the editor. It is understood that the first issue of the *Journal of the Indian Chemical Society* will appear in August.

Food Preservatives

According to "The Times" the Minister of Health has extended the terms of reference of the Departmental Committee on the use of preservatives and colouring matters in food so as to include the question whether and to what extent the practice of treating flour with chemical substances is objectionable on grounds of health, and whether it is desirable in the interest of the public health that the practice should be prohibited or restricted, and in the latter case what restrictions should be imposed. This question will be considered by the committee after they have completed the inquiry and presented their report upon the subjects for which they were originally appointed. The secretary of the committee is Mr. A. M. Legge, of the Ministry of Health, Whitehall, S.W., to whom all communications should be addressed.

REVIEWS

CHEMICALS. By A. W. ASHE and H. G. T. BOORMAN, A.I.C. The Resources of the Empire Series. Pp. 207. London: E. Benn, Ltd., 1924. Price 21s.

The book gives—so far as the authors have been able to obtain the information—the chief chemical products and requirements of the various countries forming the British Empire. It is very conveniently divided on a geographical basis, and contains much useful information on quantities and values of both exports and imports.

No useful purpose would be served by making extracts from the statistics given, as each branch of the industry will find easily, with the help of the very complete index, the figures and facts that are wanted.

From the very nature of the case the figures must not be taken too literally, but considered as a whole the authors may congratulate themselves on having compiled a very useful book.

It is unfortunate that there are one or two unnecessary mistakes, one of which had better be corrected as the dissemination of a mistaken definition can only cause confusion and the matter can be put right in any subsequent edition. On page 68 the statement is found that crude carbolic acid is generally sold as of two strengths, 50's and 60's. This is quite correct, and if the statement had been left at this point all would have been in order, but although this book is not a textbook, the authors go out of their way to explain what is meant by 50's and 60's, and give the wrong explanation. They say that 50's or 60's means that "50 or 60 per cent. of phenol will crystallise at 62·5° F." This is not the meaning. According to Lowe's method of testing crude carbolic acid, which is the test used in the trade, the expression 50's or 60's means that if, after distilling off 10 per cent. of the oil and all the water that may be present, you collect 62½ per cent. separately, and after thoroughly mixing you take the crystallising point of this 62½ per cent. fraction a 50's carbolic will crystallise at 50° F., and a 60's at 60° F., and so on.

With the conclusions and suggestions contained in the final summary the writer is in agreement but he fears that the Dominions and Colonies will manufacture any chemicals they require whenever they can do so more cheaply than they can buy them from the Home Country, and they can hardly be blamed.

An interesting note is to be found on page 190, under Bibliography, in which reference is made to the facilities afforded by the Dominion and Colonial Headquarters in London to seekers for information about their respective countries.

W. H. COLEMAN

KOHLENCHEMIE. By Drs. H. STRACHE and R. LANT. Pp. xvi+599. Leipzig: Akademische Verlag G.m.b. H., 1924. Price, paper, 24 goldmarks, bound 26 gm.

This is a work of a type which is often issued from German sources. The authors have set themselves the Herculean task of a comprehensive treatment of the chemistry of coal—exclusive of the manufacture and utilisation of fuels. They appear to feel that their purpose will not be achieved if they omit to refer, however lightly, to every imaginable aspect of the subject. It is obvious that even though they have run to 600 pages, they must fail at times. Depth of treatment must be sacrificed in the endeavour to cover the maximum area. One could quote instances where the treatment has become so slight as to be valueless. Thus in the one line devoted to Indian coal we are merely told that it is of low value. To realise the inaccuracy of this, one has only to recall that a young and vigorous coking industry supplying Indian iron blast-furnaces and foundries has already been established. Then the important subject of the behaviour of nitrogen and sulphur on carbonisation is dismissed in about one page, and there are many, including the writer, who would differ from some of the statements made. Although evidence is forthcoming that the authors are aware of recent studies of the problems in this country and elsewhere, they have not, it would seem, absorbed the results of this work.

The main and most valuable part of the work seems to be the chapters on the chemistry of coal, its origin, and the German work of recent years, especially on the carbonisation of coal at high and low temperatures. Great prominence is given to the labours of the Kohle Forschungs-Institut of Mulheim, the researches of which have already filled six volumes. The extensive bibliographic references, after each chapter will be of value even when the discriminating reader is dissatisfied with the text.

Considerable space is given at the end to the analysis of coal, and allowing for the prominence given to German practice the treatment is comprehensive, sound, and modern

It is on account of the good features mentioned that the book is to be recommended to students of coal and fuel technology, who will know how and when to exercise discrimination.

H. J. HODSMAN

THE RESIN INDUSTRY IN FRANCE

A lecture was recently delivered in Paris by Monsieur Dupont, describing the operations by which 130,000 tons of resin is collected annually in the Landes. After discussing the treatment of the crude material and the separation of the different products, turpentine, resin and tar, it was suggested that great improvements would result from the introduction of continuous vacuum distillation apparatus. The annual production of turpentine in France was 25,000 t., and of resin, 100,000 t., compared with 85,000 t. and 100,000 t. respectively in the United States, where the forests are being exhausted and internal needs are more and more restricting exportation. The production of pit props, masts, etc., was a flourishing industry in the Landes district, and a good future seemed in store for paper-making by means of pine pulp treated by the basic process.

LEGAL INTELLIGENCE

THE MANUFACTURE OF CHEMICALS BY A GAS COMPANY

On May 21, the Court of Appeal heard an appeal by J. L. Deuchar, Secretary of the Castner Kellner Alkali Co., Ltd., from the refusal of Mr Justice Astbury (*cf. Chem. & Ind.*, Jan 25, 1924) to make a declaration that the Gas Light and Coke Co. was acting *ultra vires* in manufacturing any chemical necessary for treating any of the products arising in making gas. The appellant said that the Gas company produced naphthalene and to convert it into betanaphthol had purchased chemicals from the Castner Kellner and other companies. Recently the Gas company had laid down plant to make caustic soda which, by reason of profits made on the gas undertaking might be sold even at a loss. The Gas company stated it manufactured caustic soda not for sale but only in such limited quantity as was necessary to treat the residual naphthalene. Mr Justice Astbury held that what the Gas Co. was doing was not *ultra vires*.

For the appellant, it was conceded that the Gas company might make articles produced from materials used in the manufacture of gas, or might convert residuals, but it could not start the business of making things which it used for converting residuals. It could not start a colliery business because it used coal, and it could not make caustic soda to produce chlorine which was to be turned into bleaching powder, nor could it sell the powder. The manufacture of caustic soda was not incidental to the powers vested in the company.

For the respondents, it was argued that one of the Gas company's businesses was that of converters of gas residuals. Unless an extension of business transformed the business into something else it had never been held that such extensions made *bona fide* were outside the powers of the company. In this case it was the more clearly within the powers of the company because one of the company's main stated objects was to deal with residuals. All that the Gas company had done was done in pursuance of one of its statutory powers. If the company had produced caustic soda for sale that might have made a difference, but its plant was only sufficient to produce the amount required.

The Master of the Rolls, giving judgment on June 20, said the ordinary commercial method of utilising naphthalene was to convert it into beta-naphthol by means of caustic soda. Formerly the Gas company purchased this, but had decided that it would be cheaper and more economical to make the caustic soda and had erected plant sufficient to supply requirements of this chemical, but no more. Incidental to the production of caustic soda, chlorine was produced, but that did not affect the company's power to make caustic soda. It was clear that the purposes and business of the Gas Light and Coke Company was two-fold: to make gas and to dispose of the residuals which had resulted from the process of making gas. It was not denied that the proper method of utilising naphthalene was to convert it into beta-naphthol and to do so caustic soda was needed. It must be provided, and there was nothing to cut down the right of provision. There being nothing to limit the right of provision and no express prohibition against manufacture, it would be taking too narrow a view to hold that the making of caustic soda lay outside the powers of the company. Lord Justices Warrington and Sargant concurred and the Appeal was accordingly dismissed.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Lead Paint Bill

On June 20, Mr. R. Davies moved the second reading of the Lead Paint (Protection against Poisoning) Bill The purpose of the Bill was to lessen the risk of contracting lead-poisoning among painters and its provisions had been drafted so as to enable the Government to ratify the International Convention on that subject. After discussing the statistics of white-lead poisoning, he said that the trade would have until November, 1927, to adjust itself. Paint of good quality could now be obtained free from white lead and was already used on a large scale in this country. The Home Office experts were satisfied that wet-rubbing down with waterproof sandpaper did not meet the case. The Bill would prohibit the employment of women and young persons in painting buildings with lead paint and would regulate the use of lead paint in other directions.

Mr. Harvey, in moving an amendment welcoming regulation, but opposing ratification of the Convention, quoted statistics to show that painters, were less affected by lead-poisoning than other industrial groups and pointed out that the experts of the Geneva Conference recommended a system of regulation and not prohibition for internal painting, and that the resolution of the Conference itself for prohibition was a compromise and not binding on this country. Referring to the finding of the Public Works Department that substitutes for white lead were inefficient, Mr. Harvey quoted Sir T. Oliver's statement that wet-rubbing down obviated danger of poisoning.

Mr. E. Grenfell, supporting the amendment, said that this country kept on passing legislation agreed to at Geneva, and in which none of our great competitors were ready to follow us. A decrease in the use of white lead would increase the price of zinc and also of painting and would reduce employment. The question should be left open and reconsidered in 1927.

Lord Cavendish-Bentinck supported the Bill mainly on humanistic grounds, and claimed there was no reason for hesitation. The white lead corroders could convert their premises and the workers would gain by employment in a healthy process. Mr Raynes, speaking in support, also welcomed the Bill, saying that there was an adequate substitute for white lead and that wet rubbing-down appeared almost impossible of application.

The Bill received a second reading on the understanding that if Clause I (prohibiting interior painting with white lead) were rejected in Committee, the remainder of the Bill would be proceeded with.

COMPANY NEWS

BOOTS PURE DRUG CO., LTD.

An interim dividend has been declared on the ordinary shares for the quarter ending June 30 at the rate of 9 per cent., less tax.

MAGADI SODA CO., LTD.

Mr. H. E. Burgess, the Senior Official Receiver in Companies Liquidation, has obtained the leave of the Court to call meetings of debenture holders, creditors and shareholders of Magadi Soda Co. to consider proposals for selling the property in the Kenya Colony to a new company to be formed by Messrs. Brunner, Mond and Co., Ltd. The notices will be issued in about three weeks, and, owing to the distance at which some of the parties reside the Court has directed that the meetings are to be held three months from that time. Under the scheme the first debenture holders will receive debentures for the same amount as in the old company and at the same rate of interest. The second debenture holders and the general body of creditors are to receive fully-paid preference shares, whilst the shareholders will receive fully-paid second preference shares, with the right to subscribe for another class of preferred shares carrying a higher rate of interest. Messrs. Brunner Mond and Co. have undertaken to provide the necessary working capital, and have given guarantees satisfactory to the Official Receiver and to the Colonial Office as to the extent to which they will work the undertaking.

CAPE ASBESTOS CO., LTD.

The report for 1923 shows a net profit after allowing for depreciation of fixed assets of £15,591 (£13,840 for 1922), and £5504 was brought forward. The addition is £2225 (against £5000), thus raising the fund to £65,750—equal to 50 per cent. of the issued capital. The basic dividend on the preference shares takes £2306, and out of the remainder of £16,564 it is proposed to pay a dividend of 10 per cent. (unchanged) on the ordinary shares; this requires £5497, and a similar amount is divisible as extra dividend on the preference shares. The carry forward is £5571.

W. J. BUSH & CO., LTD.

At the 27th annual general meeting, Mr. J. M. Bush, the chairman, said business conditions in 1923 resembled those in 1922. The increase in the net profit was due to the pre-war rate of depreciation on plant. The maintenance of the net profit was due largely to improved efficiency of processes in the fine chemical department and to working economies in the firm's factories. The fine chemical department had been greatly extended and had been fostered by the Safeguarding of Industries Act. In view of low wages on the Continent and depreciated currencies, the expiry of the Act in 1926 would be serious; the company might have to discontinue to make certain products. But several processes had been improved and he (the chairman) was confident that foreign competition in a number of products would be met. The subsidiary companies in the United States and Canada had made substantial profits.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

All grades of boric acid have been reduced by £3 per ton as from June 11. Borax prices are unchanged. Prices generally remain steady.

Acetic Acid, 40% tech. ..	£23 10s. per ton.
Acid, Boric, Commercial—	
Cryst.	.. £45 per ton.
Powder ..	.. £47 per ton.
Acid Hydrochloric	.. 3s. 6d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	.. £21 10s.–£27 per ton makers' works according to district and quality.
Acid Sulphuric ..	.. Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	.. £6 15s. per ton, f.o.r. Special terms for contracts.
Bleaching Powder	.. Spot £11 d/d., Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	.. £7 per ton, packages extra.
Borax, Commercial—	
Crystal	.. £25 per ton.
Powder ..	.. £26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	.. £5 17s. 6d. per ton d/d.
Methylated Spirit 64 o.p.—	
Industrial ..	.. 3s. 1d.—3s. 5d. per gallon, according to quantity.
Mineralised ..	.. 4s. 2d.—4s. 6d.
Potash Caustic ..	.. £30—£33 per ton.
Potass. Bichromate	.. 5¾d. per lb.
Potass. Chlorate ..	.. 3d.–4d. per lb.
Salammoniac ..	.. £32 per ton d/d.
Salt Cake	.. £3 10s. per ton d/d.
Soda Caustic, solid	.. Spot lots: delivered. £16 17s. 6d. to £19 7s. 6d. per ton, according to strength. 20s. less for contracts.
Soda Crystals .	.. £5 5s—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	.. £24 per ton.
Sod. Bicarbonate	.. £10 10s. per ton, carr. paid.
Sod. Bichromate ..	.. 4¼d. per lb.
Sod. Bisulphite Powder 60/62%	.. £18—£19 per ton, according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate ..	.. 3d. per lb.
Sod. Nitrate refd. 96%	.. £13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £14 10s. per ton d/d.
Sod. Sulphide cryst.	.. £9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	.. 5¾d.—1s. 4d. per lb., according to quality.

Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	6¼d.—6¾d. per lb. Market firmer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	15s. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	4s. 10d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All prices keep fairly stable, but there is room for improvement in business.

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton. Fair demand.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Demand below normal.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. ,, ,, 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall. 60% O.P. Market dull.
Solvent	5s. 6d. per gall 40% O.P. Fairly good demand.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£16 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d.—6¾d. per lb. Better inquiry.
Crude 60's	1s. 9d.—1s. 10d. per gall. Market flat. Only odd lots being offered.
Acid Cresylic, 97/99	2s 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—1s. 11d. per gall. Steady demand.
Dark	1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	9½d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 5½d. per gall.
Pure	1s. 10d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	9d.—9½d. per gall. Few inquiries.
Middle Oil, Heavy, Standard Specification	6¾d.—9d. per gall. according to grade and district. Market very quiet.
Naphtha—	
Solvent 90/160	1s. 4d.—1s. 5d. Market steady.
Solvent 90/190	1s. 1d.—1s. 4d. Fair business, passing.
Naphthalene Crude—	
Drained Creosote Salts	£6—£6 10s. Demand falling off.
Whizzed or hot pressed	£9—£12 per ton. Little business.
Naphthalene—	
Crystals and Flaked	£16—£17 per ton.
Pitch, medium soft	52s. 6d.—57s. 6d. per ton. No export business at present. Plenty of inquiries for next season.
Pyridine 90/160	21s.—22s. per gall. Market less firm.
Heavy	12s.—12s. 6d. Market steady.

INTERMEDIATES AND DYES

Business in dyestuffs has been fairly good and has shown a little further improvement during the past week. Prices remain constant.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 6d. per lb.
Acid H	4s. 3d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 1½d.—1s. 2d. per lb. Better demand at reduced prices
Acid Sulphanilic	9½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4½d. per lb. Demand steady.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	4s. 9d. per lb. d/d., packages extra, returnable.
Dimethylaniline	2s. 4d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene—48/50° C.	8d.—9d. per lb. naked at works.
66/68° C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. per lb. d/d
Monochlorbenzol	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.

Nitronaphthalene	.. 11¾d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis
m-Phenylene Diamine	.. 4s. 2d. per lb. d/d.
p-Phenylene Diamine	.. 10s. 3d. per lb. 100% basis d/d.
R. Salt	.. 2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 5d. per lb. 100% basis d/d.
o-Toluidine ..	.. 8½d. per lb.
p-Toluidine ..	.. 3s. 6d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The demand is steady for the small quantities required for home consumption, but export inquiry for larger bulk is wanting.

Acid, Acetic 80% B.P.	.. £47 per ton.
Acid, Acetyl Salicyclic	.. 3s. 3d.–3s. 5d. per lb. Value maintained.
Acid, Benzoic B.P.	.. 3s. 9d. per lb. Larger supplies available.
Acid, Boric B.P.	.. Cryst. £51 per ton, Powder £55 per ton. Carriage paid any station in Great Britain. Prices reduced by £3 per ton.
Acid, Camphoric..	.. 19s.–21s. per lb.
Acid, Citric ..	.. 1s. 6½d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic ..	.. 3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst.	.. 7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic ..	.. Prices quoted from 2s. per lb. down to 1s. 8d. for ton lots. Market still weak.
Acid, Tannic B.P.	.. 3s. per lb. Market quiet.
Acid, Tartaric ..	.. 1s. 1½d.—1s. 2d. per lb. less 5%. Better tone but not yet very active. Cheap offers of second hand parcels of foreign acid. Higher prices expected in view of firmness of raw materials.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 2s. 3d. per lb. for quantity. Demand slow. Prices shaded to secure large orders.
Amidopyrin ..	.. 13s. 3d. per lb. Neglected. Stocks low.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make.
Barbitone.. ..	.. 15s. per lb. Quiet market.
Benzonaphthol ..	.. 5s. 6d. per lb. Small inquiry.
Bismuth Salts ..	.. A steady market. Prices according to quantity:
Bismuth Carbonate	.. 12s. 9d.—14s. 9d. per lb.
„ Citrate..	.. 11s. 4d.—13s. 4d. „
„ Salicylate	.. 10s. 2d.—12s. 2d. „
„ Subnitrate	.. 10s. 9d.—12s. 9d. „
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides— ..	.. Fluctuating market. Continental prices decidedly firmer.
Potassium ..	.. 11d. per lb.
Sodium.. ..	.. 1s. „
Ammonium ..	.. 1s. 1d. per lb.
Calcium Lactate..	.. Demand active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate	.. 3s. 7d.—3s. 9d. per lb., duty paid.
Chloroform ..	.. 2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Formaldehyde ..	.. £57 per ton, *ex* works. English make.
Glycerophosphates—	Fair business passing.
Calcium, soluble and citrate free ..	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Magnesium ..	.. 9s. per lb.
Potassium, 50%	.. 3s. 6d. per lb.
Sodium, 50% ..	.. 2s. 6d. „
Guaiacol Carbonate	.. 11s. per lb. for cwt. lots. Slightly cheaper.
Hexamine ..	.. 3s. 6d. per lb. for English make. Market quiet and steady.
Homatropine Hydrobromide	.. 30s. per oz.
Hydrastine hydrochlor	.. English make offered at 120s. per oz.
Hydroquinone ..	.. 4s. 3d. per lb. in cwt. lots. Foreign make.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb. lots.
Potassium ..	.. 4s. 1d. per lb.
Sodium ..	.. 4s. „
Iron. Ammon. Citrate B.P.	2s. 1d.—2s. 5d. per lb., according to quantity.
Magnesium Carbonate—Light Commercial	.. £36 per ton net.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £26 per ton, less 2½%.
Heavy Pure ..	.. 1s. 6d.—2s. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 55s. per lb. Weaker.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials ..	.. Market firm.
Red oxide ..	.. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. „
White precip. ..	.. 4s. 7d.—4s. 8d. „
Calomel ..	.. 3s. 11d.—4s. „
Methyl Salicylate	.. 2s.—2s. 3d. per lb. for carboys. Not much demand.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 3s. per lb.
Paraldehyde ..	.. 1s. 4½d.—1s. 6d. per lb. in free bottles and cases. Better demand.
Phenacetin ..	.. 6s. per lb. Ample stocks available.
Phenazone ..	.. 7s. 3d. per lb. for cwt. lots. Quiet.
Phenolphthalein	.. 6s. 6d. per lb. Easier with supplies more plentiful.
Potass. Bitartrate—99/100% (Cream of Tartar) ..	.. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate ..	.. 1s. 10d.—2s. 2d. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 5s. 6d. per lb.
Saccharin.. ..	.. 63s. per lb., in 50-lb. lots.
Salol	.. 3s. 6d.—3s. 11d. per lb. Easier in sympathy with other salicylates.
Silver proteinate..	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	.. 2s. 9d. per lb. In steady demand for good qualities.

Sod. Citrate, B.P.C., 1923	1s. 11d.—2s. 2d. per lb., according to quantity. Firm in common with other citrates.
Sod. Hyposulphite—Photographic ..	.. £13 £15 per ton, according to quantity, d.d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	.. 77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.
Sod. Salicylate ..	.. Market easier. Powder 2s. 2d. 2s. 6d. per lb. Crystal at 2s 5d.—2s. 8d. per lb. Flake 2s. 9d. 2s. 10d. per lb.
Sod. Sulphide—Pure recryst ..	.. 10d 1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s —£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol	.. 15s 16s 6d. per lb for good white crystal from ajowan seed. Very firm and scarce

Camphor Oil ..	.. 75s. per cwt.	
Cananga Oil Java	.. 10s. 6d. per lb.	
Cinnamon Oil, Leaf	.. 6½d. per oz.	
Cassia Oil, 80/85%	.. 8s. 9d. per lb.	Cheaper.
Citronella Oil —		
Java 85/90% ..	.. 6s. per lb.	
Ceylon	.. 3s. 9d. per lb.	
Clove Oil . ..	. 7s. 3d per lb.	Cheaper.
Eucalyptus Oil 70/75% ..	2s. 2d. per lb.	
Lavender Oil		
French 38/40% Esters	27s. 6d. per lb.	
Lemon Oil ..	.. 3s. 2d. per lb.	
Lemongrass Oil	.. 3d. per oz.	
Orange Oil, Sweet	.. 13s. 9d. per lb.	
Otto of Rose Oil		
Bulgarian ..	.. 27s. 6d. per oz.	
Anatolian ..	.. 23s. 6d. per oz.	
Palma Rosa Oil	.. 19s. per lb.	
Peppermint Oil—		
Wayne County	.. 20s. 9d. per lb.	
Japanese ..	.. 15s. 6d. per lb.	
Petigrain Oil ..	.. 10s. per lb.	
Sandal Wood Oil—		
Mysore	.. 26s. 6d. per lb.	
Australian ..	.. 21s. per lb.	

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.		
Aubepine	14s 6d.	,,	
Amyl Acetate	2s. 9d.	,,	
Amyl Butyrate	6s. 9d.	,,	
Amyl Salicylate	3s. 3d.	,,	
Anethol (M.P. 21/22° C)	4s. 6d	,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s 10½d	,,	Cheaper.
Benzyl Alcohol free from Chlorine . ..	2s 10½d.	..	Cheaper
Benzaldehyde free from Chlorine	3s. 6d.	,,	
Benzyl Benzoate ..	3s. 6d	,,	
Cinnamic Aldehyde Natural	15s. 6d.	,,	
Coumarin	20s	,,	
Citronellol	16s.	,,	
Citral	10s.	,,	
Ethyl Cinnamate ..	15s	,,	
Ethyl Phthalate	3s. 3d.	,,	
Eugenol	10s. 6d.	,,	
Geraniol (Palmarosa) ..	35s.	,,	
Geraniol	11s. 18s 6d	per lb.	
Heliotropine .. .	7s. per lb		Advanced
Iso Eugenol	15s. 9d	,,	
Linalol ex Bois de Rose	26s.	,,	Cheaper.
Linalyl Acetate .. .	26s	,,	Cheaper.
Methyl Anthranilate ..	9s. 6d.	,,	
Methyl Benzoate ..	6s.	,,	
Musk Ambrette ..	45s	,,	Cheaper.
Musk Xylol	16s. 6d.	,,	
Nerolin .. .	4s 9d.	,,	Advanced.
Phenyl Ethyl Acetate .	12s. 6d.	,,	
Phenyl Ethyl Alcohol	16s.	,,	
Rhodinol . . .	57s. 6d.	,,	
Safrol . . .	1s. 10d.	,,	
Terpineol .. .	2s 4d	,,	Cheaper.
Vanillin	25s 3d —26s 6d.	per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.		
Anise Oil	2s. 8d. per lb.		Cheaper
Bergamot Oil	19s. 6d. per lb.		Dearer.
Bourbon Geranium Oil ..	36s. 6d.	,,	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents, those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than Aug. 18th, they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. on July 3rd.

I.—Applications

Dawson. Evaporators. 13,948. June 10.

Kirschbraun. Manufacture of emulsions 14,054. June 10.

Rieber and Veruert. Furnaces. 14,461. June 11. (Ger., 19.11.23.)

I.—Complete Specifications Accepted

7230 (1923). Internationale Bergin-Compagnie voor Olie en Kolen Chemie, and Loffler. Apparatus for indicating liquid levels in high-pressure stills or other vessels. (216,959.)

13,331 (1923). Futers, and Semet-Solvay and Piette Coke Oven Co., Ltd Separation of excess liquid from subdivided solid materials. (217,025.)

17,293 (1923). Schueler. Centrifugal separators. (217,065.)

1303 (1924). Ellis. Ball crushing mills. (217,154.)

4631 (1924). Priest. Refractory coverings for the shafts, flues, and other passages of furnaces, kilns and the like. (217,160.)

II.—Applications

Aktiebolaget Separator. Treating materials containing paraffin. 14,237. June 12. (Ger., 28.6.23.)

Bullinger, Melhardt, Weisz, Winternitz, and Zeroe Refining mineral oils etc. 14,246, June 12. (Austria, 14.7.23.)

Koppers Co. Elimination of hydrogen sulphide from fuel gases etc. 14,049. June 10. (U.S., 6.6.24.)

Koppers Co. Purification of gases etc. 14,068. June 10. (U.S., 6.6.24.)

II.—Complete Specifications Accepted

3687 (1923). Demoulins and Garner. Purification of hydrocarbons, particularly lighter petroleum fractions (216,918.)

5442 (1923). Linker. Manufacture of high quality fuel from raw peat. (216,921.)

5956 (1923). Lamplough. Treatment of hydrocarbon oil vapours. (216,922.)

6639 (1923). Wood, Jenkins, and Minerals Separation Ltd. Agglomeration of coal. (216,948.)

14,710 (1923). Fuel Recovery Syndicate, Ltd., and Bowater. Distillation of fuels. (217,041.)

24,180 (1923). Rude. Process of and apparatus for the carbonisation of solid fuel. (204,718.)

III.—Application

Stewart and Walmsley. Aromatization of tars. 13,999. June 10.

IV.—Complete Specification Accepted

8120 (1923). Carpmael (Bayer & Co.). Manufacture of azo dyes. (216,971).

V.—Applications

Bacon, and I. P. M. Syndicate, Ltd. Treatment of fibrous cellulose for production of hydrated derivatives. 14,411. June 14.

Baldinger. Obtaining fibres from leaves of agaves etc. 14,052, 14,053. June 10.

Boorne. Product of cellulose etc. fibrous materials. 14,042. June 10.

Ubbelohde. Treating fibres. 14,269. June 12.

V.—Complete Specifications Accepted

9052 (1923). Plauson's (Parent Co.), Ltd. (Plauson). Manufacture of paper. (216,923.)

6882 (1923). Cross and Englestad. Manufacture and applications of new lignone derivatives. (216,949.)

11,008 (1923). Levy. Production of artificial filaments. (217,003.)

17,468 (1923). Courtaulds, Ltd., and Cross. Manufacture of threads etc. from viscose. (217,068.)

29,067 (1923). Stewart and Brown. Digesters used in paper-making etc. (217,130.)

VI.—Application

Chem. Fabr. Griesheim-Elektron. Manufacture of mixtures for dyeing or printing textiles. 14,179. June 11. (Ger., 11.6.23.)

VI.—Complete Specifications Accepted

6196 (1923). Pattison (Tomlinson and Thomas). Apparatus for treating fibrous materials with liquids or gases. (216,929.)

6481 (1923). Bloxam (Land Akt.-Ges.). Obtaining new effects on animal fibres. (216,940.)

VII.—Applications

Belton and Budde. Adsorption of sulphur dioxide and hydrogen sulphide. 14,219. June 12.

Cosmic Arts, Inc. Treatment of natural alkaline salts. 14,273. June 12. (Belgium, 12.6.23.)

Deutsche Gold und Silber-Scheideanstalt vorm. Roessler, and Liebknecht. Manufacture of hydrocyanic acid. 14,458. June 14.

Suida. Manufacture of concentrated acetic acid. 14,281 and 14,341. June 12 and 13. (Austria, 26.6.23.)

VII.—Complete Specification Accepted

19,982 (1923). Ozon-Technik Akt.-Ges. See XI.

VIII.—Applications

Stettiner Chamotte-Fabrik Akt.-Ges. vorm. Didier. Manufacture of retractory bricks etc. 14,259. June 12. (Ger., 21.6.23.)

VIII.—Complete Specification Accepted

1631 (1924). Priest. See I.

IX.—Application

Arnot. Adhesives and cements. 14,343. June 13.

IX.—Complete Specifications Accepted

7328 (1923). Butler and Popham. Bituminous and like compositions. (216,911.)

6974 (1923). Broadfoot and Sons, Ltd., and Robertson. Cement and filling material. (216,951.)

X.—Applications

Gelsenkirchener Bergwerks-Akt.-Ges. Carbonization of ores etc. 14,462. June 14. (Ger., 24.1.24.)

Harada. Manufacture of aluminium alloy. 14,257. June 12.

Oppermann. Refining and freeing bubbles from molten metals. 14,111. June 11.

Western Electric Co., Ltd. (Western Electric Co., Inc.). Metallic compositions. 14,128. June 11.

X.—Complete Specifications Accepted

19,605 (1923). Electrolytic Zinc Co. of Australasia, Ltd. Treatment of zinc-bearing ores etc. (201,918.)

19,606 (1923). Electrolytic Zinc Co. of Australasia, Ltd. Electrolytic recovery of zinc from zinc-bearing ores etc. (202,299.)

XI.—Applications

Monnot. Production of electrodes for alkaline storage batteries. 14,371. June 13.

Shearman. Apparatus for electrification of gases. 14,131. June 11.

Western Electric Co., Ltd. (Western Electric Co., Inc.). Insulating-materials for submarine cables etc. 14,129. June 11.

XI.—Complete Specifications Accepted

11,093 (1923). Pepper. Electric batteries. (217,004.)

19,606 (1923). Electrolytic Zinc Co. of Australasia, Ltd. See X.

19,982 (1923). Ozon-Technik Akt.-Ges. Apparatus for electrically producing ozone. (201,938.)

29,387 (1923). Chloride Electrical Storage Co. (Electric Storage Battery Co.). Electric accumulators. (217,131.)

XII.—Applications

Goonewardene and Julien. Manufacture of desiccated nuts and oil from coconuts etc. 14,174. June 11.

Kirschbraum. 14,054. See I.

XII.—Complete Specifications Accepted

33,226 (1922). Legradi. Manufacturing soap poor in water. (202,263.)

32,623 (1923). Calderwood, Webb, and Reibl. See XIII.

XIII.—Applications

Mehta. Manufacture of resins. 14,244. June 12. (U.S., 12.6.23.)

Mulligan. Paints and washes. 14,328. June 13.

XIII.—Complete Specifications Accepted

6975 (1923). Broadfoot and Sons, Ltd., and Robertson. Plastic material for the production of moulded articles. (216,952.)

15,769 (1923). Davidson. Fraud-preventing ink. (217,053.)

32,623 (1923). Calderwood, Webb, and Reibl. Preparation of oils for varnishes, printing inks, paints, linoleums, and the like. (217,150.)

XIV.—Applications

Churchill. Vulcanising material. 14,394. June 13.

Mann. Treatment of rubber latex. 14,312. June 13.

XV.—Complete Specification Accepted

6976 (1923). Broadfoot & Sons, Ltd., and Robertson. Adhesive. (216,953.)

XVII.—Complete Specification Accepted

8870 (1923). Brunn. Process for the production of phosphoric derivatives of inositol. (216,982.)

XIX.—Applications

Roberts. Food products. 14,102. June 11.

Westaway. Treating and preserving cream etc. 14,445. June 14.

XIX.—Complete Specifications Accepted

13,621 (1923). Cuthbertson. Process for preserving meat. (217,028.)

21,843 (1923). Bley. Preserving food. (217,103.)

25,000 (1923). Cuthbertson. Preserving fruit and vegetables. (217,117.)

XX.—Applications

Chem. Fabr. vorm. Sandoz. Manufacture of cardiac glucoside of Bulbus scillæ. 14,046. June 10 (Switz., 7.6.23).

Coke and Maxted. Oxidation of cyclic bodies. 14,115. June 11.

Desborough, Knight, and Thomson. Nitration of materials. 14,144. June 11.

Marks (Carbide & Carbon Chemicals Corporation). Processes of making alkyl chlorides. 14,077. June 10.

XX.—Complete Specifications Accepted

8715 (1923). Medical Research Council, and Dudley. Manufacture of a purified form of insulin. (216,978.)

15,634 (1923). Chem. Fabr. vorm. Sandoz. Manufacture of the cardiac glucoside of Bulbus scillæ. (199,400.)

31,991 (1923). Comp. Nat. de Mat. Colorantes et de Prod. Chimiques. Manufacture of perylene. (208,722.)

XXI.—Complete Specification Accepted

8545 (1923). Bolton, and Cavendish's, Ltd. Fixing-solutions for photography. (216,976.)

XXII.—Application

Desborough and others. 14,144. *See* XX.

XXIII.—Application.

Boothman, and Kershaw & Co. Viscometers. 13,991. June 10

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35 Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department, and quoting the specific reference number:—*Argentina:* Silk, (722 and 723); *Belgium:* Leather, skins, varnish, (709); *British India:* Steel, copper, (The Director-General, India Store Department, Branch No. 10 Belvedere Road, Lambeth, S.E. 1); *Canada:* Steel, (704); *Greece:* Metals, building materials, (712); *Netherlands:* Glassware, (713); Iron, (714); *South Africa:* Paper, (708).

Trade Information

Fuel Economy.—At the Convention of the District Engineer Representatives attached to the Feed Water Specialists Company, held in Liverpool from June 10 to 13, the Annual Dinner took the form of a send-off to the Manager, Mr H. W. Bannister, who is now on a voyage to the United States to obtain further data for securing economies in steam raising, so that still greater services will be rendered to steam users all over the world in the treatment of boiler-feed water. Mr. W. H. Crowe, of the Andrew Maxwell Co., referred to the appreciation by steam users of the research in colloidal chemistry carried out under the direction of Mr. Bannister. The treatment of each set of boilers, or even one boiler of a battery, made the service of the district engineers of particular value, whilst the reduction of intricate laboratory tests to the point of simple demonstration enabled works' managers and superintendent engineers to see at their own desks, within ten minutes, how the adoption of colloidal principles led to increased power at lower fuel and repair costs.

The Tully Gas Plant in Canada.—The City Council of Belleville, Ontario, Canada, has decided to adopt the recommendation of the special committee investigating the Tully Gas Plant, by which the plant will be accepted by the city. The special committee reported: (1) That the plant is capable of producing 45,000 cb. ft. of 450 B.Th.U. gas per ton of coal, with an oil consumption of less than 1½ gallon per 1000 cb. ft. of gas. (2) That one man per shift will operate the plant with assistance for clinkering every 24 hours. (3) That the plant as far as was possible for the Committee to ascertain, lives up to the guarantees of the Tully Gas Plants, Ltd. (4) That since the Tully system has been installed the Government heat tests of the gas have ranged from 458 to 484 B.Th.U.'s. (Government standard being 450 B.Th.U.'s.) The committee further said it felt assured that the installation of the Tully system was wise and that the Gas Department would now be on a profitable basis.

Smokeless Fuel in Glasgow.—The Glasgow Corporation Gas Department has decided to erect a plant utilising the Maclaurin process for producing smokeless fuel. The chief feature of the process is the producer, which is built by Messrs. Blair, Campbell and McLean, Ltd., of Govan, Glasgow. This low-temperature producer is internally heated only and supplies gas ranging from 140 to 350 B.Th.U. per cb. ft., according to whether it is worked for complete gasification, smokeless fuel, or metallurgical coke. The low cost of the gas makes the process very suitable for heating retorts, but the main object of the plant to be installed in Glasgow for carbonising 35,000 tons of coal annually, is the production of smokeless fuel.

Pulverised Fuel.—It is announced that the Birmingham Corporation has decided to install the Lopulco system of pulverised fuel on six boilers in the Nechells power station, instead of the mechanical stoker equipment previously ordered. As there is no room for the ordinary arrangement of coal bunker, drier, pulveriser and separator independently for each boiler, a separate pulveriser house will be erected on the other side of a canal by the boilerhouse, and the pulverised fuel will be blown across through narrow-bore pipes under 40 to 50 lb. pressure.

A. F. Craig & Co., Ltd., Engineers, Paisley, announces that their London office will be moved on June 24 from 12, Old Jewry Chambers, E.C. 2, to Abbey House, 2-8, Victoria Street, Westminster, S.W. 1.

PUBLICATIONS RECEIVED

James Dewar. By H. E. Armstrong. Pp. 32. London E. Benn, Ltd., 1924. Price 1s. 6d.

Chemical Reviews, Vol. 1, No. 1. Pp. 141. Published quarterly for The American Chemical Society. Baltimore, U.S.A.: Williams and Wilkins Company, 1924. $4 to members, $5 to non-members.

Report of the Livesey Professor, J. W. Cobb, C.B.E., B.Sc., for the session 1922–1923. Department of Coal Gas and Fuel Industries (with Metallurgy). The University of Leeds. Pp. 11.

Kelly's Directory of Merchants, Manufacturers and Shippers of the World. A Guide to the Export and Import, Shipping and Manufacturing Industries. Thirty-eighth edition. Vol. I, Pp. ccci+2522. Vol II, Pp. cxviii+2158. London: Kelly's Directories, Ltd., 1924. Price 64s.

INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDED 31st DECEMBER, 1923.

EXPENDITURE.		Corresponding			
		[illegible]	£05 0 0 Southern Railway 5% Pref. Stock	[illegible]	14,666 2 3
		746 7 2			
		£1[illegible],141 17 11 (Depreciation=10·1% on cost).	,, Office Furniture	379 5 0	
			Less: Depreciation	100 0 0	279 5 0
	£18,445 4 3				£18,445 4 3

"MESSEL FUND."

INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDED 31st DECEMBER, 1923.

EXPENDITURE.	£ s. d.	INCOME.	£ s. d.
To Audit Fee	10 10 0	By Dividends	1048 13 2
,, British Empire Exhibition	250 0 0	,, Income Tax Refund (1922-23)	71 4 11
,, Balance, carried to Balance Sheet	866 6 6	,, Bank Interest	6 18 5
	£1,126 16 6		£1,126 16 6

BALANCE SHEET AS AT 31st DECEMBER, 1923.

LIABILITIES.		£ s. d.	ASSETS.	£ s. d.	£ s. d.
Capital Account		18,076 13 9	By Cash on Deposit at Midland Bank, Ltd.		978 0 1
Income and Expenditure Account—			,, Investments at Value at date of transfer, or at Cost—		
Balance at 31st December, 1922	1,790 7 5		£400 0 0 Birkenhead Corporation 5% 1924-34	350 0 0	
Add: Excess of Income over Expenditure for the year 1923	866 6 6	2,656 13 11	1200 0 0 Exchequer Bonds, 3% due 25-1-30	972 0 0	
			1580 0 0 Metropolitan Water Board, Staines Reservoir Guaranteed Debenture Stock	766 6 0	
			1000 0 0 Metropolitan Water Board, Grand Junction Waterworks 3½% Debenture Stock	535 0 0	
			720 0 0 London Electric Railway 4% Debenture Stock	435 12 0	
			200 0 0 London Midland and Scottish Railway 4½% Red. Pref. Stock	179 0 0	
			600 0 0 London & North Eastern Railway 4% Guaranteed Stock	381 0 0	
			16,725 4 10 War Loan 5% 1929/47	14,686 9 7	
			2264 13 11 Conversion Loan 3½%	1450 0 0	19,755 7 7
			(Market Value at 31st December, 1923, £22,887 9 3)		
		£20,733 7 8			£20,733 7 8

To the Members of the Society of Chemical Industry.

We have audited the above Balance Sheet, dated 31st December, 1923, as also that of the Messel Fund, with the Books and Vouchers of the Society, and have verified the investments, and we are of opinion that such Balance Sheets correctly set forth the financial position of the Society and of the Fund at 31st December, 1923.

PRICE WATERHOUSE & CO.,
Chartered Accountants.

3 Frederick's Place, Old Jewry, London, E.C. 2.

19th May, 1924.

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

Vol. 43 NEW SERIES LONDON, MAY 2, 1924 No. 18

EDITORIAL

OUR editorial in last week's issue was written before we had seen the letter from Dr. Fritzsche, which is printed in this number. It therefore gives us considerable satisfaction to find that he is in agreement with us in believing that a better understanding will be founded on a basis of truth—not on a basis of untruth and hypocrisy. We in this country have but little knowledge of what took place in East Prussia; our own newspapers and our principal Government publications naturally dealt mainly with those portions of the world in which British troops were engaged. Dr. Fritzsche is mistaken in thinking that we in this country approve of any actions in East Prussia not in accordance with the so-called rules of civilised warfare. We are in entire ignorance of these breaches and if any occurred we are confident that the vast majority of our people regret them. We see no reason why Dr. Fritzsche and the German men of science should not equally regret any breaches which occurred in France and in Belgium. It was the belief that the German men of science approved of what was done there, that it was well-merited, that inspired our editorial comments. Dr. Fritzsche will render a service to the cause of truth if he will disclose to us details of the documents he refers to as being concealed by the Allied Governments. Have they been published? When, and where? We do not attach such importance to the individual who has the singular brain referred to by Dr. Fritzsche. But many of us in this country have come across a number of Germans who before the war expressed their belief that the Germans represented a higher degree of civilisation than the British and that the war which they foresaw would come, would establish this fact. We do not attach great importance to this, other Germans were more sensible. As to Chauny we are certain that Dr. Fritzsche does not consider that Germany should adopt as her standard, the standard of Russia in East Prussia. As a true friend of humanity can he not regret that Chauny was destroyed, not by the ordinary destruction of artillery in a time of fighting, but in the way it was? As we write these notes we receive with the *Chemiker Zeitung* a copy of Kladderadatsch with some caricatures of no specially refined type. We wonder why the German men of science send these unscientific publications to their foreign subscribers. Is it to convince us of the unreasonable ways of the French or of those of the Berlin Town Council. What singular ideas prevail of this sort of propaganda! Does Dr. Fritzsche think the circulation of this document makes a very favourable impression in foreign countries? We suppose that in all probability Dr. Fritzsche has as little knowledge of Chauny and Louvain as we have of East Prussia. This *Journal* is no place for the elucidation of matters of history. Knowing nothing of East Prussia, but knowing the sort of thing that occurs in war, we make no effort to justify what took place there. Can Dr. Fritzsche believe that things happened in France and Belgium that he would not justify? It is in respect of these two countries that the difficulty is the greatest.

* * *

We have received from Professor Noyes a further communication and from some other correspondents letters which lack of space compels us to hold over until next week. It seems to us that we shall by then have sufficiently ventilated this matter for the present. English chemists are already visiting Germany and a few German chemists come to this country; we suppose that no one expects or desires that the gulf which at the moment separates the French and the Germans will continue indefinitely; already there are signs of a possible general European settlement which will diminish some of the ill-feeling which now exists. That settlement may be so satisfactory that a period of hostility will be replaced by one of neutrality and that again by one of friendliness. We suppose that every chemist hopes for this and that they will all, whatever nationality they possess, cheerfully and gradually drift into a more placid state of mind. Nothing is so harmful as the feeling of nursing our wrath to keep it warm. The views expressed in this *Journal* are of some interest as showing and even to some extent defining points of view which will be gradually modified or abandoned, not by the individuals who now hold them, but by the average chemist who desires the international unity of science and the complete dissociation of chemistry and politics.

POLITICAL PLATFORM FOR THE INTERNATIONAL UNION OF PURE AND APPLIED CHEMISTRY

By Prof. W. A. NOYES

Germans and Austrians have been excluded from the Union for political reasons. If this is to continue the Union should adopt some political platform as the basis for adherence to the Union. Consciously or unconsciously, the reason why Frenchmen are unwilling to see Germans admitted is because they believe that Germany is preparing for another war, and that German chemists are in sympathy with such a purpose. With this in mind, the proper platform for the Union would be :—

1. War under modern conditions is intolerable, and must be avoided.
2. Nations adhering to the Union must agree that, in the future, they will settle all their differences by diplomatic means, or through the World Court.

As between Germany and the Allies the following logical consequences seem to follow.

Germans should agree :—

1. That Austria was wrong when she refused to submit her quarrel with Servia to The Hague, and Germany was wrong in supporting her.
2. That as soon as Germany has been admitted to the League of Nations, and to equal terms in the World Court, all questions of difference between Germany and any of the Allies shall be submitted to the World Court for decision, and shall not be used as a basis for another war.

The Allies should agree :—

1. That the question of the legality of the occupation of the Ruhr should be decided by the World Court.
2. That, in the future, additional German territory shall not be occupied, except in support of a decision of the World Court.

I am very far from thinking that any political platform for the Union is desirable. A political basis for membership seems to me just as undesirable as a religious basis would be. But if a political basis is to be continued, it should be clearly defined and applied impartially, instead of resting, as it does now, on the misunderstanding, hatred and suspicion which have grown from the war.

So long as either the Allies or Germans insist that the mistakes and wrongs of the last 60 years have been all on one side, there can be no peace, and each will continue to prepare for another war. When each is willing to admit that there has been some wrong on their own side, and when each is willing to leave to a less partisan coming generation a more accurate decision about *relative* guilt, and, above all, when each is willing to agree that future differences must be decided by some legal process and not by war, there will be some hope of a permanent peace.

The political leaders of Germany and of the Allies seem to be preparing for peace on the basis of the report of the Commission of experts. Is it not possible for the scientific men of the world to *lead* in ways of peace instead of merely following the financiers and politicians ?

THE PHENOMENA OF ROTATION DISPERSION

By Prof. T. S. PATTERSON

A discussion on rotation dispersion at the Chemical Society reported in *Chemistry & Industry* of March 28, (p. 331) prompts me to the following remarks on the subject.

It may perhaps be said that the purely empirical period in the development of our knowledge of optical activity came to an end in the year 1913. I believe I was the first (*J.C.S.*, 1913, **103**, 145) to generalise the subject by correlating and discussing from a single point of view all the different factors which influence the rotation of a compound—its chemical constitution, the effect of temperature, the influence of solvents and the influence of the refrangibility of the light used. A few months later (April) Armstrong and Walker (*Proc. Roy. Soc.*, [A] **88**, 392), studying the behaviour of fructose, assumed its rotation to be due to the superposition of the rotations of two iso-dynamic forms of this compound, the rotation of each form being unaffected by other factors such as temperature change or the influence of solvents, thus applying to fructose a suggestion similar to that made by Arndtsen (*A. ch. ph.*, 1858, [3], **54**, 421) regarding tartaric acid, which in turn depended upon an observation of Biot's that the dispersion of tartaric acid could be imitated by the behaviour of a mixture of turpentine and camphor. They conceived further the idea of plotting their results upon what they called a characteristic diagram, and were able to show that the data which had been obtained from various other active compounds lay also along straight lines on characteristic diagrams.

In a similar manner Pickard and Kenyon found that the majority of their data also fitted in a most interesting manner on to characteristic diagrams, and, on the whole, they appeared to adopt as an explanation of the fact, the view put forward by Armstrong.

Lowry has been a very ardent advocate of Arndtsen's hypothesis, and, placing his faith in an expression suggested by Drude, attempted to distinguish between what he calls simple, complex and anomalous rotatory dispersion, a point which will be referred to further on.

In three papers published in 1916 (*J.C.S.*, **109**, 1139, 1176, 1204) I carried the generalisation of this subject a stage further, pointing out from purely experimental considerations that the study of temperature rotation curves leads, without the introduction of any theory at all, to what is really the fundamental significance of the characteristic diagram, namely, the fact that, for related series of compounds, the common value of the rotation for two different colours of light is independent of other factors, such as temperature, solvent and—within limits—constitution, and on this account I suggested the idea of a rational zero from which dispersion coefficients should be calculated. I also subjected (l.c., p. 1204) Lowry's views to some criticism, pointing out their complete insufficiency to account

for the observed phenomena. This criticism met with the approval of other authors, (P. F. Frankland and Garner, *J.C.S.*, 1919, **115**, 638, 639; H. M. Dawson, *Chem. Soc. Ann. Reports*, 1917, **13**, 25), and it is very satisfactory to find, from his recent letter in *Chemistry & Industry*, April 4, p. 365, that Dr. Pickard now also supports the views which were put forward by me in 1916.

To my criticisms, however, Lowry has not made any attempt to reply and it can only be regarded as remarkable that after his views had been seriously impugned he has republished them in a paper with Austin (*Phil. Trans.*, 1922, [A] 222, 249), an abstract of which appeared in *Nature* of April 8, 1922, p. 447.*

I propose therefore to restate the main difficulties to which Lowry's hypothesis gives rise.

In the first place it has been found in recent years that in a great many cases, both for homogeneous active substances and for active substances in solution, the rotation rises with increase of temperature to reach a maximum value, and then falls again, or conversely, falls to a minimum value and then rises again. According to Lowry, the change of rotation with change of temperature is due to alteration in the relative proportions of dynamic isomerides assumed to be present. It seems clear that, unless one makes assumptions so gratuitous as to render all argument impossible, and to remove the matter to a sphere where faith takes the place of reason, this theory cannot account for the observed behaviour. To this very important point Lowry makes no reference whatever.

In the second place I pointed out that the behaviour of nitrocamphor in regard to mutarotation and other rotatory phenomena is widely at variance with Lowry's hypothesis. In such a substance as ethyl tartrate, to take a definite example, the specific rotation in 10 per cent. aqueous solution is +26°, in 10 per cent. ethylene bromide solution it is —11·5°. According to Lowry this is due in these two solvents to a difference in the relative proportions of two dynamic isomerides of ethyl tartrate, these isomerides having unequal rotations. Now, in the cases of such substances as glucose or fructose which show mutarotation, the isodynamic change takes place slowly whereas solvent influence, as in the above case, is an instantaneous phenomenon. Lowry merely begs this question by first assuming the changes to take place and adding "whatever the nature of these chemical changes may be, they must proceed to equilibrium with very great rapidity, since even the most careful experiments have failed to detect any lag in the adjustment of rotatory power in the tartaric esters when conditions have been altered." (*Phil. Trans.*, l.c., p. 259, see also *J.C.S.*, 1915, **107**, 1177; 1916, **109**, 1214.) This must surely be one of the strangest arguments ever put forward in a scientific paper, the failure of experiments undertaken to test an hypothesis being regarded not merely as confirmation, but even as amplification of it. This same test would not only reveal the existence of mutarotation in every substance exhibiting anomalous rotatory dispersion, but also in any other substance whatever to which one might choose to apply it.

In favour of their view Lowry and Austin submit the chemical evidence that, in the case of nitrocamphor, isomerides in equilibrium actually exist and "that their behaviour is in accordance with that which must be postulated for the 'two kinds of optically active molecules' assumed by Arndtsen." (*Phil. Trans.*, l.c., 260.) In view of the importance which the behaviour of nitrocamphor thus assumes, I may point out again that the effect of mutarotation and the effect of solvent influence in nitrocamphor can, from Lowry's own investigations, be clearly shown to have no connexion with each other.

If a 5 per cent. solution of the *a* form of nitrocamphor in benzene is examined, the rotation is found to alter with lapse of time. But by extrapolation from these results, one can obtain the value —125° as the initial rotation for this solution, that is, the rotation of one definite form of nitrocamphor before it has commenced to change into the other form. In exactly the same way the initial rotation in xylene is found to have the value —99°, and in chloroform the value 27°. These are the values of one and the same form of nitrocamphor uninfluenced by mutarotation; the values before mutarotation comes into play. It is therefore apparent that *a*-nitrocamphor shows a very marked solvent influence, and it is also obvious that this solvent influence is quite independent of the ordinary mutarotation of the nitrocamphor, and since mutarotation and solvent influence can be thus clearly differentiated from each other, it follows that they have no necessary connexion. In exactly the same way it can be shown that the rotation of pure *a*-nitrocamphor before mutarotation occurs, varies with concentration in benzene, and this again entirely excludes dynamic isomerism and brings nitrocamphor into line with ethyl tartrate and other similar substances. Since therefore the behaviour of nitrocamphor when the influence of mutarotation has been eliminated is in all respects analogous to the behaviour of ethyl tartrate, there is clearly no case for the suggestion that mutarotation is the cause of the solvent effects observed with ethyl tartrate. Thus the behaviour of nitrocamphor instead of being a support of Lowry's hypothesis, affords perhaps the strongest evidence which can be brought against it.

Nevertheless, Lowry and Austin find it difficult to resist "the conclusion that tartaric acid, like nitrocamphor, can exist in two forms and yields two types of derivatives, and that the presence of these two types is responsible for the complex rotatory dispersion of the acids and of some of its derivatives." (*Nature*, l.c., 450.) Lowry, somewhat prematurely, even suggests formulæ for these isomers

* In the account of this paper which appeared in *Nature*, [illegible], Lowry and Austin make the mistake of attributing to Biot (1812) the explanation of the sequence of beautiful colours produced by the interposition of quartz plates cut perpendicular to the axis, between a polariser and an analyser at extinction. This phenomenon was, in fact, not only discovered by Arago in 1811 but fully understood and explained by him. Biot merely developed—with characteristic verbosity—the discovery of Arago.

of tartaric acid, Lowry and Burgess stating (*J.C.S.*, 1923, **123**, 2118) that "after ten years search the co-ordination of the hydrogen atom has at last provided a satisfactory formula for the elusive laevo form of the acid."

Lowry and Austin (*Phil. Trans.*, l.c., 259) say that, "in recent years this extreme sensitiveness has been regarded by many writers as an inherent quality of the physical property of optical rotatory power, but all the new evidence goes to show that Biot was right in attributing it to chemical change in the optically active liquid."

But the whole of the evidence upon which Lowry and Austin rely consists of :—1. The experiment cited above, by Biot, (A. ch. ph. 1852, [3], **36**, 462) regarding which it need perhaps only be remarked that the optical behaviour of a mixture of turpentine and camphor has not been investigated by modern methods, it being therefore by no means certain that it is analogous with that of such a substance as tartaric acid. Further, this part of the evidence would seem to assume that both of the substances, turpentine and camphor, have so-called simple and normal rotation dispersion. It appears, however, to be the case that both of the substances on which this proof depends, themselves show anomalous rotation dispersion, a fact which seems sufficient to invalidate the whole argument. 2. The behaviour of nitrocamphor, which, as explained above, tends exactly in the opposite direction, and 3, their mathematical application of Drude's expressions to rotation-dispersion curves, which last presumably constitutes "the new evidence" as there is nothing more. This "mathematical evidence" consists in assuming that the relationship between rotation and wave length ought to be represented by the expression suggested by Drude—$a = \frac{k}{\lambda^2 - c}$. The statement that certain data can be represented by a Drude expression containing only one term sounds perhaps more simple than it is, for this expression represents a cubic curve and contains two arbitrary constants. Nevertheless, if values for k and c can be found to fit the experimental data, Lowry calls the dispersion simple, and assumes that the active substance present is homogeneous. If suitable constants cannot be found the expression is altered to $a = \frac{k_1}{\lambda^2 - c_1} + \frac{k_2}{\lambda^2 - c_2}$ which is an expression of the *fifth* degree containing *four* arbitrary constants. Considering the complexity of the expression it is not surprising that it can be adapted to fit most rotation-dispersion curves. If it does fit Lowry calls the dispersion, according to circumstances, anomalous or complex, and maintains that since there are two Drude terms there are two dynamic isomerides present, the discovery of which "is a fascinating problem which still awaits investigation." (*Nature*, l.c., 450) The rotation-dispersion of quartz, as appears from Lowry's work, can only be represented by a Drude expression containing three terms. Presumably therefore the discovery of three dynamic isomerides of quartz is another fascinating problem for the future.

All these "theories" about rotation dispersion seem to indicate a strange neglect of what appears to me, at least, to be the chief fruit of many years of investigation. According to Lowry's way of looking at the subject, not merely each particular substance, but each particular substance in all the infinite number of different circumstances in which it might be placed by change of temperature, change of solvent, and change of concentration, must be regarded as a separate case almost completely unrelated to each other, whereas, in fact, the experimental results obtained by Frankland, Lowry, Pickard and Kenyon, myself, and others, regarded from a broader point of view, show a most remarkable uniformity and allow of a very wide generalisation. In the accompanying figure is shown a characteristic

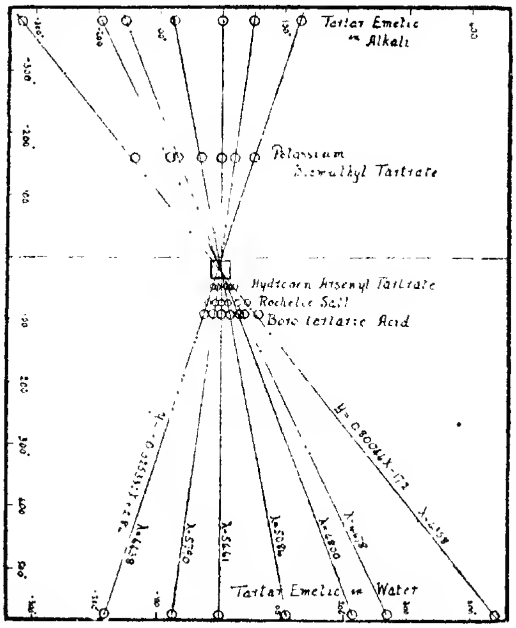


diagram embracing Lowry and Austin's results, the diagram being constructed according to the method suggested by me (*J.C.S.*, 1916, **109**, 1181) Rotation values for mercury green are plotted along the horizontal axis which is therefore taken as the reference line, and vertically above or below these (according to sign) there are plotted the corresponding differences between these rotations and those for other colours of light.

The data represented by the diagram vary from the value $[M]^{20}_{4358} = 1015{\cdot}8$ for tartar emetic in 5·32 per cent. aqueous solution to $(M)^{20}_{4358} = -702$ for tartar emetic in alkaline solution. Since the highest values of the rotation of tartaric acid itself is only 27°, it is impossible to make the data for tartaric acid visible along with the others on a diagram of practicable dimensions. It will be seen, however, that the data of Lowry and Austin for tartar emetic, potassium tartrate, Rochelle salt, borotartaric acid and potassium bismuthyl tartrate

all in aqueous solution and for tartar emetic in alkaline solution lie very nearly along straight lines in the diagram. The values for tartaric acid lie within the region marked by a square, the region within which anomalous rotation dispersion is most obvious. In spite of the fact that, according to Lowry and Austin, the dispersion of tartar emetic in aqueous solution as well as in excess of alkali is both simple and normal, whilst that of tartaric acid is highly anomalous the data for them all appear to fit on to one diagram. On account of the difference of scale this is most easily shown by calculation. In the figure, the line which joins the point representing the rotation of tartar emetic in water ($p = 5·32$) for violet light, and that representing the corresponding rotation for tartar emetic of a similar concentration in the presence of excess of alkali, has the equation $y = 0·80044X - 17·2$, whereas that joining the two points representing the rotations for the cadmium line 6438, has the equation $y = 0·325222X + 2·84$. These two lines intersect one another at a point whose co-ordinates are (+17·8, —2·92): at this point the rotation for these two colours would be equal and would have the value +14·88°, the corresponding value for mercury green being +17·8°. By constructing a separate diagram on a much larger scale for tartaric acid, the cadmium red and mercury violet lines are found to intersect at the value +13·19°, a point which can, of course, actually be realised in practice, and which is astonishingly close, considering the circumstances, to the 14·88 which is derived from the tartar emetic curves. Is it not a very significant fact that the highly "anomalous" rotation dispersion of tartaric acid can be calculated thus closely from the data, so very different in degree, of tartar emetic in water or in alkaline solution, considering the fact that in both the latter cases, the rotation dispersion is "normal" and simple." Surely, therefore, the whole lesson of the characteristic diagram is that the dispersion of all these substances for these two colours of light should be calculated with reference to this particular point +13·19°,—the rational zero for these two colours.

Similarly, of course, the dispersion ratio for mercury violet and mercury green should be calculated from the point of intersection of these two lines which, by calculation from the data for tartar emetic, is +17·8°, and from the diagram for tartaric acid is 19·7°. In the table in the next column dispersion coefficients for $\frac{Hg_{gr}}{Hg_{v}}$ calculated (1), by the ordinary method, and (2) from the rational zero (19·7) are compared.

Whilst the ordinary dispersion co-efficient varies between 0·2795 and 1·869, the rational dispersion coefficient only varies between 1·709 and 1·861, and embraces a considerable number of different substances under different circumstances. This procedure seems to summarise Lowry and Austin's work very much more simply than their own, since the latter involves the elimination of some fifty or sixty arbitrary constants.

This question seems analogous to that of the specific heats of the elements. When Dulong and Petit found that, for the most part, the atomic weight of an element multiplied by its specific heat gave a constant, they simply adopted, without theorising on the subject at all, what appeared to be a suggestion made by nature itself. In the present instance nothing could be clearer than that, for a set of chemically related compounds, the ratio of the rotation for a given colour of light to that for some other colour of light ought to be calculated with reference to the common rotation value for these two colours—with reference to the rational zero. When such a regularity as is shown in the table can be introduced amongst a heterogeneous collection of data like these, surely the obvious conclusion ought to be adopted whether or not a theoretical "explanation" connecting the phenomena with hypothetical absorption bands or problematical electrons can be offered. For after all, what this phenomenon requires is investigation rather than "explanation."

DISPERSION COEFFICIENT OF DERIVATIVES OF TARTARIC ACID

Temperature 20°; Rational zero +19·7°.

Active substance	Molecular rotations $\lambda = 4358$	Molecular rotations $\lambda = 5461$	Ordinary dispersion coefficient	Rational dispersion coefficient
Sodium tartrate (p : 22·54)	+107·74	+68·23	1·579	1·8153
Sodium tartrate (p : 34·32)	103·04	65·58	1·571	1·8165
Potassium tartrate (p : 33·6) ..	126·61	79·61	1·591	1·785
Rochelle salt (p : 44·63)	104·45	72·16	1·586	1·740
Ammonium tartrate (p : 32·1) .	122·83	76·77	1·600	1·8072
Tartar emetic (in water p : 5·32) ..	1015·8	573·7	1·7707	1·798
Tartar emetic (in excess of alkaline solution p : 5·53)	—702·0	380·4	1·8454	1·804
Tartaric acid (p : 55)	+2·772	+9·919	0·2795	1·731
,, ,, (p : 45)	5·446	11·479	0·474	1·734
,, ,, (p : 35)	15·197	17·126	0·8874	1·749
,, ,, (p : 25)	17·356	18·355	0·9456	1·743
,, ,, (p : 15)	21·730	20·888	1·040	1·709
,, ,, (p : 5)	26·687	23·504	1·135	1·837
Potassium tartrate in presence of alkali (c = 4·7) ..	97·3	61·4	1·585	1·861
Sodium tartrate in presence of alkali (c = 4·6)	98·7	62·4	1·582	1·850
Potassium arsenyl tartrate (c = 2·5) ..	114·9	72·2	1·591	1·813
Potassium bismuthyl tartrate with excess alkali (c = 2·5)	−298·9	−159·9	1·869	1·774
Borotartaric acid (0·10 mol. per 100 cc.)	+150·2	+90·6	1·658	1·841

Organic Chemistry Department,
University of Glasgow
April 9, 1924

The death is announced of Prof. Siegmund Gabriel, for many years director of the organic division of the Chemical Institute of the University of Berlin, and author of numerous researches on the synthesis of organic compounds, especially of phthalic acid derivatives, and amines.

THE HOLMBOE ELECTROLYTIC HYDROGEN GENERATOR

By MARC HANSSEN
Chief Eng., Fredrikstad, Norway

The use of hydrogen in the chemical industry for the hydrogenation of oils and fats and in various synthetic processes as in the manufacture of precious stones, has been considerably increased during the last ten years, and it seems as if the successful development of many important branches of the chemical industry will, to a large extent, depend on the safe production of large quantities of pure and cheap hydrogen.

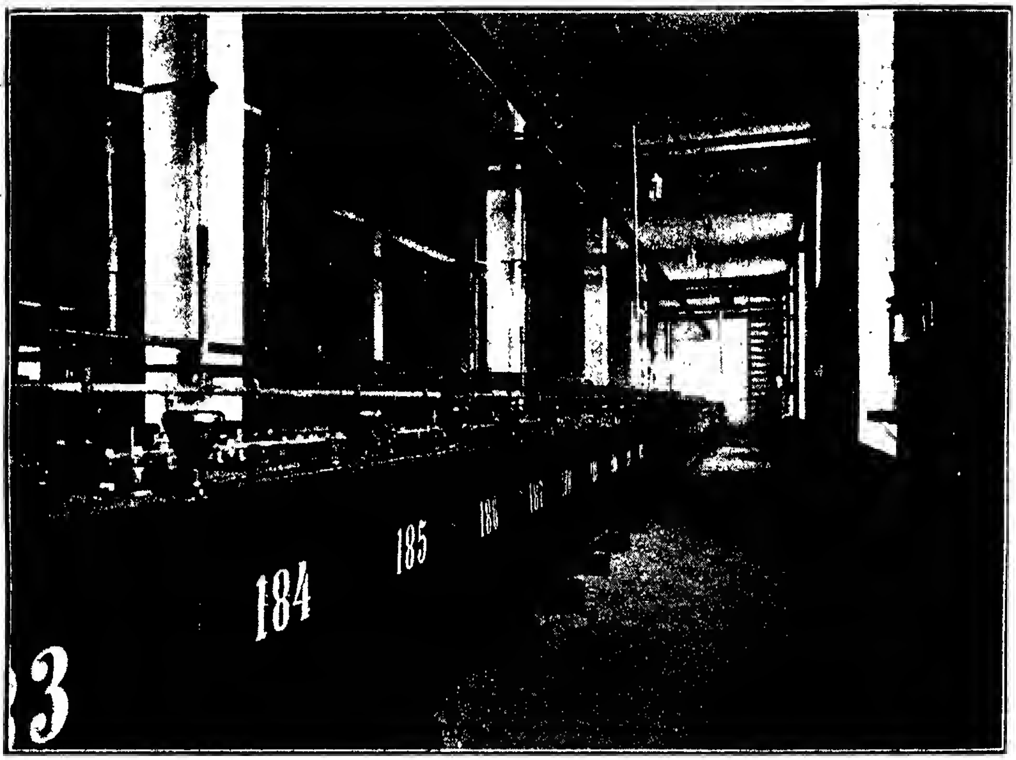


Fig. 1

The purity of the gas is of the greatest importance and it is generally required that hydrogen shall have a purity of 100 per cent., and be free from moisture. The only process, which up to the present has been able to comply with this requirement, is the electrolytic process, as most of the electrolytic plants can produce hydrogen with a purity close to 100 per cent., the impurities being oxygen, moisture and probably traces of the alkali used as electrolyte. The gas is mostly purified by passing it through a furnace containing an electrically heated catalyst, in order to combine the excess of oxygen with hydrogen to form water.

Owing to the increasing demand for hydrogen, a great number of inventors in all parts of the world have concentrated their attention on the design of a efficient electrolytic cell and a large patent literatu... already covers this subject. The majority of tl... suggested types, however, has not passed beyond th... drawing board or the experimental stage. Of thos... few types which have found their way into practica... use, most are limited by their special design to ... comparatively small specific output, too small fo... commercial use on a large scale. The reason for this limited success may depend upon the fact that only a few inventors have had the opportunity of actually running large electrolytic plants for a number of years, and therefore lack the practical experience and knowledge of the requirements essential for the design of an efficient and reliable electrolytic cell.

A type of cell which has proved to be highly efficient and economical is the Holmboe hydrogen generator, designed by C. F. Holmboe, D.Sc., the managing director of De Nordiske Fabriker, Denofa A/S, in Fredriksstad, Norway. The first units of these cells were started up in 1919, and have been in continuous operation since, day and night without stop. The cells have up to the present neither been opened for inspection nor has any part been repaired or renewed. They have been filled twice a day with distilled water, which is all the work required.

Fig. 1 illustrates the battery of Holmboe hydrogen generators, installed at the Denofa works at Fred-

ikksstad. The cells, which are of the 3000-ampere type, are totally enclosed.* In the cell-room, shown in Fig. 1, are 400 cells. On each shift only one man is required to look after the plant, his work consisting in the control-analysis of the gases, keeping the cells filled with distilled water, and looking after the stills for the production of distilled water.

The electrolytic efficiency of the Holmboe hydrogen generator is equal to about 7·3 cb. ft. of hydrogen per kw.-hr., measured at 20° C. and 760 mm. taken as an average over one year. The efficiency varies with the output between 7·1 and 7·6 cb. ft. hydrogen

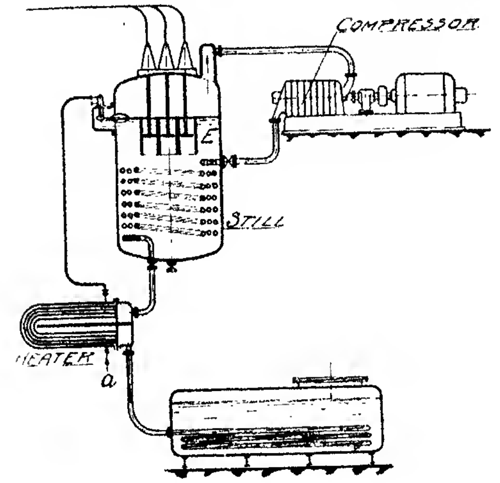


Fig. 2

per kw.-hr., and is remarkably constant, although the gas output from month to month can fluctuate 30 per cent. above and below the medium output. This fact is due to the electrothermal storage in the cells themselves, which is a special feature of the Holmboe hydrogen generators.

The hydrogen leaves the cells with a purity of 100 per cent., the traces of moisture being separated by a special device. The oxygen has an average purity of 99·75 per cent., and can be compressed direct into cylinders. A special purification of the two gases is therefore not necessary. The floor-space and building required for the Holmboe hydrogen generators are very moderate and the cost of the building with normal foundations only about 30-50 per cent. of the cost of the plant, depending upon the size. The total power of the power station attached to the plant is 7500 kw. d.c.

Owing to the high efficiency and the simple and durable design of the Holmboe hydrogen generators, the total production cost is very moderate. The plant illustrated in Fig. 1 produces 1000 cb. ft. of hydrogen in the gas-holders of the works at a total cost of 1s. 9d., including cost of power, distilled water, labour, sundry expenses, interest on capital invested in the plant and maintenance.

It is very important that the cells are supplied with pure distilled water. A new method of producing distilled water, particularly in cases where cheap power is available, is illustrated in the drawing, Fig. 2. The still is fitted with electrodes E (in this type 3 electrodes for 3-phase alternating current) and a system of coils. When the current passes through the electrodes the water in the still begins to evaporate. The steam so produced passes through a pipe connected to a motor-driven centrifugal-compressor in which the steam pressure is increased. This steam, at a pressure higher than atmospheric, flows through the coil-system in the still and in condensing gives off most of its heat to the water in the still. From the coil in the still the condensate and what may be left of the steam pass through a heater and thus into the large storage tank for distilled water. The electrodes carry in actual operation only a little more than the current equal to the heat required for raising the temperature of the feed-water to about 110° C. plus the heat lost by radiation. The fresh water enters the heater at "a," is pre-heated and passes to the float-valve which keeps the water-level constant in the still. This method of producing distilled water is very simple, efficient and highly economical where water power at moderate cost is at hand.

* So that escape of alkaline particles from the electrolyte (which has proved so unpleasant a feature of open cells) is quite impossible, and fitted with a special equalising device for the gas pressures.

PULVERISED FUEL FOR STEAM GENERATION

(From a Correspondent)

The North Metropolitan Electric Power Supply Co. have now placed with Messrs. The Underfeed Stoker Co., Ltd., for their Willesden electricity station, the first order in Great Britain for a modern "Lopulco" pulverised fuel equipment, to be applied to one "Clayton" water tube boiler of a normal duty of 60,000 lb. water evaporated per hour, to be running in October. This fact is significant, as it means that the struggle between pulverised fuel and mechanical stoking (of which the two general types are the improved travelling grate and the multiple retort) for supremacy in the water tube boiler world has spread in earnest to Great Britain, following on the enormous developments in the United States during the past three years, and the very recent orders in France for the Vitry and the Gennevilliers stations.

The matter is particularly interesting to the chemical engineer, because there seems to be every indication that the many difficult problems of burning fuel in a pulverised condition under water tube boilers have been solved, and one may expect sooner or later equal progress not only in metallurgical and general furnace work, but also for cylindrical boilers on land and sea, as well as locomotives.

The installation at Willesden is to consist of the latest type of "Clayton" bent tube type water-tube boilers, as suitable for the purest feed water, with a heating surface of 7200 sq. ft., working at 200 lb. pressure, and 650° F. superheat, the temperature of the inlet feed-water being 150° F, the rating with

ordinary mechanical stoking being 50,000 lb. of steam per hour actual.

The "Lopulco" pulverised fuel equipment will consist of one of the newest vertical gravity coal driers, utilising only the hot exit flue gases in the chimney base, mixed with air to give a temperature of about 215° F., working in conjunction with a "Raymond" pulveriser of the 6-roll, low-sided type, the combined set having a duty of 6 tons of bituminous coal per hour, reducing the moisture from 10% to 4%. It is interesting to note that one of the latest developments in pulverised fuel fixing is that only the mechanical moisture is now found to be of importance, and excessive drying is no longer regarded as necessary. The fineness of the grinding is to be 90% through a 100 mesh, and 80–85% through a 200 mesh, being therefore somewhat finer than the usual 65% through 200 mesh. The coal as it enters the plant, before passing to the overhead bunkers above the vertical drier, will be crushed so as to pass wholly through a ¾ in. screen.

The pulverised coal is separated automatically in the pulveriser by means of a continuous enclosed air current, and conveyed to the overhead pulverised coal bunker, after passing through a cyclone separator to disentangle the fuel from the air. The apparatus includes two standard "Lopulco" variable speed 3-group feeders, supplying therefore in all 6 "Lopulco" burners in the top of the combustion chamber pointing downwards in the usual way. The combustion chamber is of the most modern design, with large volume, and hollow firebrick walls throughout, including the usual air inlet ports and regulating devices, and will be fitted with the patent "Detrick" suspended firebrick arch, in addition of course to the essential "Lopulco" water screen, consisting of 4-in. water-cooled steel tubes in the bottom of the chamber in circuit with the boiler so as to prevent the melting of the ash (slagging). Further, also the plant includes two "Usco" air heaters which will preheat the air for combustion to 300° F. before passing into the hollow walls, reducing the final flue gas temperature to 359° F. The air then passes into the combustion chamber at 600–800° F., thus increasing the efficiency of the combustion and cooling the brickwork at the same time.

The normal duty coal consumption will be 8840 lb. per hour of coal, which will be of the ordinary semi-bituminous quality, with a lower calorific value of 10,000 B.Th.U. as received. This will be equivalent to a normal evaporation of 60,000 lb. water per hour actual, together with a long overload of 72,000 lb., and in addition the guarantee includes a maximum peak load duty for two hours' operation of 80,000 lb. per hour, an interesting point in view of the controversy as to the alleged high cost of pulverised fuel equipment and also because of the fluctuation in the demand for steam in the chemical industry.

The efficiency guarantee is amazing, being no less than 80 per cent., based on the nett calorific value of the fuel, and is higher than the latest American installations, corresponding to only about 20 per cent. excess air above the theoretical and 17 per cent. carbon dioxide, the average industrial plant being 75–120 per cent. excess air, 6–8 per cent. carbon dioxide, and less than 60 per cent. efficiency.

FORTHCOMING EVENTS

May 5. SOCIETY OF CHEMICAL INDUSTRY, *London Section*. Annual meeting at the Chemical Society, Burlington House, W. 1, at 8 p.m. "Bauxite as a Refining Agent." Part 1, General, by A. G. Dunstan, D.Sc., F. B. Thole, D.Sc., and F. G. P. Remfry, D.Sc. Part 2, "Application in the Refinery," by A. M. O'Brien.

May 5. ROYAL SOCIETY OF ARTS, John Street, Adelphi, at 8 p.m. "Photography in Industry, Science, and Medicine," by T. Thorne Baker.

May 5. UNIVERSITY OF LONDON, University College, Gower Street, W.C. 1, at 5.30 p.m. "Positive and Negative Valences," Prof. W. A. Noyes.

May 5. INSTITUTION OF THE RUBBER INDUSTRY, *London Section*, Engineers' Club, Coventry Street, London, W., at 8 p.m. "The Rubber Industry —A Plea for Closer Working," by J. Fairbairn

May 6. ROYAL COLLEGE OF SCIENCE CHEMICAL SOCIETY, Royal College of Science, South Kensington, S.W. 7, at 5 p.m. "Fuel Cells or the Direct Conversion of Fuel Energy into Electrical Energy," Prof. A. J. Allmand, D.Sc.

May 6. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section*, the University Chemical Department, Bristol, at 7.30 p.m. "The Somerset Oil Shale Fields," by Dr. W. F. Leslie.

May 6. ROYAL PHOTOGRAPHIC SOCIETY, 35, Russell Square, W.C. 1, at 7. Fourth Harter and Driffield Memorial Lecture, "Tone Reproduction in Photography." Dr. C. E. K. Mees.

May 7. SOCIETY OF PUBLIC ANALYSTS, Chemical Society's Rooms, Burlington House, Piccadilly, W. 1, at 8 p.m. (1) Determination of Sugar in Urine by Means of Fehling's Solution with Methylene Blue as Internal Indicator," by J. H. Lane and L. Eynon. (2) "Simple Forms of Hydrogen Electrode," J. J. Considene. (3) "Note on the Recognition of Hydrogenated Oils," by K. A. Williams and E. R. Bolton. (4) "Estimation of Copper and Tin, and Copper-Tin Alloys," by A. T. Etheridge. (5) "Notes on the Analysis of Milk Powders and Condensed Milks," by D. W. Steuart. Informal dinner will be held at 6.30 p.m. at the St. James's Restaurant 178, Piccadilly, W. 1.

May 8. INSTITUTION OF ELECTRICAL ENGINEERS, Savoy Place, Victoria Embankment, London, W.C. 2. at 6 p.m. Annual General Meeting.

May 8 and 9. IRON AND STEEL INSTITUTE, at the Institution of Civil Engineers, Great George Street, London, S.W. 1. Annual Meeting. Annual dinner at the Hotel Cecil, Strand, on May 8, at 7.30 p.m.

June 11 to 13. SOCIETY OF DYERS AND COLOURISTS. Annual dinner on June 11 at the Hotel Victoria Northumberland Avenue, London, S.W. 1. Conference on June 11 and 12 at the British Empire Exhibition, Wembley; on June 11 (3 p.m.) J. R. Hannay will give "An Historical Survey of Dyeing and Calico Printing," and on June 12 (11 a.m.) Prof. A. G. Green, F.R.S., will speak on "Modern Methods of Dyeing." River outing (cost 15s. per person) to Windsor on June 13. Application for tickets should be made to the Society of Dyers and Colourists, 30, Pearl Assurance Buildings, Bradford, before May 10.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 11 a.m.

A preliminary programme appears on this page.

In accordance with the provisions of by-law 23 intimation is hereby given that the following members of Council retire from their respective offices at the forthcoming Annual General Meeting: Dr. E. F. Armstrong, F.R.S., *President*; Mr. Julian L. Baker, Mr. C. S. Garland, Sir Max Muspratt, Bart., and Sir Wm. J. Pope, K.B.E., *Vice-Presidents*; Mr. John Allan, Prof. J. W. Hinchley, Dr. J. H. Paterson, and Mr. W. J. U. Woolcock, C.B.E., *Ordinary Members*.

Mr. W. J. U. Woolcock, C.B.E., has been nominated for election to the office of President under by-law 19; Dr. E. F. Armstrong, F.R.S., Prof. J. W. Hinchley, Prof. J. C. Philip, F.R.S., and Sir Richard Threlfall, K.B.E., F.R.S., have been nominated Vice-Presidents under by-law 20.

Mr. E. V. Evans has been re-elected Hon. Treasurer, and Sir Wm. J. Pope, K.B.E., has been re-elected Hon. Foreign Secretary.

Members are requested to nominate, on or before May 9 next, fit and proper persons to fill the four vacancies among the Ordinary Members of Council. Forms for this purpose can be obtained from the General Secretary of the Society.

By-law 22.—An Ordinary Member of Council shall be nominated by five or more members upon Form B in the Schedule, a copy of which form shall be furnished by the General Secretary upon the written or verbal request of any member, but a member shall not be eligible to sign more than one such nomination form, and the member nominated shall sign the declaration set forth on the form.

A nomination shall be declared invalid by the Council if:—

(*a*) The member thereon nominated is disqualified for election, or ineligible to be elected, as provided by the by-laws.

(*b*) The nomination is not made on the authorised printed form, or substantially not in the manner directed thereon.

(*c*) The nomination form is signed by less than five members not disqualified or not ineligible to nominate as provided by the by-laws.

(*d*) The nomination form is not received before or upon the day appointed therefor.

(*e*) The member nominated has not signed the declaration printed upon the form.

A member whose nomination aforesaid is declared to be invalid shall receive notice thereof from the General Secretary, and shall not be submitted for election.

J. P. LONGSTAFF,
General Secretary

The following is a Preliminary Programme of the meetings to be held in Liverpool on July 9-12 inclusive.

WEDNESDAY, JULY 9.—*Morning*: Council Meeting. Annual General Meeting in the Arts Theatre, the University. Presidential Address by E. Frankland Armstrong, D.Sc., F.R.S.; *Afternoon*: Business Session in the University. Visit to White Star Liner "Cedric," and tea on board by invitation of the White Star Line. *Evening*: Reception and Dance at the Town Hall by invitation of the Right Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.).

THURSDAY, JULY 10.—*Morning*: Messel Memorial Lecture by the Right Hon. Viscount Leverhulme, in the Arts Theatre, the University, and presentation to the Lecturer of the Society's Messel Medal for 1924. Visit to the works of Messrs. Joseph Crosfield & Sons, Ltd., Warrington. Luncheon by invitation of the Directors. *Afternoon*: Inspection of the Works. *Evening*: Annual Dinner of the Society at the Midland Adelphi Hotel.

FRIDAY, JULY 11. *Morning*: Business Session in the University. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of the United Alkali Co., Ltd. Visit to a Works of the United Alkali Co., Ltd. *Evening*: Dinner at Lady Lever Art Gallery by invitation of the Chairman and Directors of Messrs. Lever Brothers, Ltd.

SATURDAY, JULY 12.—Visit to Lake Vyrnwy. Inspection of Liverpool Corporation Water Works.

A detailed programme will be sent later to every member of the Society.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

LIST OF MEMBERS ELECTED,

11th April, 1924

Baborovsky, Jiri, University of Technology, Falkensteinerova 7, Brno, Czechoslovakia. Professor of Physical Chemistry.

Cross, Reginald B., Daisybank, Maxwell Road, East Kilbride, Scotland.

Desbarats, H. Jean, Cascade Inn, Shawinigan Falls, P.Q., Canada. Works Foreman.

Fujioka, Chuji, Imperial Hygienic Laboratory, Igumi-cho, Kanda-ku, Tokyo, Japan. Research Chemist.

Furlong, John R., 75, Swinderby Road, Wembley, Middlesex. Research Chemist.

Herapath, Cyril A., "Newgrove," 142, Church Road, Upper Norwood, London, S.E. 19. Chemist.

Hickinbottom, Wilfred J., 46 Frederick Road, Stechford, Birmingham. University Lecturer.

Holland, W. W., Standard Oil Co. (Indiana), Wood River, Ill., U.S.A. Oil Refiner.

Jones, Ronald H., 28, Capel Road, Clydach, Swansea. Analytical Chemist.

Kuchiki, Yoshio, c/o Japanese Embassy, 37, Portman Square, London, W. 1. Chemical Engineer.

Lewkowitsch, Miss P. R. Elsa, 71, Priory Road, W. Hampstead, London, N.W. 6. Student.

Oka, Shunpei, c/o Dept. of Applied Chemistry, Faculty of Engineering, Tokyo Imperial University, Tokyo, Japan. Research Chemist.

Rogers, L. Joslyn, Mining Building, University of Toronto, Ont., Canada. Professor of Chemistry.

Sands, James E., Robinson Road, Mapperley, Nottingham. Laboratory Furnisher.

Short, William A., United Alkali Co., Ltd., Cunard Building, Liverpool. Managing Director.

Westwood, John B., Abbey Brewery, Edinburgh. Chemist.

NOTTINGHAM SECTION

At the meeting on March 26, Dr. E. B. R. Prideaux in presenting the annual report, said the session now drawing to a close had been characterised by a testing and adaptation of the new policies which had been initiated in preceding sessions. Although the leading members of the council had not been free from anxiety on the financial side, it had been decided to continue boldly the weekly publication of *Chemistry and Industry* as a high-class journal, in the forefront of science and at the same time popular in the best sense. Most members will agree that it is unique in these respects even if they do not give their unqualified approval in others. A pleasing feature is the liberal space now allotted to sectional meetings and discussions, which form part of the Society's activities. The co-operation with the Chemical Society had continued in the direction of granting mutual privileges in respect of subscriptions. The process of unifying the abstracts of the two societies was also rapidly approaching completion. The facility afforded for reading at our sectional meetings papers intended for publication in the Chemical Society had not been as largely taken advantage of as was originally intended, but it was hoped that members would bear it in mind as occasion arises.

The lamentable loss of our chairman, fresh as it was in our minds, called for mention, since he was secretary of the Section for so many years. Only those who now continue that responsibility would realise how much his experience was missed. He had already last autumn made preliminary arrangements to secure the lecture from Prof. A. R. Ling on the history of fermentation.

In passing it was perhaps not out of place to record our congratulations to Mr. S. J. Pentecost, on his accession to the presidency of the Society of Dyers and Colourists. There had been seven meetings in the session, one of which was held jointly with the Society of Dyers and Colourists. On this occasion Mr. K. H. Saunders read a paper by himself and Prof. A. G. Green, F.R.S., on the "ionamine" dyestuffs. At the opening meeting the late chairman touched on some important aspects of chemistry in its application to the discovery of accessory food factors and the supply of fertilisers in agriculture. The paper was followed by an interesting note by Dr. Firth and Mr. J. Higson on the products of the action of sodium hyposulphite on silver nitrate. The next meeting, contributed by members of the College, described researches in bacteriology, organic compounds, and regulators of acidity. The Section was indebted to the Stanton Iron Works for two papers. Mr. Woodhouse described the use of the metallurgical microscope and photomicrography and Mr. G. J. Ward gave an account of the manufacture of concrete pipes. Finally, from the laboratory of Mr. S. R. Trotman, there were communicated the results of researches by himself and Mr. R. W. Sutton on the analysis of gelatin, examination by chemical and microscopical methods of foodstuffs, textiles, etc. The paper on the weathering of cotton and wool was the latest of a long series through which Mr. Trotman had advanced step by step in the elucidation of textile problems.

Early in 1924 a sectional list of members with rules, etc., was compiled in response to a demand which had become somewhat pressing, since the last edition was in 1917-1918. The membership of the Section was now about 150. The proportion, however, that attended the meetings could not be considered satisfactory, even when allowing for the dispersion of members in the East Midlands area, and for those who resided abroad or in other areas. The associate membership had been maintained by the addition of new members, many of whom were not only keen in attending the meetings, but also took part in the discussions.

There was probably no meeting, whatever its nature, from which even the oldest and most experienced members did not carry away something of value. Technical men might be assisted to follow recent progress in general chemical knowledge; academic men had an opportunity of being impressed by advances in applied chemistry shortly after these are made. The younger men, whose academic knowledge should be more up-to-date, needed to keep in constant touch with progress in pure and applied chemistry, since upon them would devolve the responsibility for the chemical industry. Technical chemists especially might use these meetings to broaden the basis of their knowledge. How much more conclusive our discussions would become if a group were to "get up" the subject of the paper, with the intention of informing the meeting and settling doubtful points.

Chemical industries must always be progressive in their nature, and all industries had become with the advance of science more or less chemical industries. The only real hope of maintaining these in the face of ever increasing international competition was for the technical man, more especially the chemist, to make himself susceptible to knowledge from whatever quarter it might blow and for the manufacturer to realise his need for educated and alert men, to treat them generously and to increase their numbers in proportion as he discovers their beneficial effect on the quality of products and economy of production.

SOCIETY OF GLASS TECHNOLOGY

The seventh Annual General Meeting was held in Sheffield on April 16, the president, Prof. W. E. S. Turner, D.Sc., in the chair. Col. S. C. Halse, was elected President in succession to Prof. W. E. S. Turner. The other vacancies were filled as follows: Vice-presidents, F. G. Clark, R. L. Frink; Members of Council, H. A. Bateson, W. R. Dale, J. Moncrieff, W. J. Rees, B.Sc. Tech., J. H. Steele, J.P., and H. Webb; Hon. Treasurer, J. Connolly; American Treasurer Wm. M. Clark, Ph.B.; Hon. Secretary, S. English, M.Sc.; Auditors, Ed. Meigh, M.Sc., and Dennis Wood, F.S.A.A. The Annual Report and Accounts showed that 1923 was a successful year. The foreign membership continued to increase, numbering 190 (including 109 resident in the United States) out of 615 at the end of 1923. Altogether the society was connected by membership with no fewer than seventeen countries. Prof. H. Le Chatelier, Paris, was elected honorary member of the society.

A paper entitled "The Physical Properties of Some Alloys Resistant to Heat and Corrosion" was read by J. H. G. Monypenny, F.Inst.P., who dealt with problems which might occur in machinery pertaining to the glass industry, and said there were also certain general engineering uses for material having these special properties, such as the application of the material to various fittings for steam service and hydraulic work. Dealing first with stainless steel, he outlined the range of properties obtainable, dwelling also on the mechanical and heat-resisting properties. Passing on to alloys developed for special properties, particulars were given of stainless material in which resistance to mineral acids had been greatly increased, and the tendency for galvanic action in contact with bronze and other copper alloys entirely removed. A short description of some special alloys which had been developed for resisting scaling was given. A sample exposed in a brick kiln for a fortnight, the temperature reaching 1200° C., revealed a total change in weight of only 0·04 per cent. The glass industry required alloys suitable for a number of special purposes, in some cases for resisting general corrosion, and in others for resisting the effects of high temperatures. Probably no single alloy would be suitable for all purposes, though for any of those purposes some type of stainless steel would be found useful. For developing any one special property in an exceptional degree, it was generally found necessary to sacrifice other properties to some extent, so that it was advisable for the maker and the user to collaborate.

Mr. W. R. Barclay, A.M.I.E.E., followed with a paper entitled "Some Properties and Possible Industrial Uses of Alloys containing Nickel," devoted to two alloys, the simple nickel-copper series and the nickel-chromium series, with no other metals added. Referring to the nickel-copper alloys he emphasised their remarkable ductility, combined with considerable toughness and strength, and very considerable resistance to corrosion. A retention of strength at temperatures higher than those at which ordinary non-ferrous metals broke down was particularly evident in the nickel-copper alloys containing high nickel. As an illustration of the enormous ductility, he quoted a recent example of material manufactured, in which it has been possible to cold-work a 2 in. bar right down to 0·2 in. without annealing. The two nickel-chromium alloys hitherto developed were the 85 per cent. nickel, 15 per cent. chromium, and the 80 per cent. nickel, 20 per cent. chromium. They were remarkable materials, bridging the great gulf that had hitherto existed between ferrous and non-ferrous materials, and combining in a high degree the best properties of both. These were the alloys which had made modern developments of electric heating possible. A very important application was their use in annealing furnaces.

During the morning an exhibition of special steel and non-ferrous alloys, and of tools and plant made from them, was held in the Department of Glass Technology of the University of Sheffield. The following firms exhibited: Brown Bayley's Steel Works, Ltd., Sheffield; Cronite Foundry Co., Ltd., Tottenham, London; T. Firth and Sons, Ltd., Sheffield; Foster Instrument Co., Ltd., Letchworth; H. Wiggin and Co., Ltd., Birmingham; T. G. Wolstenholme and Sons, Sheffield.

SOCIÉTÉ DE CHIMIE INDUSTRIELLE

The fourth Congress of this Society will be held in Bordeaux from June 15 to 21, and local committees are already at work. The Congress will be divided into six groups, viz.: (1) Works and laboratory, (2) Fuels, (3) Metallurgical and mineral industries, (4) Organic industries, (5) Agriculture and agricultural industries, and (6) Economic organisation. The main programme of the Congress will be as follows: *Sunday, June* 15, arrival at Bordeaux, and visit to the Fair. In the evening there will be a reception by the Organising Committee in the Grand Theatre. *Monday, June* 16, the Congress will be formally opened, and will be followed by conferences and meetings of the presidents and secretaries of the groups. In the evening there will be meetings of the sections of the conference and a reception at the Bordeaux Town Hall. On the morning of *Tuesday, June* 17, there will be visits to dockyards and factories, followed by sectional meetings. Further visits will be paid on the morning of *Wednesday, June* 18, and in the evening there will be sectional committee meetings followed by the formal meeting of closure, concluding with a banquet. On *Thursday, June* 19, there will be an excursion in the Graves and Sauterne districts, including the tasting of the principal "crus," and concluding with a banquet. Numerous excursions of great interest will also be arranged for June 20.

As in former years, numerous foreign societies have been invited, and we are asked to state that the Société de Chimie Industrielle hopes to receive at Bordeaux a large delegation from Great Britain, and in particular from the Society of Chemical Industry.

CORRESPONDENCE

LEGISLATION IN RELATION TO CHEMICAL INDUSTRY

Sir,—In your last issue you comment on the learned Referee's award in the recent complaint against the inclusion of "Rongalite" in the list of scheduled chemicals under the Safeguarding of Industries Act, and the associations of this award with the articles that appeared in your columns about a year ago upon the definition of the chemical terms used in the Act. The fact that these articles figured so prominently in these recent proceedings not only furnishes the occasion, but also, I venture to think, constitutes a complete justification, for the consideration in your columns of the several issues raised thereby, affecting, as they do, legislation in its relation to chemical industry, and the true position of the scientific man who contributes towards their solution by giving evidence in the public courts.

At the Rongalite hearing I only had the opportunity of giving evidence as a buyer of chemicals; I would claim the hospitality of your columns on a broader plea, for not only am I an original member of our Society, but I am one of the few now left who saw its constitution hammered out at the earlier meetings, when it barely escaped entering upon its career under the narrower title of the Society of Chemical Engineers.

The matter presents itself in three aspects:—

I. The relation of the chemist to the Act in its drafting, passage through Parliament, and subsequent application in practice.

II. The position of the chemist as witness during the hearing of the cases under the Act, particularly as regards the policy of acting as an advocate for a particular issue.

III. The consideration as to how the chemist comes out of the ordeal, and how his status in the eyes of the public as a professional man is influenced thereby, and what lessons may be learned therefrom.

I. Definitions under the Act—The essential point of interest in the Act to the chemist engaged in industry is the schedule accompanying the first part of the Act and the resultant list prepared by the Board of Trade of 3000 or so chemicals listed as fine chemicals, synthetic organic chemicals, analytical chemicals or fermentation products. Seldom has a clause in an Act of Parliament been subjected to such destructive criticism, and this reached its climax in the onslaught of Sir William Pope on the Carbide decision in his letter to the *Times* of December 8, 1922 reproduced in your January issue of 1923, and elaborated in the three articles already referred to, published by you about the same time.

In your current leading article you comment on the desirability of a Court of Chemists that should frame definitions of the terms used in the Act. This advice is wise, but somewhat belated, and the Court you suggest is not only without representation of that body of chemists which was the only one that at the inception of the Act recognised the necessity of defining its terms before they were put into operation, but which also from the industrial character of its membership is the best fitted to advise upon their formulation. The British Association of Chemists took action before the first hearing of a case in the Referee's court, and by ventilation of the matter in the *Times* and other newspapers, and by negotiations with kindred societies, strove to get chemists to put forward authoritative definitions which would guide the Referee in his decisions, and so would consequently have reduced to a minimum the acrimonious and confusing proceedings in the Referee's court that, in the opinion of Sir William Pope, constituted a "ridiculous farce," a judgment too severe, though not entirely unmerited. Had that been true, the blame would not have lain with the Referee, whose conduct of the cases has been irreproachable, but with the chemists themselves, who had burked the issue, for, apart from the B.A.C., the Manchester section of our Society was, so far as I remember, the only body of chemists who made any effort to solve it, and even they gave up the attempt.

The terms used in the Act, "fine chemical," "synthetic organic chemical," etc., have no fixed and invariable significance to the chemist or technician, and the one that has been most discussed, and to which I shall confine myself, viz., that of "synthetic organic chemical," conveys to the professor in his university a very different meaning to that which it does to the technical chemist in his works. The first point that emerges therefore in considering the proper definition of the terms is to decide to whom the Act is addressed, and who as a consequence will be the proper authority to give its terms their interpretation. The preamble of the B.A.C. letter to the *Times* above referred to states accurately, it appears to me, both the conditions under which the terms should be interpreted and the type of person to whom they are addressed. It states: "The governing terms employed in this Act are not interpretable in purely scientific terms. The contents and avowed object of the Act must, and accepted commercial usage should, be taken into consideration. What is immediately necessary is to secure the expression of a considered opinion by chemists with commercial experience reconciling the views of those producing and those consuming 'chemicals' as an authoritative guide to the administration of the Act." What, then, should have been the attitude of the professional man to the Act in its early stage of incubation? The profession should have been so organised that it would have had spokesmen in the House of Commons who could have pointed out the futility of using terms upon which those competent to judge would inevitably have been in disagreement if the forms used were maintained, and an effort should have been made to have such clear-cut definitions adjusted as would have gained common acceptance, and so served as a guide to the Referee and simplified the task of this much maligned but extraordinarily patient public servant.

II. The chemist in the witness-box.—I sat through the hearing of the Oxalic case, the Formaldehyde case, and the Rongalite case, but my remarks under the present section will be confined to the last named. If Sir William Pope's statement in reference to the earlier cases (and in particular the Calcium Carbide

case), that the proceedings were "an orgy of misinterpretation and misrepresentation" is approximately accurate as describing the general method of trial and the part played by the chemist who contributed to that method being carried out, then I would say that that "orgy," if such be the proper expression, repeated itself in the last trial at which Sir William was himself present, and it is to the evidence that was given in that trial that I propose to apply myself. It is unfortunate that this cannot be done shortly, but its importance must be the justification of its length.

The issue of the trial pivoted on the articles by Sir William Pope already referred to, and his extension (I should prefer the term abandonment) of the definition given by him in those articles of the term "synthetic organic chemical." Sir William's third article in this *Journal* concentrated on the definition of an organic synthesis as residing in the linking up with one another of carbon atoms which previously were not combined or were not combined together. This definition was necessary to class calcium carbide as a synthetic organic chemical. Sir William's revised definition, as used in the Rongalite case, and accepted without question by the Referee, was that the "word synthesis means the artificial formation of a particular group or unit of constitution which was not previously present." Some such definition as this is necessary if Rongalite is to be classed as a synthetic organic chemical, seeing that it contains only one carbon atom, and therefore the linkage definition fails when applied to it. How such a definition becomes at once a trap was evident from the fact that Sir William under it excluded mono-chlor-benzene from the synthetic class on the ground that "the replacement of the Hydrogen atom by the Chlorine atom was such a simple operation," and it did not help the Referee out of his difficulties to have Prof. Collie immediately afterwards differing from Sir William as to the synthetic character of this mono-chlor body.

The matter to which I wish to address myself is whether the original definition given by Sir William in his article in your paper, or the new *ad hoc* definition given by him in this particular case, is the true definition, and the one that would gain assent from the general body of chemists to whom this Act is addressed.

The point I hope to establish is that Sir Wm. Pope, in the admirably conceived and fully documented article, pages 169-170 of the 1923 issue of this *Journal*, gives a definition based on an exhaustive review of the minds of leading organic chemists, whose opinions are entitled to acceptance; that their definitions are clearly stated, incapable of misinterpretation, and cumulatively decisive, and that they are not accompanied in the works in which these authors give them by any subtractions or enlargements that render them other than what they profess to be. As against this, Sir William stated that the word "synthetic" has changed in meaning with the development of chemical science, and he goes on to say (I quote him verbatim): "I can illustrate that by taking one of our most modern works on organic substances, Posner, from which an extract has already been read, and then simply reading on find lines in continuation of the quotation; Posner goes on to say: 'in the present book, however, the idea of synthesis shall be used in the widest possible sense, namely, for the whole collection of artificial methods for preparing chemical compounds in opposition or contrast to the simple isolation of them from the natural products.'" Sir William then continued, repeating his new definition: "This is our modern idea of chemical synthesis; it means the creation of a new unit of constitution which was not previously present." The intelligent reader will hardly admit that Posner does really mean this, but I shall return to that point later.

It will, I think, be admitted that if Sir William Pope, in quoting this presumed extension of Posner's definition, had intended to convey that the author really meant in any sense to jettison his clearly worded definition in favour of one of much wider scope, and if Sir William thereby sought to establish a justification of his own abandonment of the arguments used by him on the Carbide case, such presentation of the fact would justify the Referee in concluding that this was only one example which would equally apply to all the other definitions quoted in that article, and that each of the other authors had similarly widened his views in the pages of the works that were cited. Had this not been the case, it would have been proper for Sir William to have guarded the Referee from attaching such a general significance to the particular example quoted by him.

I think I shall be able to establish that not only did none of the other authorities quoted modify their definitions in any particulars whatever, but also that Posner in the words quoted has no intention of departing from the definition that he specifically and categorically puts forward. If I succeed in establishing this, I think I may claim that Sir William's "Rongalite" definition of organic synthesis is peculiar to himself and does not carry the seal of the recognised authorities whom he quotes in his article.

This is best done by taking these authorities in the order of their date, viz.:—Lieben (1868), Elbs (1889), Posner (1903), and Richter (1909). The other authorities quoted, Dalton, Berthelot, Meldola, are less relevant, and I accept Sir William Pope's view as indicated in his article, that they merely form links in the true line of descent of the idea of synthesis outlined by him in the article.

All these authorities agree that the formation of a carbon compound from its elements is true synthesis. This is outside debate, and it is taken as admitted in all the references that follow. The disputable ground is as to what reactions following on, or outside the range of, this first step, constitute a true synthesis.

Lieben, as quoted by Sir William Pope, is very specific. In Sir William's words, Lieben explained, in the "Annalen" of 1868, "very lucidly his reasons for restricting the term synthesis to those operations in which carbon atoms become actually joined together." So far from admitting that an organic body containing a single carbon atom can be syn-

thetic (save, of course, when the product of an elementary synthesis), Lieben refuses this designation to organic compounds formed by the combination of carbon containing groups when such carbon groups are joined together in the resultant compound by a non-carbon element (as, for example, oxygen), and he restricts the term to compounds formed by the direct linking of carbon atoms to one another. His statement of this position is elaborate and complete, and he fortifies it by specific examples. A special value attaches to the definition of synthesis given by Lieben in this paper, as it arises out of and is integral to the research work which it is the main purpose of the paper to set forth.

Elbs, following substantially on the lines of Lieben, is in a very special way decisive and conclusive. His whole statement of his view is particularly illuminating. His text might be taken as the best guide to an official definition of what an organic synthesis really is. He first takes the precaution of giving his definition in italics, and he then gives particular examples of bodies that ordinarily might be considered synthetic, but which are excluded by his definition; these examples being instances in which the number of carbon atoms in the resultant molecule in the one case remains unaltered, and in the other is increased, but in both cases the carbon linkages are in no way affected. The two cases quoted are the syntheses of urea from ammonium cyanate and ether from ethyl alcohol, and he points out that in the former case the carbon atom nucleus remains unaltered, and in the latter case that the two ethyl groups are separated by the oxygen linkage, and consequently the carbon nuclei remain unchanged.

No definition can be found that will be water-tight, and here Elbs boldly takes his courage in his hands and says in substance: This is my definition; any compounds that might by some be considered to be synthetic organic bodies are not such, for they do not come within my definition. Our present-day chemist will also have to take up this attitude if he is to elaborate a definition that will be valid and workable as a guide to the legal profession, who are likely to usurp his function if he does not bestir himself.

Richter does not put his definition so clearly as his predecessors. In fact the Referee rather boggled at it, but on careful reading there is no element of doubt as to his meaning. He says: "By the synthesis of *a carbon compound* is understood *its* building up from . . . such *carbon compounds* as could be produced from the elements." (The italics are mine.) This sentence clearly indicates the building up of a singular carbon body from a plurality of carbon compounds, that is an increase in the carbon atom contents of the body produced; and he further states on page 75 (1919 edition), quoting Lieben as an authority: "These reactions in which carbon atoms not before combined with one another become united claim particular importance in the synthesis of organic compounds," and he goes on to say: "such reactions are *the synthetic methods of organic chemistry* in the more restricted sense; in the future we shall designate them *nucleus-syntheses*." (The italics are his.) He describes no syntheses except such nucleus-syntheses and the syntheses from the elements themselves, so that these two classes constitute the totality of his synthetic methods. There is nothing to indicate (as presumed by some apparently to be the case) that the words, "more restricted sense," have any other meaning than to make this discrimination between the two classes named. I am sensible of, and admit the fact, that this second definition of Richter's does not run quite on all fours with the earlier one, for there may be a direct linkage of carbon atoms and consequently a true synthesis without addition to the number of carbon atoms in the molecule, but I have already said that Richter's definitions have not the clarity of those given by his predecessors.

None of the authors above mentioned have in the context modified by extension or subtraction the rigidity of the definitions they have put forward. In the case of Posner alone is this presumed to be the case, and I shall now deal with Sir William's caveat respecting Posner's definition. The first thing to notice is that Posner follows Elbs almost word for word. Having some experience as to how authors write books, I have no doubt that Posner had Elbs' book before him and copied his definition with such minor alterations as authors make under such circumstances. Quite a proper thing to do, but it is prima facie evidence that what Elbs meant, Posner also means. As regards Posner, Sir William, in quoting to the Referee the continuation of Posner's paragraph (and using this as a justification of his own extension of the definitions given by him in discussing the carbide decision), states that he only quoted so much of the authorities as was requisite for the establishment of the particular case with which he was then concerned. The following verbatim quotations of passages between the Referee (R.) and Sir William (P.) on this point are very illuminating:

"(R.) You say the word synthetic, according to all classical writers, is entirely applicable to the manufacture of calcium carbide. This is the use of the term you have elaborated in the article, is it not?"

"(P.) No, this is only a small part of it."

"(R.) It would have been a very strong authority to have produced if Sir William had not been here. In fact it would probably have been conclusively in your (*addressing the complainants*) favour; but then he is here, and he says: 'I was not meaning it in that way, and was only going so far as was necessary.' He tells us quite frankly that it does not represent his whole view but we might assume that it did if he was not here.

"(P.) I think I have shown that pretty clearly because I have given here a part of a passage from Posner, and then there is a continuation of it. I left the rest out because it was not necessary for my purpose."

Now, had I not been in court and heard Sir William's explanation of his reasons for this omission I should have thought he left it out because it was entirely irrelevant to the immediate issue and in no way modified the general statement of the definition

specifically given. I think this will be admitted by any candid reader of the passage referred to. In substance it amounts to this—I paraphrase, and I submit fairly paraphrase, Posner's paragraphs to bring out their significance. Having given his definition, Posner wishes to make it clear to his readers that, as it is his purpose in this particular work to treat in a collective way of all the group reactions of organic chemistry, he may wish to include cases that are wider than his definition. He therefore says: "In the following pages I shall, *notwithstanding* my definition (im vorliegenden Buch *jedoch*), adopt a much wider scope, and I shall consider as synthetic reactions all the reactions of organic chemistry." That this is the true meaning of the passage quoted by Sir William is confirmed by a later passage in Posner's book, where he seems to go out of his way to warn his readers against any preconceived misinterpretation of the passage in question. On page 158, after treating of the Perkin synthesis and allied reactions, he adds (I quote the original so that there may be no possibility of mistranslation): "Die genannten Reaktionen stellen wichtige wahre Synthesen (Kohlenstoffverkettungen) dar." Thus Posner comes round full circle and reiterates and clinches the definition with which his volume opens. This sentence is the true conclusion to the continuation of the passage quoted to the Referee, and it would have been helpful to him if it had also been placed before him. I would with all respect submit to Sir William that in the true line of descent from Posner he accept the Tennysonian dictum and recognise that "it is not true that second thoughts are best, but first and third which are a riper first." It is too late to ask the Referee to follow suit in the present case, but it would be fit matter for his consideration if the definition of synthesis comes up again for discussion in his court.

I shall not concern myself with Prof. Collie's definition of synthesis, as it has little bearing on the present issue, being concerned with laboratory preparations only, and including within its substance the very term which it is seeking to define.

III. Lessons.- Arising out of the foregoing, I would ask the chemist to consider, on the one hand, how ambiguous is his position in his relations to the formulation of the laws of the country on matters of vital interest to him in his professional capacity, and, on the other, how invidious is his position when he comes to participate in the interpretation of these laws as a witness in the courts, and I would ask him how far he is in a position to answer the following relevant questions:—

1st. How is it that the profession of chemistry is so unorganised that, in a case such as that of the passing of the Safeguarding Act, there was no body of chemists to whom the Government could turn for a considered and authoritative opinion as a guide in the drafting of the Act, with the reasonable assurance that such opinion would carry with it the assent of most of the chemists of the country?

2nd. How far is it consistent with the status of the profession that the help that should be given to the Government in the chemical aspects of its work (and, in particular, as crystallised in legislation) can only be got in the heated atmosphere of the law courts, and in the form of *ex parte* statements liable to the charge of prejudice?

3rd. Where is the court of honour at which chemists can get advice from the accredited leaders of the profession as to their proper conduct under such circumstances, and which will legislate as well as advise with respect to the ethics of the witness-box?

4th. When is the chemist going to realise the humiliating character of this condition of things, and when is he going to put his house in order?

One explanation (and it is the one given to me six years ago by one of our leading professors when I was trying to interest him in the new movement to found a British Association of Chemists) is that chemists are too individualistic as a class to act in concert for their own or the common good. In the interval, however, there has been seething and movement in the inert chemical mass. The B.A.C. has continued its struggling existence and is beginning to make good; the Institute has transformed itself and become revivified and powerful; the Federal Council has added a new and valuable weapon in your *Journal*; Prof. Baly, at Liverpool, has set forces into motion which should bring professional men into more intimate relation with one another; and the time is ripe for achieving that unity without which the chemist will remain a cipher in his influence on the vital movements of the times. Solidarity in the chemical profession is as essential to success as it is to the commercialist and the artisan. It has become a truism since the experiences of the war that with the chemist lies the future not only of national safety but also of industrial progress. There is exaggeration in this, but if the chemist is to play the part that has been assigned to him, his force must become collective and unitary, and the inner purpose of this letter (arrived at by a somewhat roundabout line of argument) is to urge upon the chemist that if he values his profession it, like the ship, must find itself if its voyage is to be safe and prosperous.—I am, Sir, etc.,

Wm. E. Kay

349, The Cliff,
Manchester
April 10, 1924

CONFERENCE OF THE SOCIETY OF DYERS AND COLOURISTS AT WEMBLEY

Sir,—This Society has made arrangements for a Conference at the British Empire Exhibition, Wembley, as follows:—Wednesday, June 11, at 3 p.m., Mr. J. R. Hannay, F.I.C., will give an address on "An Historical Survey of Dyeing and Calico Printing"; and on Thursday, June 12, at 11 a.m., Prof. A. G. Green, F.R.S., will give an address on "Modern Methods of Dyeing."

I am requested to give a hearty invitation to all members of the Society of Chemical Industry to attend both these Lectures.

On application to the Offices of the Society given below, special tickets admitting your members to the Exhibition Grounds and to the Lectures will

be supplied at a charge of 1s. 6d. each person for each Lecture. The Conference Authorities at Wembley will not permit persons to enter the Conference Hall without these special tickets. I would point out that the charge for these is not more than the usual charge for admission into the Exhibition Grounds only. Non-members of the Society can also attend our Annual Dinner and River Outing, if application is made to these Offices—I am, Sir, etc., J. B. Atkinson
Secretary

30, Pearl Assurance Buildings, Market Street, Bradford

[Attention is drawn to the announcement of the Conference in question in "Fortheoming Events," p. 460.]

BUILDING FOR PEACE

Sir,—The comments which you make on my letter in your editorial of March 28 induce me to write you a few lines in order to make my point of view in the question under discussion quite clear.

You wonder whether I saw Chauny soon after the end of the war. I did not. However, it may have appeared it could not have distressed a true friend of humanity more than the sight of East Prussia in August, 1914. In that province, as apparently you may not know, flourishing villages and towns were destroyed, and all the horrors of war let loose at the command of the Russian Government which was, almost at the same time, assuring the German Government that it did not intend to make war against Germany! The rest of our enemies entered into an alliance with this same Russian Government, which did not even observe the customs of the majority of savage tribes in warfare. Hence these Allies approved of these acts. It is, therefore, not too much to say that Germany has been attacked by robbers. Nothing is known which can in the slightest degree shake this belief. On the other hand, documents have come to the knowledge of the whole world which confirm the fact that the Allies approved of Russia's action, and which prove Belgium's guilt in the preparation for the attack. The Allied Governments have good reasons for concealing their documents concerning the cause of the war.

German scientific circles are by no means satisfied with the present relations with their colleagues on the Allied side, and would welcome a return to normal intercourse. This, however, must not take place on a basis of untruth and hypocrisy, but by spreading the truth. Hence we are at pains to have truth recognised, and are not giving up hope that it will prevail. From this point of view your remarks inspire some hope. For in the same manner in which the Boer War was recognised, after some time, in England to be a "mistake" on the part of the British Government, one can perhaps hope for a recognition of "mistaken" policy on the part of the same Government in the World War.

Incidentally, you would perform a meritorious action if you would request your correspondent, Mr. Hickman, to give you the name of the alleged German who declared in his office that the English were a dying nation, and that the Germans intended to take their place. This alleged German might be induced to sell his brain to an anatomical museum, as it would be of intense interest to many anatomists, for it proves an altogether extraordinary culture such as can no longer be found in Germany.—I am, Sir, etc., Dr. P. Fritzsche

Leipzig
April 14, 1924

"FATS: NATURAL AND SYNTHETIC"

Sir,—It is difficult to understand whether your correspondent "Labor omnia vincit" designs in his letter in this week's number of *Chemistry and Industry* merely to enliven with a little humour the somewhat staid annals of applied chemistry, or whether he intends to offer a serious criticism of the volume "Fats: Natural and Synthetic" published in our joint authorship in January last.

Lest some of your readers should take the latter view we desire to make a few comments on the insinuation, which is the substance of the letter, that a passage in the book extending over less than forty lines is a précis of the interesting and important article on "Hydrogenation Flavour," by Mr. K. H. Vakil, appearing in your columns on August 17, 1923. In these forty lines of "précis" we find the following points which do not appear in the August article:—

1. If an oil is treated under the conditions of hydrogenation but with an inactive nickel catalyst no characteristic odour is developed.

2. The odour is as pronounced in samples of oil which have been reduced by one or two units of iodine value as in samples which have been completely hydrogenated.

3. The "New acids of Hydrogenation" ("Iso-acids") are not produced under the conditions of 1.

In the "précis" we state that in laboratory hardened oils the hydrogenation odour is distinct although the hydrogen is not circulated and on this point we are in disagreement with Mr. Vakil. On the other hand, Mr. Vakil's article contains the following useful and interesting points which find no mention in our "précis":

1. The hydrogenation odour can be successfully removed from the hydrogen by treating the gas with a 10 per cent. solution of ferrous sulphate in a centrifugal scrubber.

2. The oil may be permanently deodorised by treatment with a current of a gas such as nitrogen or carbon dioxide.

3. The hydrogenation odour may be due to certain decompositions in the oil.

Mr. Vakil's article appeared only six weeks before we went to press, so that it was not possible for us to incorporate the above statements in our text, but if we had done so we should certainly have given a reference to the source of our information as we have consistently endeavoured to do throughout the work.

There are, nevertheless, some resemblances between the two writings, but these are merely references

to publications of other investigators which are naturally bound to appear in any adequate discussion of hydrogenation odour.

For example, the statement appears in both writings that the hydrogenation odour is incompatible with many perfumes or flavourings, but the same statement may be found in an article by one of the writers (W. W. M.) in the *Chemical Age* of April 28 of last year.

We feel bound to say that we strongly resent the publication in a responsible journal of a vindictive and misleading letter from a correspondent who has neither the courage nor the courtesy to append his name for publication.—We are, Sir, yours, &c.,

WM. W. MYDDLETON
T. HEDLEY BARRY

Chemical Department,
Birkbeck College
London, E.C. 4

PERSONAL AND OTHER ITEMS

The trustees of the Ramsay Memorial Fellowships for Chemical Research will consider, at the end of June, applications for not more than two fellowships, of which one is limited to candidates educated in Glasgow.

Monsieur S. Winogradsky of the Agricultural Laboratory of the Pasteur Institute has been elected a foreign associate of the Académie des Sciences in place of the late Monsieur Vanderwaals.

After 37 years' service, Dr. W. Beumer has resigned his post as economic editor of *Stahl und Eisen*.

According to the *Mining Magazine* a nodule of native arsenic has been discovered during the sinking of a shaft at Tolgus. This discovery is of considerable interest as the occurrence of uncombined arsenic has hitherto not been definitely recorded for the British Isles and a British specimen does not appear to be included in any public collection.

At the annual meeting of the American Institute of Chemists the following officers were elected: President, M. L. Crossley; vice-president, L. van Dorn; treasurer, C. K. Simon; secretary, L. R. Seidell.

Kommerzienrat C. Hilgenberg, who died on April 10, had been largely concerned in the development of the German potash industry.

Ing. W. Brückner, a well-known expert on heating problems, has died in Vienna, aged 79. Karl Schmeisser, who had been the first director of the Geological Institute and director of the Mining Academy in Berlin, died in Breslau, aged 68.

Holger Schmidt, a well-known figure in the Swedish soda industry, has died, aged 58 years.

Dr. Grunwaldt, a consulting chemist, who died recently, was the author of a work on the chemical technology of raw materials for enamels.

The death of K. T. Somlo deprives Austria of a technologist who had made many improvements in malting and distilling, particularly the development of the amylo process.

REVIEW

MECHANICAL STOKING. By DAVID BROWNLIE, B.Sc. Pp. x+234. London: Sir Isaac Pitman and Sons. 1923. Price 5s. net.

One of the outstanding features of the whole problem of the economic utilisation of fuel is that, whilst all are agreed that effective action must be taken and taken quickly, there rarely seems in practice to be any advance beyond the stage of suggestion and recommendation. Whereas every fuel consumer is prepared to listen to advice, only in rare instances is it possible to bring him to the point of carrying the suggestions put before him into practice, but the by no means inconsiderable bulk of recent literature bearing on the subject must surely tell in the end, and even now there are signs that the voices of the propagandists are not altogether crying in vain. The subject of steam-raising and boiler-house management is but one phase of the whole problem, but he who employs steam is, perhaps, the most wilful of delinquents, and it will be no mean step in the right direction if he can be persuaded that such things as the difference between theoretical and actual evaporative power of the fuel he uses have not only a direct bearing on his own balance sheet but on the country's welfare. When it comes to a question of boilers we almost automatically think of Mr. Brownlie, and we cannot deny him the compliment of saying that within recent years he has contributed more of value on this particular subject than any other writer or worker. It is, perhaps, this fact which will scarcely excuse him in the eyes of some for attempting to condense his knowledge within the scope of a booklet; but although at the moment we are concerned with what is no more than a primer we may derive encouragement from the announcement that Mr. Brownlie is in due course to publish something approaching a super-volume dealing with every aspect of the involved practice of boiler operation. As it is, we are given a gossipy little book which deals in simple language and in a rather severely practical style with the essentials of mechanical stoking, the object in view being that of writing down to the boiler attendant as well as providing information of a character such as will interest and educate the works manager. Taken as a whole, the book is a remarkably concise yet complete description of all the more important types of mechanically-operated stokers which may be found in this country, and the author has not been afraid to throw in amongst the descriptions his own opinions as to the respects in which specific plants excel or fail. The busy modern reader has not, perhaps, much time to spend in the fascinating pursuit of historical details, but here we have a remarkably absorbing and almost unique survey of the work of some of the earliest of pioneers. This will well repay reading, if only for the fact that some of the really amazing work carried out prior to 1850 should serve to remind us that we are not quite such a superior generation as we are sometimes apt to suppose.

ALWYNE MEADE

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech.	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	6¼d.—6¾d. per lb. Market firmer. There is a possibility of legislation to control the amount of natural gas used in production of American black. This may mean higher prices, and manufacturers are not anxious to accept orders.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	43s. 6d. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	5s. 1d. per lb. Much dearer, following rise in quicksilver.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s.—5s. 3d. per gall. 60% O.P. market stiffer.
Solvent	5s. 6d.—6s. per gall. 40% O.P. Fairly good demand but little offering.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£49 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	7¼d. per lb. Only limited inquiry
Crude 60's	2s.—2s. 3d. per gall. Market steady.
Acid Cresylic, 97/99	1s. 11d.—2s. 1d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—2s. per gall. Steady demand.
Dark	1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	10d.—11d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall ex works in tank wagons.

Toluole—90%	1s. 4½d.—1s. 7d. per gall.
Pure	1s. 8d.—1s. 11d. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	10d. per gall. Few inquiries.
Middle Oil / Heavy / Standard Specification	7½d.—9d. per gall. according to grade and district. Market a sh. de firmer.
Naphtha—	
Crude	8d.—9d. per gall. Better demand. Prices firm.
Solvent 90/160	1s. 5d.—1s. 7d.
Solvent 90/190	1s. 2d.—1s. 3d.
Naphthalene Crude—	
Drained Creosote Salts	£6—£7 10s. Demand not so good.
Whizzed or hot pressed	£9—£12 per ton. Not much inquiry.
Naphthalene—	
Crystals and Flaked	£17—£18 per ton.
Pitch, medium soft	52s. 6d.—57s. 6d. per ton. Market steadier.
Pyridine—90/140	22s.—24s. per gall. Demand well maintained. Price again advanced.
Heavy	11s.—12s. Occasional inquiries: little business.

INTERMEDIATES AND DYES

Business in dyestuffs has been restricted since the holidays. An improvement is expected in the new month.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 6d. per lb.
Acid H.	4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 9d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 4d. per lb. Steady demand.
Acid Sulphanilic	10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4¾d.—5¼d. per lb. Demand moderate.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	5s. per lb. d/d., packages extra, returnable.
Dimethyaniline	2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluene—48/50°C.	8d.—9d. per lb. naked at works.
66/68°C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. 2d. per lb. d/d.
Monochlorbenzol	£63 per ton.
α-Naphthol	2s. 5d. per lb. d/d.
β-Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	4s. 2d. per lb. d/d.
p-Phenylene Diamine	10s. 4d. per lb. 100% basis d/d.
R. Salt	2s. 9d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 6d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 10d.—4s. 3d. per lb. d/d.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£49 per ton.
Acid, Acetyl Salicylic	3s. 4d.—3s. 6d. per lb. Quiet.
Acid, Benzoic B.P.	4s. per lb. Larger supplies available.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal. Market very steady.
Acid, Pyrogallic, Cryst.	6s. per lb., for 28 lb. lots.
Acid, Salicylic	Prices quoted from 2s. 3d. per lb. down to 1s. 9d. for ton lots. Market rather weak, but tends to improve.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 3d. per lb. for quantity. Very weak.
Amidopyrin	13s. 6d. per lb. Neglected.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. 6d. per lb. Weak market.
Benzonaphthol	6s. 3d. per lb. Firmer.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Market very firm, although not active. Continental prices advancing.
Potassium	9d.—10½d. per lb.
Sodium	9d.—10½d. „
Ammonium	10½d.—1s. „
Calcium Lactate	Prices vary over a wide range. Good English make can be had from 1s. 7d. to 2s. 3d. per lb.
Chloral Hydrate	3s. 9d. per lb.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Guaiacol Carbonate	12s. per lb. for cwt. lots.
Hexamine	3s. 9d. per lb. for foreign makes. Without much inquiry. Large stocks.
Homatropine Hydrobromide	30s. per oz.
Hydroquinone	4s. 9d. per lb. Foreign make. Much firmer.

Iron. Ammon. Citrate B.P. 1s. 11d.—2s. 3d. per lb., according to quantity.

Magnesium Carbonate—
Light Commercial .. £36 per ton net.

Magnesium Oxide—
Light Commercial .. £75 per ton, less 2½%.
Heavy Commercial .. £26 per ton, less 2½%.
Heavy Pure .. .. 2s.—2s. 3d. per lb., according to quantity. Steady market.

Menthol—
A.B.R. recryst. B.P. .. 70s. Strong upward movement due to disappointing Japanese crop.
Synthetic .. .. 26s.—35s. per lb., according to quantity. English make. Steady demand.

Mercurials .. .. Market rather flat, but prices unchanged.
Red oxide .. .. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate .. 3s. 6d.—3s. 7d. „
White precip. .. .. 4s. 7d.—4s. 8d. „
Calomel .. .. 3s. 11d.—4s. „

Methyl Salicylate .. 2s. 4d.—2s. 9d. per lb. for carboys. A slightly better market.

Methyl Sulphonal .. 24s. per lb. neglected.

Paraformaldehyde .. 3s. 6d. per lb., without much inquiry.

Paraldehyde .. .. 1s. 4d.—1s. 6d. per lb. in free bottles and cases.

Phenacetin .. 6s. 3d.—6s. 9d. per lb. Shows slight improvement.

Phenazone .. .. 8s. per lb. for cwt. lots. Firmer tendency.

Phenolphthalein .. 7s.—7s. 6d. per lb. In more plentiful supply.

Potass. Bitartrate—
99/100% (Cream of Tartar) .. .. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.

Potass. Citrate .. .. 1s. 8d.—2s. per lb.

Potass. Iodide .. .. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.

Potass. Metabisulphite .. 7½d. per lb., 1-cwt. kegs included.

Potass. Permanganate—
B.P. Crystal .. .. 8¾d.—9d. per lb. carriage paid. English make.
Commercial .. .. 8d.—8¼d. per lb. carriage paid. English make.

Quinine Sulphate .. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.

Resorcin .. .. .. 5s. 6d. per lb.

Salol .. .. .. 4s. per lb. Very quiet.

Silver proteinate .. 9s. 6d. per lb.

Sod. Benzoate, B.P. .. 3s. per lb. In more plentiful supply.

Sod. Citrate, B.P.C., 1923 1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.

Sod. Hyposulphite—
Photographic .. .. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.

Sod. Metabisulphite cryst. 37s. 6d.—60s. per cwt. nett cash, according to quantity.

Sod. Nitroprusside .. 16s. per lb. Less for quantity.

Sod. Potass. Tartrate (Rochelle Salt) .. 77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.

Sod. Salicylate .. .. Market improved with good deal of inquiry. Powder 2s. 4d.—2s. 9d. per lb. Crystal at 2s. 6d.—2s. 10d. per lb. Flake 2s. 10d.—3s. 4d. per lb.

Sod. Sulphide—
Pure recryst. .. .. 10d.—1s. 2d. per lb., according to quantity.

Sod. Sulphite, anhydrous £27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.

Sulphonal .. .. .. 18s. 6d. per lb.

Tartar Emetic .. .. 1s. 4d. per lb.

Thymol .. .. .. 13s. 6d.—15s. 9d. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone .. .. 12s. 6d. per lb.
Aubepine .. .. .. 13s. 6d. „
Amyl Acetate .. .. 2s. 9d. „
Amyl Butyrate .. .. 7s. 3d. „
Amyl Salicylate .. .. 3s. 3d. „
Anethol (M.P. 21/22° C.) 4s. 6d. „ Dearer.
Benzyl Acetate from Chlorine-free Benzyl Alcohol 3s. 3d. „
Benzyl Alcohol free from Chlorine .. .. 3s. 3d. „
Benzaldehyde free from Chlorine .. .. 3s. 6d. „
Benzyl Benzoate .. 3s. 6d. „
Cinnamic Aldehyde Natural .. .. .. 15s. 6d. „
Coumarin .. .. 20s. „
Citronellol .. .. 16s. „
Citral .. .. .. 10s. „
Ethyl Cinnamate .. 15s. „
Ethyl Phthalate .. .. 3s. 9d. „
Eugenol .. .. .. 11s. „
Geraniol (Palmarosa) .. 35s. „
Geraniol .. .. .. 11s.—18s. 6d. per lb.
Heliotropine .. .. 8s. 3d. per lb.
Iso Eugenol .. .. 15s. 9d. „
Linalol ex Bois de Rose .. 32s. 6d. „
Linalyl Acetate .. .. 32s. 6d. „
Methyl Anthranilate .. 9s. 6d. „
Methyl Benzoate .. 6s. „
Musk Ambrette .. .. 52s. 6d. „
Musk Xylol .. .. 19s. „
Nerolin .. .. .. 4s. „
Phenyl Ethyl Acetate .. 12s. 6d. „
Phenyl Ethyl Alcohol .. 16s. „
Rhodinol .. .. .. 57s. 6d. „
Safrol .. .. .. 1s. 10d. „
Terpineol .. .. .. 2s. 9d. „
Vanillin .. .. .. 25s. 3d.—26s. 6d. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. .. .. .. 15s. 6d. per lb.
Anise Oil .. .. .. 3s. per lb. Firmer market forward
Bergamot Oil .. .. 18s. 6d. per lb.
Bourbon Geranium Oil .. 35s. „
Camphor Oil .. .. 75s. per cwt.
Cananga Oil, Java .. 10s. 6d. per lb. Advanced.
Cinnamon Oil, Leaf .. 6¼d. per oz.
Cassia Oil, 80/85% .. 9s. 3d. per lb.
Citronella Oil—
Java 85/90% .. .. 5s. per lb. Easier.
Ceylon .. .. .. 3s. 9d. „
Clove Oil .. .. .. 8s. 3d. „ Easier.
Eucalyptus Oil 70/75% .. 2s. 2d. „ Easier.
Lavender Oil—
French 38/40% Esters 26s. per lb.

Lemon Oil ..	.. 3s 4d. per lb.
Lemongrass Oil ..	.. 3d. per oz. Dearer.
Orange Oil, Sweet	.. 13s. 9d. per lb. Dearer.
Otto of Rose Oil—	
Bulgarian ..	.. 27s. 6d. per oz.
Anatolian ..	.. 23s. 6d. per oz.
Palma Rosa Oil ..	.. 19s. per lb. Very short supply.
Peppermint Oil—	
Wayne County	.. 21s. 9d. per lb.
Japanese ..	.. 19s. 3d. per lb.
Petitgrain Oil ..	.. 10s. per lb.
Sandal Wood Oil—	
Mysore	.. 26s. 6d. per lb. Advanced.
Australian ..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition within two months of the date given; they are on sale at 1s each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C 2, 15 days after the date given.

I. Applications

Basset. Reverberatory furnaces. 9138. Apr. 11. (Fr., 20.4.23.)

Farberei und Appretur Ges. vorm. A. Clavel und F. Lindenmeyer. Centrifugal drying-apparatus. 9415. Apr. 11. (Swiss, 14.1.23.)

Grate. Furnaces or kilns. 9553. Apr. 15.

Gunz. Drying fragmentary etc. material 9419. Apr. 11.

Jones Separation of substances having different density. 9446 Apr. 14.

Lewis Catalysts and carriers therefor. 9654. Apr. 16.

Picken Centrifugal separators. 9744. Apr. 17.

Slatineanu. Carrying out chemical reactions. 9859. Apr. 17 (Swiss, 19.4.23.)

Wiesmann. Evaporating the volatile constituents of solutions, emulsions, etc 9403. Apr. 14.

I.—Complete Specifications Accepted

1333 (1923). Travers and Clark, Ltd. Furnaces. (213,999.) Apr 24.

13,022 (1923). Dupuy. Apparatus for the distillation of solid or liquid substances (198,661.) Apr. 24.

II.—Applications

Donald. Drying peats etc 9653. Apr 16

Gatton Gas-producer plant. 9371. Apr. 14

Griffiths. Apparatus for distilling carbonaceous materials. 9610. Apr. 15.

Londeld, Trenlolm, and Swedris and Co. Production of gas. 9700. Apr. 16.

Wolf. Process of converting oils of high boiling point into those of lower boiling point. 9718. Apr. 16. (Ger., 1.5.23.)

Zollinger Process of increasing viscosity of oils. 9575. Apr 15 (Swiss, 30.4.23.)

II. Complete Specifications Accepted

23,869 (1922). Neath. Manufacture of gas from coal, or from coal and oil. (213,754.) Apr. 24.

33,473 (1922). Heyl. Treating oils. (213,946.) Apr. 24.

780 (1923). Koppers Co. Purifying gases. (207,488.) Apr. 24.

13,022 (1923). Dupuy. See I.

III.—Application

Lomax, Lucas, and V.L. Oil Processes. Production of the lower from the higher phenols. 9786. Apr. 17.

IV. Applications

Bonnard. Manufacture of azo-dyestuffs. 9703. Apr. 16.

Lomax, Lucas, and V.L. Oil Processes. 9786. See III.

Soc. of Chemical Industry in Basle. Dyestuffs. 9594. Apr. 15. (Swiss, 19.4.23).

Soc. of Chemical Industry in Basle, and Schobel. Manufacture of azo-dyestuffs. 9713. Apr. 16.

IV.—Complete Specification Accepted

26,154 (1923.) Soc. Anon. Mat. Col. et. Prod. Chim. de Saint-Denis, Wahl, and Lantz. Manufacture of dyestuffs of the azine group. (206,488.) Apr. 24

V.—Applications

Courtaulds, Ltd., Gilles, Smith, and Templeton. Treatment of cellulose artificial silk. 9696. Apr. 16.

Hay, and Wiggins, Teape & Co. Paper and manufacture thereof. 9386. Apr. 14.

Hohenloher Seifenfabriken Akt.-Ges. Process for washing etc. fabric etc. 9663. Apr. 16.

Hough and Privett. Treating paper and boards. 9571. Apr. 15.

Union Photographique Industrielle (Etablissements Lumiere et Jougla Réunis). Process of nitrating regenerated cellulose films or paper. 9699. Apr 16. (Fr., 23.4.23.)

V.—Complete Specification Accepted

2090 (1923). Scholz. Impregnating fibres, yarns, and fabrics with leather. (192,387). Apr. 24.

VI.—Applications

British Dyestuffs Corporation, Ltd., Fyfe, and Perkin. Dyeing acetyl silk. 9583. Apr. 15

Chemische Fabrik Griesheim-Elektron. Production of fast black shades on fibre. 9855. Apr. 17. (Ger., 17.4.23.)

VI.—Complete Specifications Accepted

9643 (1923). Mate and Pickstone. Bleaching textile fabrics etc. (211,079). Apr. 24.

13,137 (1923). Clark and Co., and McLintock. Mercerising-machines. (214,103.) Apr 24

13,993 (1923). Morton Sundour Fabrics, Ltd., and Kilby. Dyeing cellulose acetate fibres. (214,112.) Apr. 28.

VII. Applications

Ewan. 9621 and 9622. See X

Oesterreichische Chemische Werke Ges Manufacture of persulphuric acid etc. 9604. Apr. 15. (Aus., 22.5.23.)

VII.—Complete Specification Accepted

3173 (1923). Priest. Kilns for burning limestone or the like. (214,022.) Apr. 24.

VIII.—Application

British Thomson-Houston Co., Ltd. Quartz working. 9602. Apr. 15. (U.S., 18.4.23.)

VIII.—Complete Specification Accepted

7763 (1923). Stocker. Treatment of china clay. (214,062.) Apr. 24.

IX.—Application

Levy, and Prodor Soc. Anon. Manufacture of concrete. 9683, 9714. Apri. 16.

IX.—Complete Specification Accepted

3173 (1923). Priest. See VII.

X.—Applications

Bonnafoux, and Stern A.-G. Process to recuperate iron and manganese from slags. 9406. Apr. 14.

Calvert. Furnaces for de-tinning metal plates etc. 9626. Apr. 16.

Ewan. Manufacture of alkali metals. 9621 and 9622. Apr. 16.

Harris. Manufacture of tin-plate. 9778, 9779. Apr. 17.

Jouvenet and Mohr. Treatment of mispickel etc. 9569. Apr. 15. (Fr., 15.5.23.)

Lanz. Refined cast iron. 9676. Apr. 16. (Ger., 23.6.23.)

Lanz. Manufacture of grey cast iron. 9677. Apr. 16. (Ger., 1.12.23.)

Levoz. Furnaces for melting and treating ores etc. 9822. Apr. 17. (Belg., 17.4.23.)

X.—Complete Specification Accepted

6317 (1923). Rodrian. Smelting and electrolysing processes. (194,314.) Apr. 24.

XI.—Applications

British Thomson-Houston Co., Ltd. (General Electric Co.). Electric furnaces. 9805. Apr. 17.

Jones. Storage batteries. 9690. Apr. 16.

Simms (Potter). Electric accumulators. 9834. Apr. 17.

XI.—Complete Specifications Accepted

876 (1923) McBlain. Electrical apparatus for generating ozone. (213,975.) Apr. 24.

2915 (1923). Mather and Platt, Ltd., and Barclay. Electrolysers. (214,020.) Apr. 24.

6317 (1923). Rodrian. See X.

30,713 (1923) Monnot. Electric storage batteries. (214,177.) Apr. 24.

XII.—Applications

Commanditaire Vennootschap Dros & Geb. Tieleman Stoomzeep-Fabriek de Gekroonde Haan, and Tieleman. Production of transparent soap. 9871. Apr. 17.

Hemingway. Manufacture of soap. 9392. Apr. 14.

Zollinger. 9575. See II.

XIII.—Application

Ticka. Manufacture of liquid waterproof coating material. 9474. Apr. 14.

XIII.—Complete Specification Accepted

17,265 (1923). Snape and Mohlman. Varnish. (214,134.) Apr. 24.

XIV.—Application

Naugatuck Chemical Co. Process for treating rubber etc. 9554. Apr. 15. (U.S. 25.6.23.)

XIV. Complete Specification Accepted

15,915 (1923). Marks. Manufacture of hard rubber compositions. (214,124.) Apr. 24.

XV.—Application

Ellenberger und Schrecker. Production of gelatin and glue from chrome leather etc. 9562. Apr. 15. (Ger. 28.1.24.)

XV.—Complete Specification Accepted

2090 (1923). Scholz. See V.

XVI.—Complete Specification Accepted

28,464 (1923). Soc. Chim. de la Grande Paroisse. Manufacture of fertilisers. (210,399.) Apr. 24.

XVII.—Application

Steffen Continuous washing of tricalcium saccharate. 9587. Apr. 15.

XVIII.—Applications

Bexon and Church. Aerating etc. wort in brewing etc. 9853. Apr. 17.

Distillers Co., Ltd., and Meyer. Dehydrating alcohol. 9704. Apr. 16.

Hauser und Sobotka Akt.-Ges., and Stern. Process for production of preparations of diastases etc. 9717. Apr. 16.

XVIII.—Complete Specifications Accepted

1023–1025 (1923) Marks See XX.

XIX.—Applications

Howles and McDougall Insecticides. 9576. Apr. 15.

Whale. Softening water 9665. Apr. 16.

Williams. Preserving fruit and vegetables. 9785. Apr. 17.

XIX.—Complete Specifications Accepted

14,244 (1921). Soc. Chim. Usines du Rhône. Flavouring food with vanillin. (175,589.) Apr. 24.

586 (1923). Marston. Treatment of skimmed milk, soured milk, or buttermilk to separate calcium caseinate or casein. (213,962.) Jan. 8.

XX.—Applications

Cassella und Co., Ges., L. Manufacture of arsenic compounds of the aromatic series. 9590. Apr. 15. (Ger., 17.4.23.)

Distillers Co., Ltd., and Meyer. 9704. See XVIII.

XX.—Complete Specifications Accepted

1023–1025 (1923). Marks (U.S. Industrial Alcohol Co.). Process and apparatus for obtaining alcohols free from water. (213,984–6.) Apr. 24.

1124 (1923). Howards and Sons, Ltd., and Blagden. Making synthetic menthol. (213,991.) Apr. 24.

XXI.—Applications

Dufay. Colour photography. 9727. Apr. 16. (Fr. 11.6.23.)

Union Photographique Industrielle. 9699. See V.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific number:—*Australia*: Leather (446); Silks (447); Surgical and dental requisites, glassware, scientific instruments, perfumery and oils (448); Drugs (449); Steel (13,520 and 13,521/E.D./E.C./2); *British India*: Tin sheets (Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); *Canada*: Steel (13,477/E.D./E.C./2): *Chile*: Steel (9649/F.L./E.C./2); *Germany*: Silk (451); *Rumania*: Chemical goods, glassware (457); *Santiago de Cuba*: Leather (469); *South Africa*: Iron, steel, brass (13,539/E.D./E.C.); *United States*: Hardware (460): Pharmaceutical goods, hardware (462); *Uruguay*: Oil (9659/F.L./C.C./2).

Foreign Company News

A company is being formed in Alsace with the help of the Salines Domaniales de l'Est for the manufacture of artificial silk.

PUBLICATIONS RECEIVED

THE MODERN THEORY AND PRACTICE OF PUMPING. By N. Swindin. Pp. 364. London: E. Benn, Ltd., 1924. Price 42s.

SUMMARY REPORT ON MINES BRANCH INVESTIGATIONS DURING 1922. Department of Mines. Pp. 273 Ottawa: F. A. Acland, 1924.

PUBLICATIONS OF THE DEPARTMENT OF COMMERCE, Bureau of Standards. Washington: Government Printing Office, 1924. Price 5 cents.:—

INTERFEROMETER MEASUREMENTS OF THE LONGER WAVES IN THE IRON ARC SPECTRUM. By W. F. Meggers and C. C. Kiess. Scientific Papers of the Bureau of Standards, No. 479. Part of Vol. 19 Pp. 273–280.

MEASUREMENT OF LOW RESISTANCE BY MEANS OF THE WHEATSTONE BRIDGE. By F. Wenner and A. Smith Scientific Paper No. 481. Pp. 297–300.

REDETERMINATION OF SECONDARY STANDARDS OF WAVE LENGTH FROM THE NEW INTERNATIONAL IRON ARC. By W. F. Meggers, C. C. Kiess, and K. Burns. Scientific Paper No 478. Pp. 263–271.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

Vol. 43 NEW SERIES | LONDON, MAY 9, 1924 | No. 19

EDITORIAL

THE deputation from the Federal Council to the President of the Board of Trade appears to have been an interesting occasion. The dyestuff industry is of such vital importance to chemistry and its difficulties have been, and are yet, so acute that our columns have on many occasions been occupied by a consideration of the problem. Mr Sidney Webb spoke of the purpose of the Government and the process of attaining the object in view. It would seem that the general purpose of the Government is to enable chemistry to be studied and practised in this country fully and freely and to maintain a dyestuff industry, so far as it is the business of a Government to maintain any particular industry, in such a state as will conduce to our national prosperity and suffice for the needs of British chemistry. Chemists are already familiar with this aspect of the problem and will be pleased to know that the Board of Trade is fully alive to the importance of the subject. It is when we come to discuss the process that the difficulties arise; the Government, though a large shareholder in the British Dyestuffs Corporation, is not in control of the company, and there are obvious reasons why the President of the Board of Trade should not attempt to act as if he were in control. The task of putting that company into proper order is a considerable one, the responsibility is great, the reward in case of success will be inadequate, the blame in the case of failure will be heavy. In these circumstances we can easily believe that Mr. Sidney Webb might feel some diffidence in attempting to determine the details of a policy on behalf of the Government which other shareholders might prevent him from enforcing.

* * *

If it is practically impossible for the Government to take charge of the situation, it is even more difficult for the Federal Council to make detailed suggestions. The Federal Council has no accurate knowledge of the negotiations said to be in progress and cannot have such knowledge; even if it had the knowledge there are so many factors to be considered that it would be futile for the Federal Council to suggest to the directors of the British Dyestuffs Corporation what steps should be taken to safeguard the shareholders' interests. And yet, by the irony of fate, the whole future of British Chemistry is at stake, and the people who have the greatest power in the matter and the whole responsibility are the company's directors whose business is before anything else to earn dividends for their shareholders, the majority of whom are not chemists and care nothing for chemistry. The Federal Council has probably performed a useful service in putting the chemists' point of view before the Board of Trade, but how anomalous is the situation! It is perhaps better than it was, and certainly the members of the deputation were to some extent reassured by Mr. Sidney Webb; but it is rather singular that the future of British chemistry should at the moment be in the hands of half a dozen men, only one of whom is a chemist, and he has so recently joined the board that he can so far have only just begun to realise the financial and other difficulties which beset the company. If half-a-dozen of the shrewdest of our chemists knew the whole details it might be possible to contrive some scheme which would satisfy both shareholders and chemists, but the details cannot be disclosed to a large body of chemists. That no solution can be found we do not in the least believe; we feel convinced that a satisfactory solution can be found and we hope that it will. Perhaps before it is too late it might be worth while to sit down quietly and consider whether the future of some other vital factor of modern civilisation is dependent upon some limited company over whom neither Government nor anyone else can exercise control and to whom advice must be tendered submissively and cautiously because the lack of accurate knowledge renders boldness out of the question.

* * *

We think that the Federal Council values very highly the invitation by Mr. Sidney Webb to communicate with His Majesty's Government, through the Board of Trade, on the dyestuffs question and are other chemical topics. Many problems of interest and importance arise from time to time, and the Federal Council is not only willing, but anxious to do all in its power to assist this or any future Government to understand and to solve these problems. The Federal Council's most essential function is to speak for chemistry as a whole, theoretical, academic and industrial, and its members are always at the service of the State and of the science they are privileged to represent, and glad to devote their time and energy for the benefit of

the community. Politicians necessarily tend to be either individualistic or socialistic in their outlook. Chemists are in most respects essentially individualistic, but in the organisation of chemistry and in the unselfish way in which chemical knowledge and skill are made available for the community, they show a democratic spirit which deserves commendation from the most rigid and austere of the Socialists. A great opportunity for chemists to show their devotion to the community of chemists is now being developed in connexion with Chemistry House, and this scheme will afford abundant scope for both individual effort and social advancement. We shall return to this particular topic at a later date.

* * *

Those who were present at the meeting of the London Section on Monday evening must have listened with a great deal of interest to the accounts that were given of the use of bauxite as a refining agent. It is, indeed, fascinating to attempt to account for the way in which bauxite can remove both colour and sulphur compounds from petroleum products with ease and regularity, without any loss other than that due to mechanical disintegration. The preparation required consists solely in roasting the mineral to remove the moisture and in grading it to a specified fineness. Material that has lost its activity through use can be recovered with efficiency undiminished simply by steaming and roasting again. On considering the troubles that arise in the refining of petroleum by purely chemical means, the importance of such a simple and reliable method can readily be understood. Bauxite is by no means a mineral new to science, as it was first described by Berthier in 1821, and named " beauxite " by Dufrénoy in 1847 and " bauxite " by St. Clair Deville in 1861. The name is derived—and the derivation should decide the controversy that arose some years ago regarding the correct pronunciation of " bauxite " —from Les Baux or Beaux, a locality near Arles in the South of France, where the mineral was first found. Deville, of course, originated the well-known process for producing pure alumina from bauxite for the manufacture of aluminium. Indeed, a great many of the names associated with the development of the aluminium industry appear to be foreign, but this country can claim Faraday as the first to isolate the metal, and now we owe the development of bauxite as a refining agent to British science. One wonders whether this new use for bauxite will in any way reduce the supplies required for other purposes. Cobalt, for instance, was found to possess many advantages as a material for electroplating, but its use for this purpose became economically impossible, owing to the great development of high speed alloys of which it is a constituent. Such competition is unlikely to affect bauxite, however, as we were told that there is no relation between its chemical constitution and its efficiency as a refining agent; indeed, the development of this new application should prove a stimulus to its production within the Empire, as material unsuitable for the production of alumina may prove highly efficient as a refining agent.

SOME SCIENTIFIC ASPECTS OF PUERING AND BATING *

By C. E. PICKARD, A.I.C.

This paper is an attempt to co-ordinate numerous scattered publications on the problems of puering and bating, rather than to present an additional contribution of practical research. Puering and bating, though differing practically in many ways, are identical in theory, and most of the following paper therefore applies to both processes.

The term bating, applied to the softening of skins before tanning, is generally understood to be derived from the French " abattre "—to knock off, *e.g.*, to bate a jot of one's pretentions. Puering has been stated to be derived from the French verb " puer " —to stink, and the smell of a fermenting puer liquor certainly suggests that some relationship may exist between the two words. It seems more probable however, that the English word " puer " is a form of " pure," from the French verb " épurer " —to cleanse. Puering is in fact largely a cleansing process, in which hair roots, sweat glands, pigments, etc. (collectively known as " scud ") are removed; and it is only in recent times that the more specific chemical reactions such as the breaking down of elastin and " interfibrillary " substances have been appreciated.

The bating process appears to have been confined originally to the treatment of the heavier classes of skins with fermenting infusions of hen or pigeon manures, while for a similar process applied to the lighter skins (goat, sheep, etc.) and in which dog manure was used, the term puering was allotted.

The scientific achievements in the study of the puering or bating process, however, and the consequent introduction of efficient enzyme bates, which are used on practically all classes of skins, have so confused the two words, that the " bate " seems likely to live by its association with the manufactured enzyme bates, leaving the " puer " and its unpleasant associations to become extinct.

The Action of the Bate

The study of the bate was undertaken successfully first by J. T. Wood, of Nottingham, who summarised the results of his researches as follows :—" The action of the dog dung bate is due to the action of enzymes in combination with organic compounds, amines, and salts of ammonia. The character of the principle enzyme in the dung is a proteolytic one, and resembles the trypsin contained in the pancreatic juice. Photomicrographs illustrating bating tests by J. T. Wood and showing elastin are given on the opposite page; the sections (×92) are 20 μ thick and are stained by the Weigert method.

These conclusions have not only been verified by subsequent researches, but provide the basis for the manufacture of the dog dung substitutes—Pancreol bate and Oropon—whose successful use confirms the laboratory findings of Wood, and provides incidentally a standard material for the elucidation of related problems.

* Read before the Nottingham Section on March 26.

The Criterion of Bating

There still exists however, a good deal of uncertainty as to what is the criterion of a well-bated skin, and the casual reader of current literature or patents on the subject cannot but be perplexed with the tangle of theories and new evidence which is constantly brought forward.

Wood's conclusions simply state to what bodies the action of the bate is due. The criterion of bating is a related but distinct study. To the practical bating man, the skins are bated when they have reached the right "feel," and by long experience and a kind of instinct, the correct condition of the skins can be judged. But it is of interest to go rather deeper into the question, for though bating was judged by "feel" and by the qualities of the finished leather long before it became a subject for scientific investigation, and will probably be judged

A.—Calf-skin section, before bating

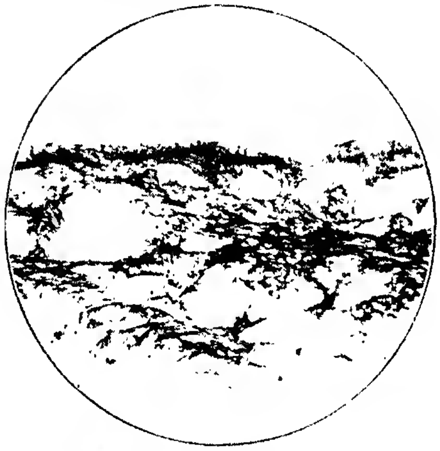
by those standards long after the whole process has been expressed in formulæ, it is always of value to be able to express in terms of definite chemical and physical change, the real mechanism of the bating process.

Systematic experiment has, in fact, aimed at distinguishing what is essential from what is unnecessary or harmful in the bating, so that having found the precise changes which must take place in the constituents of the skin, we may judge how these changes may be best accomplished.

Principles of Research

Before reviewing the work of our chief investigators, I will indicate briefly the principles which have been employed in researches of this kind. The changes which occur are exceedingly complex, involving both chemical reactions and those of organised and unorganised ferments, and it is a matter of no little difficulty to say what proportion of the observed effect should be ascribed to each of these agencies.

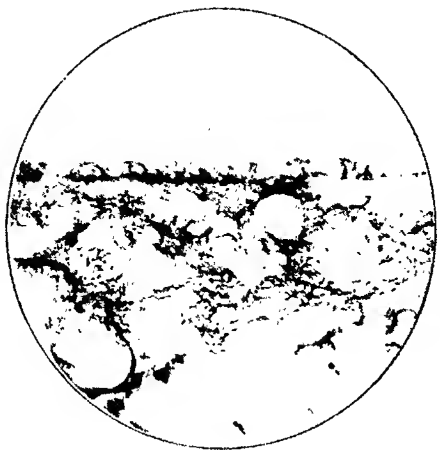
A method based on the biochemical analysis of skins before and after bating was carried out by Rosenthal,[1] who was able to conclude that elastin is digested in bating. This method is, however,



B.—Calf-skin section, bated with Pancreol 5A for 2 hrs.

limited by our incomplete knowledge of the chemistry of skin substances. The second method, by which much information of value has been obtained, is histological, which treats of the minute structure of the tissues and organs of animal bodies.

Every part or organ of the body, when separated into minute fragments, or when examined in thin



C.—Calf-skin section, bated with Pancreol 5A for 20 hrs.

sections under the microscope, is found to consist of certain tissues or textures, which differ in their arrangement in different organs, but each of which exhibits characteristic structural features. By these features, it is possible to recognise a number of the constituents of the skin[2]. The method of microscopic

identification has become very specialised, with a highly developed technique, and by the aid of selective stains[3] it is possible to observe clearly many of the structural changes to which the falling of the skin is due.

An interesting attempt to give an actual mechanical or numerical value to the effect on the skin of the puering and deliming processes is that of Wood, Sand and Law,[4] for details of which the original papers must be consulted.

There are also useful mines of information in estimating electrometrically the hydrogen-ion concentrations[5] of bating solutions and skin substances, but the results provide interesting data related rather to the physical control of bating liquors than to the structural nature of the skin.

Researches on the Effects of Bating

Turning now to the more recent reports on bating, it will have been gathered that the results of bating reach much further than the mere removal of lime[6], and involve the formation of products of enzyme action[7].

In a series of interesting contributions to the *Journal of the Society of Leather Trades Chemists*, on the "Physiology of the Skin," A. Seymour-Jones has published in detail the results of his investigations on the structure of animal skins, and the changes which take place in them during their conversion into leather. He demonstrates the actual effect of bating as compared with mere deliming, by the carrying out of experiments on sheep grains. One portion of the sheep grain split was bated with Pancreol, and one half delimed only with acetic acid, both being afterwards tanned with sumac and dried out. The author examined the leather and reported as follows:—

1. Pancreol-treated Grain

Quality. A fine example of what a skiver should be for sound leather.

Colour.—Pale cream.

Texture.—Mellow, with the soft stretching quality desired.

Under the Microscope

By transmitted light. The hairholes appear clean and clear in every instance. There is no cementing effect in any single instance. The separation of the membrane follicle walls is complete. The papillary membrane is clean, clear and intact, with evidence of separation among the fibres constituting the membrane, clearly showing that something has been digested away. The transmitted light is a bright yellow. By *reflected light* a distinct yellow colour has been shown.

After this leather had been wet back and set out, an examination

By transmitted light showed: The hairholes exhibit considerable enlargement; the papillary areas show long flat-shaped ridges; at the end of each the membrane follicle appears. The whole slide gives the impression of extensibility and cleanliness of structure. The transmitted light is a light canary colour.

Under reflected light the leather showed a light canary colour and an almost translucent sheen, giving the impression of mellowness.

2. The Delimed Grain

was now examined and showed:—

Quality.—The ideal qualities exhibited by the Pancreoled grain were missing.

Colour.—Of a brownish hue.

Texture.—Somewhat harsh, the grain being tucked in small nodules.

Under the microscope.—The leather showed by *transmitted light*: No clear hairholes: each one appears to be glued up. The holes are smaller than in the Pancreoled grain. The papillary areas are pinched up by contraction into ridges resembling sharp cut rugged mountain tops with sealed hairholes on their peaks. The slopes are saucer-shaped, again illustrating contracting influences at work. On the whole surface the view is as though the grain membrane had dried without being properly tanned. It looks horny. The *transmitted light* is a very dark orange colour. By *reflected light* the colour is a peculiar elephant grey.

After being wet back and set out, an examination showed:—

By transmitted light.—The hairholes are opened more, but all are, more or less, blocked by the basal part of the membrane follicle. The glueing effect is present, though in a lesser degree than before setting out. The papillary membrane is less rugged in appearance, yet the horny character of the membrane remains present. The *transmitted light* is an orange colour. By *reflected light* the leather showed a light grey shade of colour, and a sheen giving a horny appearance to the membrane.

The author states that: The impression created by comparing the foregoing pieces is that the contracting influence is due to undigested elastin, which unless digested, does not tan similarly or even comparably to collagen.

For detailed accounts of elastin, collagen and other skin substances, the reader is referred to "Principles of Leather Manufacture," by H. R. Procter, and to the following papers: "The Chemistry of the Skin. by A. Seymour-Jones (*J.A.L.C.A.*, 1916, Vol. XI, p. 41); "Biochemical Studies of Skin," by G. J. Rosenthal (*J.A.L.C.A.*, 1916, Vol. XI, p. 463), and "The Chemical Constituents of Skin," by A. Seymour-Jones (*J.S.L.T.C.*, 1922, Vol. VI, p. 261). To present a survey of skin substances, regarded as far as may be possible as chemical individuals, is beyond the scope of the present paper.

In "The Mechanism of Bating[8]," J. A. Wilson concludes that bating consists of two distinct parts. (*a*) Reducing the skins to a condition of minimum swelling; (*b*) digesting the elastin fibres present in the outer layers of the skin.

In "The Removal of Elastin During Bating[9]," R. H. Marriott criticises the findings of Wilson, and describes experiments which show that whilst elastin is digested by an enzyme bate, the removal is not a fundamental of the process.

In "The Properties and Action of Enzymes in Relation to Leather Manufacture[10]", J. T. Wood

states: "Although the elastin is completely removed from the skin bated by trypsin for a sufficiently long time, about 24 hours, in practice the bating is not continued to this point, but is carried on only for about 2—6 hours. The elastin is only partly removed in this time, but the skins made good leather. The writer believes that it is not necessary or even desirable for the whole of the elastin to be removed or dissolved in order to let the skin down, but that it is sufficient for the elastin fibres to be broken up or weakened, in order that the desired suppleness may be obtained."

In "The Hydrolysis of Collagen by Trypsin[11]" F. L. Seymour-Jones gives an account of the action of trypsin on the collagen constituent of the skin, and showed very definite digestion (after a preliminary passive period of 24 hours) of the collagen by the trypsin. That none, or practically none, of the collagen is removed in commercial bating is due to the fact that no concentrations of trypsin as were used in these experiments are ever likely to be present in ordinary bate liquors.

In a "Note on the Hydrolysis of Collagen by Trypsin[12]," R. H. Marriott criticises a number of the features of the dissertation by F. L. Seymour-Jones. The paper contains much valuable information.

In "The Action of Trypsin on Collagen[12]," Stiasny and Ackermann conclude that the effect of trypsin on collagen depends essentially on the preliminary state of the latter, notably on its degree of swelling and on other conditions of the experiment. The misconceptions on this fact explain the contradictory information which is found in the literature dealing with the subject.

I shall now refer to "Some Observations on the Histology of Bated Skins[14]," by the Rohm and Haas Co., Inc., Philadelphia. The original papers were illustrated by some excellent photo-micrographs, obtained in collaboration with Dr. Gies, of Columbia University. The experiments carried out and the histological results are summarised as follows:—

(a) Goatskins were bated, in parallel experiments, (1) with a natural dog-manure bate, and (2) with a manufactured enzyme (or "artificial") bate. Clippings of the skins were prepared for histological examination, and the bulk of the skins subsequently finished into leather.

Results.—The histological examination revealed that the elastin was by no means completely removed, either in the case of the dog-manure bate or the artificial bate. All the skins when finished gave normally good leather in every respect.

(b) Calf skins were bated in parallel experiments, (1) using an infusion of chicken manure, and (2) using a manufactured enzyme bate. It was considered that calf skins and goat skins present more or less the two extremes of required enzyme action, at least so far as skins for shoe leather are concerned.

Results.—The amount of elastin still present after bating was considerable, and did not vary greatly between the enzyme bate and the chicken manure series.

(c) Goat skins were bated, in parallel experiments, with the object of determining whether there is any difference between a dung bate employing bacterial enzymes and an artificial bate using pancreatic enzymes, but with different types of delimer.

Results.—In every way the deliming was complete. The swelling completely disappeared, and the skins were absolutely normal in their fallen or flaccid condition. The finger-print test was normal, and the porosity for air also, and no difference whatever was observed in this respect between artificial and dung bates.

The papers conclude: "It remains to be seen if there is any action going on, due to the presence of enzymes, that has not yet been made visible under the microscope. I imagine that the substance, usually referred to as 'interfibrillary substance,' is distributed as an unformed jelly or viscous liquid in the fibres of the skin, and subject to change in every step of the manufacturing process in the beamhouse. . . ."

". . . From the point of view of the practical tanner, there seems to be little doubt that the removal of such interfibrillary substance, which, along with hair-roots, sweat glands, etc., is generally described as 'scud'[15], does constitute one of the most important functions of the bating process. The phenomenon of the scud flowing out from the skin has not received so much attention as we should wish, and as seems to be indicated by the very necessity of the operations in the actual manufacture of leather. As an example may be taken the bating of lambskins in the manufacture of glove leather. If an attempt is made to scud these before bating, the scud adheres to the knife in the form of a substance of cheese-like consistency, whereas when scudding is conducted after bating, the scud flows freely from the skin, in a consistency only little greater than that of water."

"From the histological standpoint, I imagine that the scientific explanation of the bating operation, and of the scud, would present quite a few difficulties, since to my knowledge no selective stain has been found for the probably very heterogeneous mixture constituting the cementing or interfibrillary substance."

A. Seymour-Jones[16] speaks of the fibre bundles as being united by a soft filamentous substance of considerable tenacity and elasticity, known as "areolar tissue." Such tissues surround many organs of the body.

Schafer[17] says that Mall looks upon the intercellular or ground substance as living substance (exoplasm), and as bringing all the cells of the tissues into continuity. He regards the whole structure, cells and ground substance together, as constituting a continuum, the fibres being laid down or formed by chemical transformation in the exoplasm.

The Remaining Problem

The principal remaining problem now is what happens to this interfibrillary substance. Chemically, the matter if not simple, because both collagen and hyaline, when overlimed, are chemically changed, so that they are capable of being attacked by trypsin.

Some information might be got from the composition of the scud[18]. An analysis of a scud from English sheep grains showed only 0·164 per cent. of nitrogen, equivalent to about 1 per cent. of skin substance. The fat content was 7·19 g. per litre.

Wood also found that a sample of scud taken from machines which had been scudding sheepgrains out of puer, contained 24·62 g per litre of total solids :—

Inorganic	4·01
Free fat	7·95
Organic matter (not fat)	12·66

The last item, of course, contained the organic matter of the dung, in addition to the interfibrillary substances.

Eberle and Krall[19] analysed the fatty matter which adhered to men's knives (after the goods had been puered) in scudding lamb skins for gloving work. They obtained the following results :—

	%
Water	29·7
Fat (largely wool fat)	42·0
Fatty acids combined with lime	6·6
Albuminous matter soluble in water	3·8
Hair and insoluble albuminous bodies	14·4
Ash (containing 57% CaO)	3·5

Attempts have also been made to estimate the cementing substances by analyses of puers before and after the skins have been put through Here the results are influenced by the amount of nitrogenous matter brought into solution from the puer itself, while if an artificial bate is used, a considerable correction is necessary for the products of enzyme autolysis of glandular matter in the bate, whose solubilities are partly dependent upon the nature and relative concentrations of neutralised and free deliming agents.

With regard to histological examination, it has been suggested by Jerome Alexander[20] that the use of the ultra-microscope and darkened field might reveal features of the interfibrillary and other substances which are invisible in the illuminated field of the ordinary high-power microscope. The same authority also criticises the use of stains and alcohol in the preparation of skin sections, since the structure of the colloidal substances may be changed by treatment with such active reagents.

Procter[21] states that the cement substance seems to be removed by liming. If this is so, then there cannot be any effect on it in the bating.

It may at least be said definitely that the skin substances which are dissolved in a puer or bate, are hydrolysed almost as completely as gelatin is when the latter is boiled with dilute sulphuric acid.

Future Progress

Instead of proceeding finally to summarise the present state of knowledge of the science of bating, which I trust has been conveyed in this paper, I am tempted to make a few observations to illustrate the futility of generalising on a subject so involved. Early in the paper, I referred to "Enzymes," which are conveniently defined as organic "catalysts." Both the words however, explain nothing, and merely serve opportunely to cover an obscure idea which is not fully understood. In passing back from the word to the idea, it becomes easy to believe that "the subjective abstraction has an objective existence," or that because there is a word, something real must lie behind it.[22]

The same might also be applied to skin substances, many of which cannot strictly be regarded as distinct chemical entities, but as related forms of protein matter, differing slightly in elementary composition, each differently modified by events in the history of the skin, its source, its post-mortem changes, and its treatment in the beamhouse, and which exist together in a natural and elaborate structure which nerve matter, hair roots, bacteria, and the factors of life itself have combined to build.

But far be it from me, in emphasising the incompleteness of our knowledge, and in hinting that we are only on the fringe of the cause and effect of bating, to admit that the phenomena are beyond us. "Nature presents to our senses a panorama of phenomena co-mingled in endless variety, so that we are sometimes overwhelmed and dazed by the apparent complexity of empirical knowledge. It is the work for the intellect to educe the elements of sameness amidst diversity, and to see differences amidst apparent identity."

By such means did the old-time puerman, aided by empirical knowledge and instinct, regulate his puer liquors and prepare his skins for leather; by such means has it been possible to eliminate much of the uncertainty of the puering or bating process by the introduction of manufactured and standardised enzyme bates; and by such means, aided by logically conceived experiment, will the scientific aspects of the problem be correlated and finally understood

Bibliography

[1] J.A.L.C.A., 1916, Vol. 11, p. 463.

[2] See also "The Microscope in Leather Manufacture," J.S.L.T.C., Vol. 5, No. 2.

[3] Procter, L.I.L.B., p. 401; and Schafer, "Essentials of Histology."

[4] Wood, "Puering, Bating and Drenching of Skins" (Spon), p. 85.

[5] See Cole, "Practical Physiological Chemistry."

[6] For an account of the earlier and unsuccessful attempts to use mere deliming agents as bates, see Procter, "Principles of Leather Manufacture" (1922), pp. 202-219.

[7] A fascinating account of enzyme action is given in "Biochemical Catalysts in Life and Industry," by Effront, and in "The Nature of Enzyme Action," by Bayliss.

[8] J.S.L.T.C., 1921, Vol. 5, p. 15; or J.A.L.C.A., 1920, p. 650.

[9] J.S.L.T.C., 1921, Vol. 5, p. 280.

[10] *J. Ind. Eng. Chem.*, 13 (1921), p. 1135; or J.A.L.C.A., 1922, Vol. XVII., p. 97.

[11] J.S.L.T.C., 1923, Vol. 7, p. 293

[12] J.S.L.T.C., 1923, Vol. 7, p. 547.

[13] Le Cuir, or J.S.L.T.C., 1923, Vol. 7, p. 431.

[14] J.A.L.C.A., 1922, Vol. 17, p. 542.

[15] See also "Scudding," by Blockey; J.A.L.C.A., 1919, p. 107.

[16] J.S.L.T.C., 1918, p. 36, "Physiology of the Skin."

[17] Schafer, "Essentials of Histology," p. 98.

[18] Wood, "Puering, Bating and Drenching of Skins," pp. 48-52.

[19] *Collegium*, 1911, p. 445.

[20] J.A.L.C.A., 1923, Vol. XVIII., p. 523.

[21] "Principles of Leather Manufacture," Procter, p. 60

[22] See Mellor, "Modern Inorganic Chemistry" (1912).

A NEW METHOD FOR EMPTYING CARBOYS.

By J. ADAM WATSON, A.C.G.I., F.I.C.

As there are many occasions when it is necessary to remove a definite weighed quantity of liquid from a carboy, and in view of the risks attending the obvious method of pouring when the liquid is either corrosive or gives off dangerous fumes, the following method is suggested in the hope that it may be of use to any who have been faced with the same difficulties as the author.

Having to handle both concentrated sulphuric and nitric acids in quantities which though considerable did not permit of employing large storage tanks, the possible risks were continually brought to our notice. Carboys are on the whole rather treacherous things; when full their weight renders them liable to slip as it is only possible for two persons to co-operate efficiently in their handling; further, when, in weighing a quantity of acid, it is desired to stop pouring suddenly, there is great liability for the liquid to splash out of the mouth. All these considerations led us to try to devise some safe and simple way of handling these containers.

The most obvious method of inserting two tubes into the carboy through an air-tight bung and blowing air through one tube into the carboy is difficult of application owing to the varying size and condition of the carboy necks. Also, it is subject to the grave risk of the carboy bursting under the pressure. Eventually an adaptation of this method was evolved which, as far as we know, has not been used.

The carboy is placed in a box provided with an air-tight door and a pipe passes through the box into the carboy and delivers into a tray standing on the platform of a weighbridge. Air is blown into the box and the liquid is thereby forced out of the carboy up the pipe to the tray, where it is collected and weighed. The box is placed at a convenient height above the ground, so that the carboy may be readily placed inside, after which the door is closed. The pipe which is to deliver the liquid passes through a packing-gland in the top of the box so that it may be drawn up out of the way when it is desired to change the carboy. The packing-gland permits this movement of the pipe without impairing the air-tight properties of the box. By connecting this pipe by means of a union with the remainder of the pipe line to the tray the whole system is made simple and is easily worked. An air exhaust is also fitted to the box in order quickly to reduce the pressure inside to that of the atmosphere. The tray in which the acid to be weighed is collected is fitted with a short outlet pipe which delivers into a funnel large enough to cope with the flow of liquid from the tray and this funnel in turn is connected by a pipe with the tank in which the acid is to be mixed. While the tray is being filled the outlet is closed by a plug provided with a long handle so that it may be readily removed. The whole system is set up in such a way that the end of the delivery pipe from the carboy is at a higher level than the liquid in the carboy, thereby preventing any syphoning action while the pipe line is laid, so that there is a fairly steep slope both to the carboy and to the tray. As both sulphuric and nitric acid have to be dealt with, the sliding pipe is made of aluminium and the remainder of the pipe line of iron piping. The tray is of wood lined with thick lead and the plug is of lead fitting into a lead seating.

The advantages of this system are fairly obvious. In the first place, as there is no difference of pressure between the inside and the outside of the carboy, there is no liability to bursting. It is a simple matter to place the carboy in position, and all danger of splashing may be overcome by tying a piece of stout paper over the mouth after the removal of the bung. This paper will offer no obstacle to the insertion of the sliding pipe, but will prevent any liquid issuing from the carboy while it is being moved. By using the air exhaust in the box the flow of liquid from the pipe can be stopped instantly so that it is easy to weigh a definite quantity by the use of the weighbridge. Although there is still a considerable amount of fuming when handling strong nitric acid, yet, by this system, there is no necessity for the workmen to come into the region of the fumes. This system has been worked for about two years without any trouble and with considerably less inconvenience than attended the old method of emptying the carboys by hand.

THE ADVANTAGES OF MECHANICALLY SLAKED LIME

(From a Correspondent)

It is very remarkable that even in the chemical industries a large proportion of the lime used is still of the hand-slaked variety, whilst small users of lime, not only chemical works in general, but builders for example, have not yet realised the advantage of mechanically-slaked lime. Unquestionably in this respect we are behind the Continent, where the sale of pure dry slaked lime in bags is a flourishing industry and the material finds an astonishing variety of uses. From a purely chemical point of view, mechanically-slaked lime has the great advantage that it is a pure product, practically 100 per cent. calcium hydrate, containing no free lime (CaO) and no unslakeable material, whilst it is in the form of such an excessively fine and uniform powder that it is almost semi-liquid in mechanical properties and possesses pronounced lubricating qualities. Further it can be supplied without difficulty either entirely free from moisture, or with any pre-determined and definite amount, such as the 1 per cent. required, for example, in chlorine absorption and the manufacture of bleaching powder.

The machines used for slaking lime are of different types, but one general principle largely employed is to slake the lumps of quicklime with jets of water in a revolving screen chamber enclosed in a large outer casing. The lime as it is slaked falls to a dust of dry hydrate which passes through the perforations into the outer chamber whilst all stones and unslakeable material are left behind. The large

volume of steam given off, representing about 5 per cent. of the total weight of the lime, is caught in a jet condenser, and the water, heated nearly to boiling point, is used for slaking through the jets in the revolving screen. The slaked lime dust is then conveyed along in the inner chamber, being thoroughly agitated and mixed in the process, with the result that no trace of free oxide is left in the product, which is discharged at over 200° F., in an absolutely uniform and excessively fine powder of almost chemically pure hydrate $Ca(OH)_2$. Extra water can, of course, be added if desired, so as to give any desired moisture content to the finished product. From the point of view of the chemical or other works where large quantities of lime have to be slaked the process is almost a revolution in comparison with the laborious, objectionable, expensive, and clumsy method of slaking lime by hand, spreading it out over a large area of floor, and obtaining a product which contains lumps, all the stones and other unslakeable products, and generally an irregular content of free unslaked lime as well.

The advantages are equally important for users of lime, who obtain a pure and definite product which can be mixed with water exactly as required without any waste and which will keep indefinitely and is packed in bags. In the building trade, for example, this would save at least 50 per cent. of the lime used as compared with the present antiquated method of digging a hole at great expense and slaking lime in it, the greater part of the lime being not only never used, but also always exposed in a wet condition to the air, and absorbing carbon dioxide, for example.

The advantages of mechanically slaked hydrated lime are very apparent in connexion with water softening by the lime-soda process. The constancy of composition and freedom from impurities together with the mechanical condition of the product are of the utmost importance in this process and lead to regularity and ease of control.

Another very valuable use of mechanically-slaked lime which is now beginning to attract attention in Great Britain is in concrete mixing. If slaked lime is added to the extent of about 8--16 per cent. of the weight of the cement, the advantages in the finished concrete are very pronounced. Thus, for example, the plasticity of the mass is increased, so that less water can be used for mixing, giving therefore reduced segregation and less tendency to cracking, whilst the resulting concrete is much more dense and nonporous, and the waterproof qualities are increased to a very remarkable extent. These results are obtained because mechanically-slaked lime is in the form of very fine particles which act as void fillers, and because lime has more lubricating action than other materials of the same class

Prof. M. T. Bogert, professor of organic chemistry at Columbia University, has been elected chairman of the U.S. National Research Council committee on chemical research on medicinal substances.

DEPUTATION FROM THE FEDERAL COUNCIL TO THE BOARD OF TRADE

Mr. Sidney Webb, the President of the Board of Trade, received on May the 6th a small deputation from the Federal Council for Pure and Applied Chemistry to discuss the position of the Dyestuffs Industry; Sir Sydney Chapman, Mr. Percy Ashley and Major Church, M.P., were also present. Sir William Pope introduced the deputation, which included Prof. W. P. Wynne, the President of the Chemical Society; Prof. H. E. Armstrong, a past President of the Chemical Society; Prof. J. F. Thorpe, Honorary Treasurer of the Chemical Society; Mr. H. E. Coley, Chairman of the Chemical Industry Club; and Dr. S. Miall, Honorary Secretary of the Federal Council; and explained that the Federal Council consisted of representatives from the Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers and all the other organisations connected with English chemistry. He urged that the dyestuff industry was essential to the progress of organic chemistry, including pharmaceutical and many other branches; that the progress of research in organic chemistry was inseparable from research in the dyestuff industry and that no steps should be taken which would allow the control of advance to revert to German hands. he pleaded that any arrangements made between the British Dyestuffs Corporation and the German Interessen-Gemeinschaft should respect the original intention of making the dyestuffs industry here free from German influence or domination. Prof. W. P. Wynne referred to the great development of chemical inquiry which had taken place in this country, especially in organic chemistry, during the last few years, and stated that if German discoveries in dyestuffs were to be relied upon for the British dyestuffs industry an avenue would be closed to a number of highly trained and efficient chemists. Prof. H. E. Armstrong said that whereas formerly it was necessary for a chemist to receive training in research in Germany, it was now possible for him to acquire as good or even better training in this country; that it was essential to attract into chemistry men of ability who could advance a science which was of great importance to every manufacturing industry, to agriculture and medicine, and that every possible encouragement should be given to the promotion of chemistry here. He discussed the serious effect on the natural indigo industry of India caused by the cessation of research in this industry.

Mr. Sidney Webb in replying stated that the matter was one in which politics played no part. All were agreed as to the purpose; it was the process of carrying this out which was difficult. The present Government, and indeed all Governments, recognised the necessity of promoting scientific research and supplying opportunities and freedom for carrying it on. He was convinced that the research work in the dyestuff industry should be done here by British trained chemists, but the method of securing this was not easy. As regards the proposed agreement he pointed out that the Government was not a party to the negotiations, but he was sure that no

agreement would be concluded which was not consistent with the original purpose of the British Dyestuffs Corporation. He agreed that there could be no monopoly in research in this industry and he realised that the dyestuffs industry was essential to the progress of chemistry as a whole. He hoped that what he said would to some extent reassure the deputation and that the Federal Council would continue to communicate with the Board of Trade on this or any other chemical topic.

Sir William Pope thanked the President of the Board of Trade for receiving the deputation and for his sympathy with their views.

FORTHCOMING EVENTS

May 12. INSTITUTE OF BREWING, *London Section*, the Engineers' Club, 39, Coventry Street, W.C., at 7.30 p.m. "Some Experiences in the Erection and Use of Concrete Vessels in the Brewery," by E. B. Collier. "Note on a Dust-quenching Plant," by C. A. Finzel, M.A.

May 13. ROYAL PHOTOGRAPHIC SOCIETY, 35, Russell Square, W.C. 1, at 7 p.m. "Photographic Record for Astro-physical Research," by C. P. Butler. "A Note on the Factors Affecting Grain Size in Emulsions," by F. F. Renwick.

May 13. INSTITUTION OF CIVIL ENGINEERS, Great George Street, Westminster, S.W. 1, at 6 p.m. Annual General Meeting.

May 13. INSTITUTION OF PETROLEUM TECHNOLOGISTS, at the Royal Society of Arts, John Street, Adelphi, W.C. 2, at 5.30 p.m. "The Geology and Oil Measures of South-East Persia," by R. K. Richardson, A.R.C.Sc., M.Inst.P.T.

May 14 and 21. BRITISH EMPIRE EXHIBITION. Conferences on "Heredity as the Basis of National and Industrial Efficiency.

May 15. CHEMICAL SOCIETY. Ordinary Scientific Meeting at Burlington House, Piccadilly, W. 1, at 8 p.m. "The Bromo-derivatives of 1-Methylglyoxaline and the Constitution of 'Chloroxalmethylin,'" by I. E. Balaban and F. L. Pyman. "Synthesis of Amygdalin," by R. Campbell and W. N. Haworth, and "Reactivity and Radiation. The Photochemical Union of Hydrogen and Sulphur," by R. G. W. Norrish and E. K. Rideal.

May 21. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2, at 8 p.m. (Trueman Wood Lecture) "The Outlook in Chemistry," by Sir W. J. Pope, K.B.E., D.Sc., F.R.S.

Members of the Society of Chemical Industry are invited to attend the meeting of the Organic Industries Group of the Société de Chimie Industrielle, to be held on May 13, in the Rooms of the Société Française de Photographie, 51, Rue de Clichy, Paris, when the following papers will be read:—(1) "The Synthesis of '309' and the changes brought about in the therapeutic action of the derivatives of this family by chemical modifications" (with kinematograph illustrations), by Monsieur E. Fourneau, and (2) "The Thickening of Paint," by Monsieur Ch. Coffignier

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 11 a.m.

The following is a Preliminary Programme of the meetings to be held in Liverpool on July 9-12 inclusive.

WEDNESDAY, JULY 9.—*Morning*: Council Meeting. Annual General Meeting in the Arts Theatre, the University. Presidential Address by E. Frankland Armstrong, D.Sc., F.R.S.; *Afternoon*: Business Session in the University. Visit to White Star Liner "Cedric," and tea on board by invitation of the White Star Line. *Evening*: Reception and Dance at the Town Hall by invitation of the Right Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.).

THURSDAY, JULY 10.—*Morning*: Messel Memorial Lecture by the Right Hon. Viscount Leverhulme, in the Arts Theatre, the University, and presentation to the Lecturer of the Society's Messel Medal for 1924. Visit to the works of Messrs. Joseph Crosfield & Sons, Ltd., Warrington. Luncheon by invitation of the Directors. *Afternoon*: Inspection of the Works. *Evening*. Annual Dinner of the Society at the Midland Adelphi Hotel.

FRIDAY, JULY 11. *Morning*: Business Session in the University. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of the United Alkali Co., Ltd. Visit to a Works of the United Alkali Co., Ltd. *Evening*: Dinner at Lady Lever Art Gallery by invitation of the Chairman and Directors of Messrs. Lever Brothers, Ltd.

SATURDAY, JULY 12.—Visit to Lake Vyrnwy. Inspection of Liverpool Corporation Water Works.

A detailed programme will be sent later to every member of the Society.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

DEATHS

Evans, Lincoln W. (elected 1923), of the South Eastern Agricultural College, Wye, Kent. Lecturer in Chemistry. On March 6, 1924.

Gall, John B. (elected 1905), of 49, Glenlyon Road, Eltham Park, London, S.E. Chemist. On March 27, 1924.

Houlehan, Dr. Arthur E. (elected 1919), of Messrs. E. I. du Pont de Nemours and Co., Wilmington, Del., U.S.A. Associate Director of the Jackson Laboratory. On March 11, 1924.

McAlley, James (elected 1916), of 193, Broomloan Road, Govan, Glasgow. General Manager. On February 27, 1924.

Tucker, Alex. E. (elected 1894), of 59, Cambridge Street, Birmingham. Metallurgical Chemist. On March 28, 1924.

MANCHESTER SECTION

Dr. H. Levinstein presided over the meeting held on May 2 at the Textile Institute.

A resolution of condolence with the family of the late Dr. G. H. Bailey, Senior Demonstrator in Chemistry in the University of Manchester, was passed.

"A Note on the Detection of Persulphate in Flour and a recent Bleaching Agent for Flour," was then read by Mr. J. Miller, F.I.C.

Mr. Miller stated that the usual reagent for detecting per-salts in flour was a solution of benzidine in alcohol. His suggestion was, however, to use an aqueous solution of potassium iodide. A recently manufactured bleaching reagent for flour, sold under the name of "Novadelox B," consisted of a mixture of benzoyl peroxide and acid calcium phosphate. Benzoyl peroxide was an oxidising agent and a powerful antiseptic, but its use internally had been discontinued owing to its poisonous action on the blood. The general properties of benzoyl peroxide were reviewed, and the detection of benzoyl peroxide in flour was described as follows:—The flour is mixed into a paste with a solution of potassium iodide, and heated on a boiling water-bath. The presence of benzoyl peroxide is indicated by the appearance of dark spots. This test will indicate the presence of half an ounce of the salt in a sack of flour (280 lb.). Slides were shown illustrating the potassium iodide test for persulphates, and there were also exhibited pastes of flour containing benzoyl peroxide in the proportion of half an ounce per sack of flour (280 lb.) or an actual proportion of 1 in 9000.

In his paper "On Insulin," Dr. A. Renshaw, D.P.H., stated that the history of research on diabetes showed how very near several investigators had been to obtaining an active pancreatic extract resembling insulin. Even the method of ligaturing the pancreatic duct used by Banting, to produce atrophy of all except the Islets of Langerhans, had previously been used by other workers in an endeavour to obtain the secretion of the Islets of Langerhans. Zuelzer had nearly approached Banting's discovery in 1908, and this semi-failure showed the importance of not giving up a piece of research work until the truth was finally established. Once Banting and his co-workers had demonstrated that such an extract could be obtained, the finer methods of blood analysis now available allowed them to overcome the pitfalls into which other workers had fallen, and to show that the extract was potent in reducing the sugar content of blood. The next step consisted in translating these facts, by clinical application, into a recognised method of treatment. After this, the subsequent difficulty of manufacture of insulin on the large scale had to be faced. The generosity of Banting and his co-workers in presenting the patent rights in this country to the Medical Research Council could not be overrated. The Council had assisted chemical firms in their endeavours to produce insulin on the large scale. The manufacturing methods employed were then dealt with in detail. As much as 10 million units of insulin per week could now be produced by one firm alone, or sufficient for approximately 7000 persons.

Another feature was the manner in which the cost had been reduced to bring the product within the reach of the poor man. After seeing the ingenious methods in use by one large manufacturer of insulin, it would come as no surprise if the cost was still further reduced. Insulin, however, was not a cure for diabetes. It was rather like an artificial limb which enabled a man to walk after one leg had been lost. It had to be used as long as life lasted, and it required a great deal of care on the part of the patient who uses it.

It was with no sense of disrespect for the very fine achievement of Banting when he stated that the prevention of diabetes was better than a cure. In this respect he would like to repeat even more firmly an obeservation made two years ago, *e.g.*, that the cause of diabetes was bacterial in origin, and that its onset could be assigned to the activities of the *B. Amyloclasticus Intestinalis* described two years ago by Mr. Fairbrother and himself. Reasons were given to show how the ferment arising from this organism could disturb the function of glycogen formation; and how such disturbance was translated into terms of an increased secretion from the Islets of Langerhans followed by exhaustion of the cells. In other words, the disturbed metabolism met with in diabetes had its origin in the bacterial fermentation present in the intestines. Such an action must be specific in its neutralisation of the secretion from the Islets of Langerhans. There were very few bacteria which could act upon glycogen, which was the chief substance concerned in diabetes. The ferment arising from the bacillus mentioned could, however, act upon this substance, and it appeared probable that there was some stereochemical relationship between the antiferments or antitoxins produced against this bacillus and the insulin or ferment produced by the Islets of Langerhans. The ferment produced by the latter assisted in building up glycogen from glucose; the ferment produced by the bacillus broke down glycogen. Furthermore, it had been shown that the liver cells most concerned in the storage of glycogen from glucose could absorb the bacillary ferment.

From a consideration of these facts it appeared that the prevention of diabetes offered the main hope. Once the pancreatic islets had been exhausted, insulin appeared the only treatment along passive lines. A few early cases might be improved if the absorption of bacillary ferment could be checked. The organism occurred amongst bad potatoes, and Prof. Fowler had recently described a similar organism occurring in bad rice. The significance of this fact in relation to the higher percentage of diabetes amongst the Hindus could not be over-rated. A similar organism occurred in fermenting maize, producing an alcohol. Possibly this fermented-maize drink was responsible for the presence of diabetes in a non-civilised race like the North American Indians. This bacillus had been found in approximately three out of every four cases of diabetes examined by him.

SHAWINIGAN FALLS SECTION

A meeting was held at the Cascade Inn on March 31. Dr. Skirrow, presiding in the absence of the chairman, introduced Mr. H. Freeman, who gave an address on "A Few Problems for Industrial Research in Canada." Discussing the ever-present fuel problem, he pointed out that although the extreme west and east of Canada are well supplied with coal, the great industrial regions of Quebec and Ontario are dependent on American supplies. Large fields of lignite occur in the prairie provinces, but are practically undeveloped because the lignite, in order to become a satisfactory fuel, must be dried, carbonised, and briquetted. No really satisfactory binder for briquetting had yet been found, but the material of the required cheapness and physical properties seems to lie in the bituminous sands of the Alberta river valleys, awaiting only some well-organised industrial research to apply it to what may well become a great industry. Turning to the metallurgical industry, the speaker pointed out the essential differences between Canadian and American deposits of gold, silver, copper, lead and zinc. Whilst the latter have usually been concentrated by Nature and are leachable, the former exist as sulphides and contain large quantities of materials which must be removed. Roasting and smelting processes are expensive, and the enormous quantities of iron are usually wasted. More iron than is used on the West Coast is mined in British Columbia in the form of copper ores carrying iron and thrown on the dump. Research on electrolytic and other methods of separation could probably make this iron available for use, and at the same time cheapen the production of copper.

In connexion with the old problem of sulphite waste liquor, well-known wherever there is a paper mill, mention was made of the possibility of recovering wood oils by evaporation and distillation of the waste liquor, and the use of these oils for preserving timber and in the oil-flotation process for concentrating low grade ores. As to the odoriferous soda-pulp process, aside from the problem of making its smell less overpowering, there is that of supplying the large quantities of sodium sulphate required in producing the smell. Excellent natural deposits of Glauber's salts occur in Saskatchewan, and need only a little engineering to work out satisfactory methods of evaporation and handling to supply the Canadian Kraft mills, which now import $1,500,000 worth annually. In closing, the author pleaded for greater encouragement, either by private enterprise or by the Government, to the chemist and engineer in these and other problems so important to national prosperity.

A lively discussion followed, and after a vote of thanks to the speaker the meeting adjourned.

R. M. Howe, Vice-President of the American Ceramic Society, and at one time engaged on research on refractories as senior industrial fellow in the Mellon Institute of Industrial Research, has died at the early age of 30.

CHEMICAL SOCIETY

Presiding at an ordinary scientific meeting held on Thursday, May 1, at 8 p.m., Prof. W. P. Wynne reminded Fellows that the Faraday lecture would be delivered by Prof. R. A. Millikan at the Royal Institution on Thursday, June 12, at 5.30 p.m., instead of June 26 at 8.30 p.m. as previously announced; admission would be by ticket obtainable from the Assistant Secretary. Other announcements were to the effect that applications for grants from the Research Fund must be received by June 2, and that in the interests of economy the list of Fellows would not be printed this year.

Mr. H. T. S. Britton read the following two papers:—

The electrometric titration of chromic acid using (a) *the hydrogen electrode, and* (b) *the oxygen electrode.*

Chromic acid has been titrated electrometrically with sodium hydroxide by means of the hydrogen electrode and also the oxygen electrode. Some of the essential points to be observed in the preparation of hydrogen electrodes for use in presence of chromic acid, chromates and nitrates have been recorded. Evidence has been adduced to show that chromic acid dissociated as a normal dibasic acid. The dissociation $H_2CrO_4 \rightleftharpoons H^{\cdot} + HCrO_4'$ is almost complete in dilute solution, whereas the dissociation of the hydrochromate ion, thus $HCrO_4' \rightleftharpoons H^{\cdot} + CrO_4''$, is extremely small. The second dissociation constant is $4 \cdot 4 \times 10^{-7}$ at 18° C. The use of the oxygen electrode as an indicator of both hydrogen-ion concentrations and end-points has been demonstrated by comparison with the hydrogen electrode. It has been shown that the dibasicity of chromic acid, as H_2CrO_4, accounts for some of the reactions of chromic acid and its salts.

Chromates of thorium and the rare earths. Part II. The chromates of lanthanum, praseodymium, neodymium, and samarium.

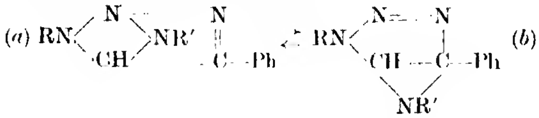
Lanthanum, praseodymium, neodymium and samarium form an isomorphous, yellow, difficultly soluble series of chromates of the general formula $M'''_2(CrO_4)_3, 8H_2O$. The variation in their solubilities shows their importance in processes of fractional precipitation with potassium chromate. The tendency to form sparingly soluble double chromates is marked in the cases of lanthanum, praseodymium and samarium. Lanthanum forms the salt $K_2CrO_4.La_2(CrO_4)_3,6H_2O$. The addition of potassium chromate to aqueous salt solutions causes the precipitation in the case of (*a*) lanthanum, of the simple chromate, if the excess of precipitant is small; (*b*) praseodymium, of the simple chromate; (*c*) neodymium, of a mixture of simple and basic chromate, (*d*) samarium, of an indefinite basic precipitate.

Investigations (with Miss H. W. Carnelley) were described by Mr. P. K. Dutt:—

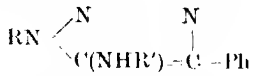
*Imino-dihydro-*1 : 2 : 3*-triazole. Part II. Intra-annular migration of the dyad type and intra-nuclear tautomerism without migration.*

The reaction between 1 : 4-diphenyl-5-chloro-1 : 2 : 3-

triazole and *p*-toluidine on the one hand and that between 1-*p*-tolyl-4-phenyl-5-chloro-1 : 2:3-triazole and aniline on the other lead to the formation of the same two products, *a* and *b*, which are tautomeric and have the general formulæ,

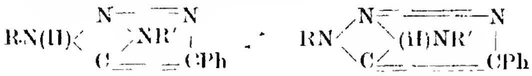


In alcoholic hydrochloric acid either of these tautomerises into another form, such as



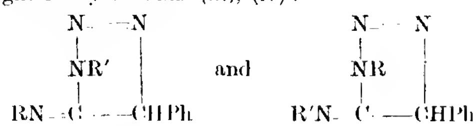
which yields N-nitroso and acetyl derivatives.

Prof C. K. Ingold thought that the work was capable of interesting extensions to other heterocyclic nuclei, but doubted whether the interpretation offered had been fully proved. It was to be expected from analogy with Diels's addition reaction that (i) and (ii) would be *directly* interconvertible (a form of ring-chain tautomerism), so that it was unnecessary to postulate an intermediate four-membered ring :



(i) (ii)

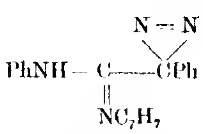
Further, the isomerides with the properties of anils might really be anils (iii), (iv) :—

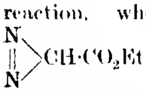


(iii) (iv)

and not the dicyclic bodies supposed. The difference in their ease of substitution might be due to the blocking up, in one of the isomerides, of the para-position of the benzene ring involved (R = phenyl, R′ = *p*-tolyl) The reactions iii⇌i and iv⇌ii were of a well-known type, so that it appeared possible to interpret all the results on comparatively simple and well-recognised lines.

Replying, Mr. Dutt remarked that a mechanism leading to the formation of an intermediate phase such as



could not be supported, since the well-known reaction, whereby a substance of the type  when treated with sodium ethoxide is converted into $EtO\cdot CH_2\cdot CO_2Et$ with evolution of nitrogen, did not take place. Further, the substances (*a*) and (*b*) did not yield nitrosoamines with nitrous acid in acetic acid, and therefore could not have the suggested alternative structure.

Prof. D. R. Boyd discussed experiments (with Mr. F. J. Smith) on :—

The formation of triphenylmethylphosphinic acid from triphenylmethoxyphosphorus dichloride.

The acid obtained from triphenylmethoxyphosphorus dichloride by the action of alcoholic potash (Boyd and Chignell, *T.*, 1923, 123, 813) has been investigated further. It is shown to be a phosphinic acid, with the formula $(C_6H_5)_3C\cdot PO(OH)_2$; and not a phosphorus acid ester of triphenyl-carbinol, as originally supposed.

During the hydrolysis of the phosphorus chloride, therefore, a molecular rearrangement must occur, analogous to the change which di-ethyl sulphite undergoes under the influence of aqueous potash :

iii

$$(C_6H_5)_3C\cdot O\cdot PCl_2 + 3KOH + C_2H_5\cdot OH$$

v

$$= (C_6H_5)_3C\cdot P{\overset{\nearrow O}{\underset{\searrow OK}{—}}}OC_2H_5 + 2KCl + 2H_2O$$

iv vi

$$O=S{<}^{OC_2H_5}_{OC_2H_5} + KOH = {}^{O}_{O}{>}S{<}^{C_2H_5}_{OK} + C_2H_5\cdot OH$$

Triphenylmethylphosphinic acid is also obtained, in small quantity, when the mixture of products formed by the action of phosphorus trichloride on triphenyl-carbinol is treated with water.

ACADÉMIE DES SCIENCES

On March 31, Monsieur Termier spoke on the changes undergone by the diamond at high temperatures. These changes, as shown by Friedel, affect the zones of birefringence. Monsieur Bogitch discussed the formation of the solid masses which sometimes clog crucibles, explained by a change of composition affecting the fusibility. According to Monsieur Audibert, explosives decompose in two stages, and the conditions of this decomposition suggest application in "fiery" mines in taking measures to ensure safety. Monsieur Lebeau described an electrical vacuum furnace with a device for measuring temperatures accurately, and consisting of tungsten heated by an electrical current of several hundred ampères, and surrounded by a cover of fused silica bathed in water so as to prevent heating. Monsieur Lebeau, who is an old pupil of Moissan, has obtained, in this way, temperatures up to 2400° C. In a paper by Monsieur E. André it appears that phocenic acid extracted from whale fat, and first isolated by Chevreul, is identical with the valerianic acid derived from the root of valerian.

On April 7, Monsieur L. Gentil discussed the magnetic anomalies observed by Lazarev in the Koursk district of Russia, and stated that these had been found of less intensity to the south of the band previously described. The conclusion drawn, that the anomalies showed the presence of deposits of magnetic iron, had been partly verified by borings. A note by Monsieur A. Mayer on the oxidation of the plant cell in relation to the moisture content of the protoplasm, was communicated by Monsieur Molliard, and Monsieur D'Arsonval communicated a note by MM. Ménard and Foubert, on the curative action of ultra-violet rays on certain diseases. Prof. Le Chatelier then presented a paper by Monsieur Audibert on the decomposition of nitroglycerin and the Abbé Sanderans described a process which he has originated for making mixed organic oxides containing alcohol and benzyl groups.

EVOLUTION IN CHEMICAL INDUSTRY

At University College, Nottingham, on March 29, the third Sir Jesse Boot Foundation Lecture, entitled, Evolution in Chemical Industry -Aniline Dyes," was delivered by Mr. H. Lambourne, B.A., B.Sc., F.I.C., in the absence, through indisposition, of Prof. S. F. Kipping, D.Sc., F.R.S.

The lecturer first dealt briefly with the natural colouring matters, some of which; *e.g.*, Tyrian purple, madder purple and indigo, were of hoary antiquity. The four main products obtained by the distillation of coal tar, namely, benzene, toluene, naphthalene and anthracene were then discussed. Some account of the life and work of the founder of the coal-tar industry—Sir William Perkin—was given, and the rapid development of the industry from 1856. Thus, aniline (from benzene) and toluidines (from toluene) produced the Rosanilines (Verguin 1859); the Azo dyestuffs (Griess, 1860) were obtained from aniline and similar basic substances; the phenols (from benzene) and phthalic anhydride (from naphthalene) gave rise to the Phthaleins (Baeyer, 1871); anthraquinone (from anthracene) was converted into alizarin (Perkin, 1869, Caro, Graebe and Liebermann, 1869); anthranilic acid (from naphthalene) with chloracetic acid gave rise to indigo (Heumann, 1890, 1897).

Numerous experiments were performed, and a number of slides shown, which illustrated the subject as outlined above.

In conclusion, two contributory factors were given as to why Germany had so largely captured this industry which had its origin in England, and its early development in England and France. The first was the co-operation which existed in Germany between industry and the universities and colleges; the second was the fact that all the German industrial concerns were scientifically controlled, and not directed by business men who occasionally perhaps referred to scientific experts.

Reference was also made of newspaper misrepresentation of scientific matters; which prevented the public from understanding and appreciating the importance of chemistry and chemists to national prosperity.

CORRESPONDENCE

INTERNATIONAL LANGUAGE FOR SCIENTISTS

Sir,—As the original remarker, allow me to express first the pleasure I have in Professor Patterson's partial approbation of the idea and, secondly, why I do not agree with his modification.

Unfortunately, I must confess that I am neither a Latin scholar nor an Esperantist, so, on the actual detailed claims of the rivals, I am not qualified to offer an opinion. However, I am quite alive to the historical value of Latin and I am thoroughly aware of what I want for my purpose in industrial science.

There is one instance where Latin escaped the slaughter of the Renaissance—I mean in Medicine. Here, Latin is used in many countries, so it should be a living example of an international language, but, when I was sick, my medical adviser left me a prescription with the directions thereon:—"Coch. Mag. in aq t.i.d. pc." The dispenser had no trouble in labelling the bottle "A tablespoonful in water, three times daily after food," but could a French or German dispenser have done it. I do not think so, besides, is not the historical beauty somewhat faded in the generality of medical Latin?

Again, when I read old Beckman's "History of Invention" or any History of Agriculture, I always find that Latin names were very lax. For example Magnesia, Manganese, Magnet (Fe_3O_4) are all derived from the same source.

Then probably 99 per cent. of the phenomena or "sense impressions" we desire to express have no true Latin equivalent. The words require to be invented and put into the old frame.

My conception is that science requires a new tool, a language capable of expressing any idea with the utmost clarity, and, at the same time, to express or show minute differences—a language, in fact, which will bear the same relation to other languages that the calculus bears to euclidian geometry.

Most of the roots are ready made, and in international use, as, ion, sol, names of elements, plants, bones, stars, etc.: all that is required is a simple extensible framework, wherein irregularities are impossible. This would be an enormous boon to coming generations, and, as we have burned their coal, ruined their physique, and, in general, played the mischief with their inheritance—we do owe posterity something.

The advantages are apparent—scientific books, papers, patent specifications and lectures would be given in one language. There would be no trouble, say, if a Chinese scientist came to Europe. He could lecture in every country and the audience would grasp his finest meanings. The language bar would be exterminated and, with it all, the petty jealousies concomitant therewith.

The one thought is time. It takes an effort to start a thing which will take twenty or more years to be of service, but it often takes three generations to build a business for private gain, so surely we have enough initiative and staying power combined with the organising ability and altruistic sentiment required to carry out a scheme like this, if it is worth

doing. At present, we must admit that "The intelligentsia has failed." Failed dismally in Germany, Russia and France. We are laughed at both by the capitalist and the worker. We are dreamers and visionaries who cannot translate our words into deeds. Scientists ought to lead the world's forces. They ought to direct all progress, but they do not even follow the leaders. They sit still and complain of neglect.

In résumé, I think a new language "made to order" is better for our purpose than Latin, as it is a machine we want, easily learned, quickly written and free from difficult sounds, capable of expressing new conceptions and fine shades of meaning.

I think the scheme would be of great service in the future, as it would have considerable effect on international relations, simplify scientific training, and cause a greater circulation of scientific ideas.

The scheme is altruistic and any effort expended on it would be for the benefit of our successors, rather than for our own good.—I am, Sir, etc.,

CAREY LAW

April 21, 1924

A REPLY TO PROF. PATTERSON'S SUGGESTION TO USE LATIN AS AN INTERNATIONAL LANGUAGE FOR SCIENTIFIC LITERATURE

Sir,—In the preface to his classic on Bridge Construction, Jeremiah Head explains that he calls his work "De Pontibus" because, having reached his 58th year, and having spent the better part of his early life in learning Latin, he feared that he might die without ever being able to make any use ot the study of many years. Now, when I read Professor Patterson's letter suggesting that Latin might be used as the International Language among scientists I, like Jeremiah Head, said to myself, "here is an opportunity of making some use of my early life's work," which, also, was an endeavour to learn Latin. But on looking at the matter more dispassionately, does it not appear that by taking this attitude Prof. Patterson and I would be rather imitating the fox that lost his tail? We, like a good many others, have doubtless wasted the bulk of our youth in learning Latin, and consequently have suffered more or less all our lives through having, perforce, neglected the study of useful subjects; but this is really no excuse for advocating that future generations should be submitted to a similar handicap.

As regards an international language for scientific literature, is it not obvious that any nation can make their language international by making their scientific literature indispensable? Is it not also an extremely humiliating fact that although the greater part of the civilised world, and almost the whole of the scientific world, speaks and writes English, nevertheless it is not possible for a chemist to arrive at the forefront of his profession without an intimate knowledge of German? The reason for this is not far to seek. Plainly, we have no works of reference that can compare with Beilstein[1], Gmelin-Kraut[2], Stelzner[3], and, to a lesser extent, the Zentralblatt; and now that all these works are being perpetuated under the auspices of the German Chemical Society, the pitch of completeness to which they are being brought makes them the most important part of any scientific library.

On reviewing these facts, therefore, does it not appear that English would automatically become the international language for scientific literature, if only the English-speaking nations could bring themselves to produce literature of a standard of perfection and utility equal to that now produced by the Germans?

The problem remains how this could be achieved, but surely our Chemical Society could do what the German Chemical Society has done?

1. Our abstracts are unquestionably very much better than they used to be, and if they could be drafted more with a view to enabling one to work from them without having to refer to the original papers, it would be quite possible without much modification to at least equal those appearing in the Zentralblatt.

2. If these abstracts were accompanied by a really full and exhaustive index (the entries for which should be supplied by the abstractors), it would be quite practicable without much additional work for that index to supply all the information for which we now have to turn to Stelzner in respect of Organic work and for which there is at present no exhaustive record in respect of Inorganic, thus placing us, in this latter respect, ahead of our German compeers.

3. With reference to Friedlander,[4] which deals with Organic patent literature almost entirely, the want for this could, I think, readily be met by modelling the abstracts of patents which appear in this *Journal*, so that they should always contain sufficient of the essence of the patent to enable the operations therein described to be carried out without reference to the original; this, in nearly every case, would be met by the inclusion, in full, of one of the examples described.

4. With regard to a complete text-book giving a summary of the world's knowledge in respect of every Organic compound which has ever been analysed, it is difficult to see how anything other than a translation of Beilstein would meet this case, and the same applies—in a lesser degree—to Gmelin-Kraut for the Inorganic side of the science.

It will doubtless be pleaded that the question of funds is the stumbling-block in such herculean undertakings, but might not this be met by eliminating the over-lapping which at present exists between the English and American Chemical Societies, both of which issue a series of abstracts of the same papers in the same language? If these Societies were to come to some arrangement similar to that which has already been come to between this *Journal* and that of the Chemical Society (London), in respect of pure and applied science whereby we, for the sake of argument, abstracted all the Organic work and the Americans abstracted all the Inorganic, then the saving thus arrived at should enable each Society to issue abstracts and indexes on these two

[1] Beilstein, Handbuch der Organische Chemie.
[2] Gmelin-Kraut, Handbuch der Anorganische Chemie.
[3] Stelzner, Literatur-Register der Organische Chemie.
[4] Friedlander, Fortschritte der Teerfarbenfabrikation.

subjects equal to, if not superior to, anything produced by the German Chemical Society (*i.e.*, the Zentralblatt and Stelzner), whilst with judicious and economical organisation it should be possible to produce an English "Beilstein" by, say, the Chemical Society, London, and an English (American) "Gmelin-Kraut," say, by the American Society.

With literature of this degree of perfection in a language spoken by more than half of the civilised world could there be any question but that English would become the International Scientific Language?

I am, Sir, etc., O. SILBERRAD

Buckhurst Hill, Essex

April 23, 1924

PUBLIC OPINION OF SCIENCE

Sir,—On several occasions recently you have remarked upon the time spent by chemists (and other scientists) in attending committee meetings, and in reading papers to one another, and on their lack of interest in outside affairs; also on the slight recognition accorded to science and to men of science, in the political and commercial worlds, and by the public generally. The one set of circumstances appears to be correlative to the other, on the surface at least.

With your permission I would like to touch upon one aspect only of this question. The majority of the general public gather most of their information and a great part of their opinions from the newspapers. They do not read books, except, perhaps, light fiction. The newspaper editor, therefore, seeks to publish what he believes his readers would like, and to a lesser degree what he would like his readers to believe. Every important newspaper in addition to the ordinary sub-editor has its own "foreign" editor, its "city" editor and its "sports" editor, with special writers on law, literature, drama, motoring, chess and even bridge. But who ever heard of a newspaper having a special writer or contributor on science?

Scientific matters, inventions and discoveries are handed over to the junior reporter apparently to be "written up," and a fine hash he often makes of them If one were to tell one of the bright young men who serve Reuter's or Harmsworth's that Charlie Chaplin had been engaged as full back for Aston Villa, or that Georges Carpentier had entered for the bantam-weight championship he would, not unnaturally, think his informant an escaped lunatic; also, he *might* look askance if he were told that G. B. S. had been "hung," artistically, of course, at the Royal Academy, or that Wells (H. G., not the Bombardier) had written a one act farce. But tell him that Prof. Humperdunck, of Berlin, has discovered how to produce petrol from sea-water, and the glad tidings will be cabled all over the world forthwith. On any question of sport, politics, commerce and so forth, the reporter goes to seek authentic information from what we may call headquarters, but it is not worth while in the case of science, and probably the reporter has no idea where scientific "headquarters" are.

Within the last few months it has been cabled out to South Africa that a German professor (it is always a German or an American who can do these wonders) had found out how to make coal out of paving-stones, and that another G. P. had discovered how to turn blue asbestos into white. Early this year someone calling himself Hendrik van der Walt "spoofed" all the Dutch newspapers in the Transvaal by informing them that the Johannesburg Chamber of Mines had planted *thousands of acres of macaroni* in the Northern Transvaal, and that *the crop was already sprouting*. This tit-bit might have been too steep (as the Americans say) for English newspapers, but one never knows.

The Chamber of Mines has not yet tried to grow macaroni, but it has founded a news bureau, a publicity department, from which reliable information (as reliable that is as the mining magnates see fit) is broadcasted by printed circulars to all the newspapers in the Union, and it is astonishing how many of these journals make use of the ready-made articles thus supplied. They are written in a popular and interesting style, and save a lot of time and trouble to the country editor, who is often leader-writer, reporter, proof-reader and business manager rolled into one. Among all the scientific bodies in Britain, could not some similar bureau of information be organised to disseminate reliable news of scientific progress, and thus serve to educate public opinion and stimulate public interest. Quite a number of private manufacturers issue periodical circulars broadcast (some very attractively got up) for their own selfish ends; the proposed scientific publicity bureau should have far more material to choose from, and its objects would be to a large extent altruistic.

—I am, Sir, etc., E. G. BRYANT

Prieska, South Africa

AN INTERNATIONAL LANGUAGE FOR CHEMISTRY

Sir,—In his article in *Chemistry and Industry*, of April 11, Prof. Patterson has very ably set out the case for Latin as the chemist's international language. He has, however, treated Esperanto more slightingly than it deserves. The problem of an international auxiliary language has been considered by a committee of the British Association, which reported in 1921 that an invented language such as Esperanto gave the most satisfactory solution. It was unanimous in its conclusion that the advantages of Latin were outweighed by its disadvantages. The introduction of Latin would necessitate its supplementation by a considerable number of new words (a glance at the Pharmacopœia is interesting in this connexion), whereas, in Esperanto, a very full vocabulary exists at the present time ready to the hand of the scientist. It was suggested that Latin was relatively difficult to the average man; Esperanto, on the other hand, being so simple that "three weeks of intensive study under a good instructor would enable a class of teachers to master the essentials and acquire a fluency which is seldom gained in French or German after twelve months' study abroad." It appears reasonable to suppose that by use of such a language valuable results might be obtained in

considerably less than the twenty years suggested by Prof. Patterson. Esperanto has received support from such bodies as the League of Nations, the French Académie des Sciences, and various Chambers of Commerce. The International Pharmaceutical Federation is now considering the adoption of Esperanto nomenclature. The utilisation of this language in the service of chemistry seems worthy of serious consideration.—I am, Sir, etc.,

EDGAR C. SMITH

Kettering

QUALIFIED AND UNQUALIFIED CHEMISTS

Sir,—The first paragraph of Mr. Bonsfield's letter may have a certain amount of force in answering the arguments of those who hold no recognised qualifications, but his whole letter ignores one important point. Why should the fact of passing the examination of a society—or in many cases admission without examination—count for more than a university degree. The universities of this country have a record and history behind them beside which the Institute with less than fifty years of life appears very young. Probably it is suffering from the inexperience of youth.

If the Institute intends to make itself the arbiter as to who shall and who shall not be called chemists it must really embrace all who by experience, training and/or position are considered chemists. If it does not, the employers of labour will not recognise the Institute's classification any more than they do now.

I suggest that in addition to the present qualifications the following might be added to meet the cases brought forward in the *Journal* :—

A.I.C. should be conferred upon those

1. Possessing B.Sc. (Pass), provided the applicant has been engaged in industry as a chemist for (say) five years
2. Possessing any degree above B.Sc. if taken in chemistry.
3. Possessing no degree, but having been engaged in industry for (say) ten years and receiving a salary above, say, £400 a year.

A man's value in industrial chemistry is surely his value to his employer, and by fixing a salary limit for unqualified men (which sum need not be published) a satisfactory line of demarcation may be found.

One word more; by insisting on passing B.Sc. with honours in chemistry the Institute proclaims that an industrial chemist should have a knowledge of chemistry and little else. Personally I have found physics and mathematics of more value than chemistry. All industries are not alike. In a case such as dyeing no doubt the Institute is right. It is from my own experience that I have suggested the first of the above new qualifications.

Regarding the suggestion to call ourselves chemors, may I make one? Why not refer to pharmacists as chemists as is done at present and denote ourselves by the more ancient spelling "chymists"?—I am, Sir, etc.,

FUEL TECHNOLOGIST

ATOMIC STRUCTURE

Sir,—I regret that owing to a clerical error in my letter to you in the issue of April 25 the word "not" has crept into the sentence relating to a suggested third quantum number for electron orbits in atoms. The third quantum numbers referred to *are identical.* with Bohr's third quantum numbers, and consequently also identical with Sommerfeld's "ground quantum numbers" derived from consideration of X-ray spectra.—I am, Sir, etc.,

J. D. MAIN SMITH

Chemistry Dept., Birmingham University,
Edgbaston

April 29, 1924

GOVERNMENT SURPLUS STOCKS

Sir,—On the 1st of April considerable publicity was given in the Press to a function which marked the termination of the late Disposal and Liquidation Commission. Since that date references to that event have been made, and it would appear that an erroneous impression has been created in the minds of the public generally, in that they have concluded that the whole of the Government Surplus Stocks have been liquidated.

There is, in fact, a large and valuable stock of machinery etc. remaining for disposal, for the sale of which we were by special contract in June last appointed agents to the Government. Whilst we have already realised a large proportion of that stock, we have yet millions of pounds worth of extremely useful stores of almost every description still to be sold on behalf of the Government.

In the interests of the public it is most desirable that these facts be brought to their notice, since the revenue obtained from the sale of these surplus stores is a contribution to the National Exchequer.—We are, Sir, &c.,

GEORGE COHEN AND ARMSTRONG DISPOSAL CORPORATION
ALFRED W. BENTHILL,
General Manager

2, Victoria Street,
London, S.W. 1
April 17, 1924

L'UNION INTERNATIONALE

Sir,—As members of the Society of Chemical Industry our principal article of Faith is the interchange of scientific and technical knowledge, as is testified by all our activities. Your editorial reference to the harmfulness of nursing our wrath to keep it warm pleases me. In Bernard Shaw's recent play "St. Joan," one of the characters aptly remarks that the courage of Faith will always outlast the courage of Wrath, and I am glad that this truth is borne out in the change in tone of your comments on the question of inviting Germans to the Union Internationale. Dr. Fritsche's letter shows that he, too, is ceasing to nurse his wrath.

The Council of the Society of Chemical Industry has never run the Society on a political basis, but

has served its members by promoting the interchange of scientific knowledge, and in spite of every political upheaval our *Journal* has continued to give equal publicity to all foreign contributions to our science.

Once the question of Reparations is settled there can be no reason except the nursing of our wrath for withholding a frank invitation to our German and Austrian chemical colleagues to take part in the International Conferences.

Most of those who believe in the ultimate triumph of intellect also believe that warfare amongst civilised communities will some day entirely cease. It is clear to them that otherwise civilisation will prove self-destructive, and intellect will fail to dominate.

By promoting common intellectual interest in science we are doing our best to hasten the day of Peace Further, a clear vision of the just history of the cause and conduct of the War is more likely to result from our coming together to discuss intellectual and scientific topics with, than by our remaining aloof from, our German neighbours.—I am, Sir, etc.,

FRANCIS H. CARR

Hampstead
May 6, 1924

A CORRECTION

In the letter on "Legislation in Relation to Chemical Industry," published in the issue of May 2, on p. 466, col. 2, 25th line from the bottom, in place of "(R)" substitute "(Mr. Kenneth Swan)," the remaining references (P) and (R) to be unchanged.

PERSONAL AND OTHER ITEMS

Royal Visit to the Chemical Hall at Wembley

On May 2, their Majesties the King and Queen, accompanied by the Duke and Duchess of York, paid an informal visit to the Exhibition at Wembley. After visiting the Palace of Engineering they made a tour of the Palace of Industry, including the Chemical Hall The Royal Party was received at one of the entrances and conducted through the Hall by the General Manager of The Association of British Chemical Manufacturers. They spent some time in the Scientific Section where the interesting Exhibits by Sir John Russell representing Agriculture, and by Sir Robert Robertson showing Explosives were noted A copy of "Chemistry in the Twentieth Century" caught the attention of the King, who had previously accepted a specially-bound copy for his own library. Some ancient Egyptian dyed fabrics were also displayed and, as a companion exhibit, the original specimen of Mauve, the historic discovery of the late Sir William Perkin. The visitors were also interested in the display of ancient appliances for producing fire before the days of matches, shown in the cottage of Messrs. Bryant and May The crystals shown by Messrs. Peter Spence and Co, also were noticed as well as the puppets on the stand of Messrs. Yardley. Before leaving the King and Queen expressed to Mr. Woolcock their pleasure at what had been shown them.

We are glad to announce that his Royal Highness the Prince of Wales, President of the British Empire Exhibition, has been pleased to accept a copy of "Chemistry in the Twentieth Century," written by some of our most distinguished chemists to mark the opening of the Exhibition.

Applications are invited by the Salters' Institute of Industrial Chemistry for a limited number of Fellowships for post-graduate chemists who are desirous of adopting an industrial career. The Fellowships are of the annual value of £250 and fall vacant in October next. Applications should be received by the Director of the Institute, Salters' Hall, St. Swithin's Lane, London, E.C. 4, on or before June 30, 1924. Forms of application may be had from the Director, Prof. A. Smithells, F.R.S.

The sudden death, on April 17, of Mr. H. J. Bailey, O.B.E., F.I.C., one of H.M. Inspectors of Alkali Works, marks the passing of a prominent figure amongst South Wales chemists. His kindly qualities, conspicuous ability and tremendous enthusiasm had gained him a host of friends in this area, and chemical industry will suffer a very considerable loss on his decease. He was a very active member of the Committee of the South Wales Section of the Society of Chemical Industry. He will also be remembered by many as the writer of the section on Acids and Alkalis in the Reports on the Progress of Applied Chemistry for the last two years. His knowledge of many branches of industry, particularly of the tinplate trade, was very considerable, and his loss at the early age of 44 cannot but be deeply regretted.

The French Photographie Society has awarded its Janssen medal to Dr C. E. K. Mees and its Davanne medal to Mr. W. B. Ferguson for their contributions to the advancement of photography. According to the *British Journal of Photography*, from which the above information is quoted, this is the first time any medals of the French Photographic Society have been awarded to foreigners.

Mr. H. O'Neill, M.Met., has been appointed lecturer in metallurgy in the University of Manchester.

Prof. G. N. Lewis, professor of physical chemistry in the University of California, received the Willard Gibbs medal at the April meeting of the Chicago Section of the American Chemical Society.

R. G. VanName has been appointed associate professor of chemistry in Yale University, Conn.

Prof. Elihu Thomson, of Massachusetts, has accepted an invitation to deliver the 30th James Forest Lecture before the Institution of Civil Engineers; therefore the lecture, originally fixed for May 6, has been postponed until July 8. It is of interest to note that Prof. Thomson has been awarded the triennial Kelvin gold medal, for 1923, and formal presentation of the medal will be made during the Kelvin Centenary celebration in July.

The Appointment of Gas Examiners

In the unavoidable absence of the President of the Board of Trade, Mr. Alexander, Parliamentary Secretary, received a deputation from the Institutes of Chemistry and Physics at the Board of Trade

on May 1 in connexion with the qualifications of gas examiners appointed by local authorities for the purpose of protecting the interests of the public users of gas supplies. The deputation, introduced by Major Church, Parliamentary Private Secretary, consisted of Sir R. Gregory, Sir H. Jackson, Sir C. Parsons, Mr. E. M. Hawkins, Mr. G. Nevill Huntly, Prof. Eccles and the officers of the Institutes of Chemistry and Physics.

Sir Richard Gregory stated that the Gas Regulations Act, 1920, required the price of gas to bear a definite relation to the quality, and not only to the quantity of gas purchased; for this purpose the Act required the appointment of a competent and impartial person to be a gas examiner. It was necessary to emphasise the importance of defining the phrase "competent and impartial person," as the section of the Act which relates to the powers of the gas referees did not require them to define competency, and there was no reference in any part of the Act to such a definition. The result was that the practice of local authorities with regard to the appointment of gas examiners varied considerably. As a rule the authorities in the Metropolitan area and of large provincial cities secured for their gas examiners highly competent persons; but small local authorities, particularly in rural areas, regarded with some disfavour expenditure on this kind of service; the protection to the public from small local gas companies, often not too efficiently directed, was correspondingly reduced. He claimed that the gas examiner should be a person of similar standing to a public analyst, over whose appointment the Ministry of Health could exercise a veto, and suggested that the Board of Trade should secure this right under statutory powers. In his opinion, the higher the standing of the gas examiner and the stronger the corporate body to which he belonged, the more adequately were the public safeguarded.

Sir Herbert Jackson pointed out that the chief concern of the Institute of Chemistry, the Institute of Physics and similar professional bodies in matters of this kind was to safeguard the interests of the public. Properly qualified professional men had behind them the traditions and status of their institutions and were sensible of the grave responsibilities of their duties, and answerable to their professional institutions for their conduct.

Interesting examples were given by Mr. Hawkins and Mr. Huntly of the manner in which incompetent gas examiners might fail to detect irregularities by which the public might suffer loss.

Sir Charles Parsons pointed out that there were no simple fool-proof instruments for gas examination like those for the measurement of electrical units. Not until he was associated with Sir George Beilby at the Fuel Research Board did he realise how difficult was the task of carrying out the test with gas calorimeters; and it was only recently that he had been made acquainted with the fact that in some places incompetent people were being employed as gas examiners. Like the other speakers, he insisted that gas examiners should be persons of high professional qualifications and standing.

Mr. Marlow, Assistant Secretary of the Institute of Chemistry, in summing up, said that the case of the Institutes was that the word "competence" in the Act required definition. The point would be met if the Board secured the necessary statutory powers to issue orders defining "competence."

In reply Mr. Alexander said that the Board were most anxious to protect the public and that the representations of the deputation would receive the most careful consideration of the President and the officers of the Board. The changes in the method of appointment of gas examiners suggested by the deputation indicated the necessity for statutory powers being granted by Parliament. He was certainly not in the position to promise legislation this Session, as there were many important and overdue Bills on the stocks. He pointed out also that the Board must work in harmony with the local authorities, and that in the event of legislation being contemplated the local authorities would have to be consulted.

The deputation thanked Mr. Alexander for their reception.

International Congress of Refrigeration

So close is the mutual relationship of biochemistry and refrigeration that the fourth International Congress of Refrigeration, which is to be held in London from June 16 to 21, under the presidency of Sir Gordon H. Campbell, K.B.E., will discuss a number of specially contributed papers on the various phases of this subject.

The features of this Congress comprise a considerable number of trips, free to members, to refrigerating establishments and other sights, such as the National Physical Laboratory at Teddington, the Port of London Docks, Bristol, Southampton, Liverpool and Manchester, to which the railway companies are granting a free Congress trip, whilst the leading shipping companies are entertaining the members on vessels in dock. A large volume of Congress Proceedings will be supplied afterwards to members.

Particulars relating to membership may be obtained on application to Mr. J. Raymond, Hon Secretary General, Fourth International Congress of Refrigeration, Weavers' Hall, 22, Basinghall Street, London, E.C. 2.

BRITISH INDIA

Winter Oilseeds Crops, 1923-1924

According to the second forecast based on reports received from provinces which contain 98·7 per cent of the total area under rape and mustard, and 99·1 per cent. of the total linseed area of British India, the total area under rape and mustard is estimated at 3,496,000 acres. This is 5 per cent. below the area reported at the corresponding date of last year The total area under linseed is reported to be 2,761,000 acres, which is 10 per cent. above the area reported last year at the same period. The condition of the crops is, on the whole, reported to be fair.

FRANCE

Coke Ovens

In a recent communication to the Société des Ingenieurs Civils, Prof. Berthelot considered modern rules for the exploitation of coke ovens, discussing modern practice with regard to the dimensions of the ovens, the choice of the quality of gas for heating, the selection of refractory products, and concluded with an account of recent methods for quenching and handling metallurgical coke. It was suggested that the width of coke ovens should be reduced to roughly 40 cm. to make them more suitable for producing metallurgical coke of the best quality and to increase their carbonising power, and the height should be reduced to 3·5 m. provided devices were used to reduce as much as possible the rapidity with which the heating gas was burnt. Similarly the length of the ovens should be increased as much as possible up to 12 or 13 m., and modern methods for heating and handling, such as those of Piette or Coppée, should be used as far as circumstances permitted.

CANADA

Forest Research in Quebec

A sum of 25,000 dollars has been set aside by the Canadian Government for the furtherance of a scheme to establish a bureau of forest research in various parts of the province of Quebec. A paper school at Quebec, and one of the Government nurseries will probably be established, where methods of encouraging the growth of trees by both natural and artificial methods will be studied during the present season.

UNITED STATES

World Output of Camphor

The world's output of camphor increased from 7,000,000 to 10,000,000 lb. during the first decade of the century, and in 1916 reached a record of over 17,000,000 lb., declining, however, to 10,000,000 lb. in 1918. The bulk of the world's supply has been from Formosa, which in 1917 exported nearly 10,500,000 lb., but since then the annual falling off in shipments of Formosan camphor has received very serious consideration in England, and new sources of supply are being sought within the British Empire. In 1921, less than 1,000,000 kin of camphor was exported from Formosa, of which Japan received by far the largest quantity. Synthetic camphor as a commercial product has attracted considerable attention of late years, and not only Germany, which has been manufacturing it on a profitable basis for some time, but Japan and America are now engaged in the industry. China is now an important source of supply of camphor, and there are large untouched areas of camphor trees in the Provinces of Kwangsi, Kiangsi, Kwangtung and Yunnan, and the island of Hainan. Exports of camphor from China totalled nearly 2,250,000 lb. in 1921, but in 1922 decreased to 1,500,000 lb., doubtless owing to disturbed conditions in South China.

REVIEWS

LUNGE AND KEANE'S TECHNICAL METHODS OF CHEMICAL ANALYSIS. Edited by C. A. KEANE and P. C. L. THORNE. Volume I. Second Edition. Pp. xx+704. London: Gurney and Jackson, 1924. Price 63s. net.

All chemists concerned with technical analysis are sure to welcome the second edition of this standard treatise, the first volume of which has now left the press. Whereas Volume I of the first edition was issued in two separate parts, the text-matter of the new edition has been slightly re-arranged, and the volumes will be simply numbered One to Six, a simplification which will appeal to all users. The book under review contains the text-matter of the former Volume I up to and including Cyanogen Compounds, but excluding Potassium Salts, which will be treated in Volume II. Two new sections have been added, the one on Electrolytic Methods, by Dr. H. J. S. Sand, the other on Physical Measurements in Technical Analysis, by Dr. J. S. G. Thomas. The remainder of the old Volume I will make up the future Volume II. With the exception of Dr. Keane (who again treats of General Methods of Technical Analysis and Gas Analysis), the contributors to the present work do not include any of the original authors. Mr. G. Nevill Huntly has revised the section on Fuel Analysis, Dr. J. T. Dunn those on Sulphuric, Nitric, and Hydrochloric Acids, Sodium Carbonate, and the Chlorine Industry, whilst Mr. H. E. Williams is responsible for the article on Cyanogen Compounds.

To review the whole of this authoritative treatise within the brief space allotted to the writer is naturally impossible. It is likewise unnecessary to say that the fame of the first English edition, like that of the German original, has long since been firmly established; the names of the present editors and their collaborators convey an assurance that the book will fully maintain its reputation for general excellence and comprehensiveness.

In the chapter dealing with the analysis of pyrites, the writer would have expected to find a reference to the newer methods for the volumetric estimation of arsenic, though, of course, the arsenic assay in ores will be treated more exhaustively in Volume II. Most of the methods described advocate precipitation of the arsenic as silver arsenate, which is either weighed or titrated. The following considerations induced the writer some years since to abandon this form of estimation. When a mineral mixture is fused with alkaline oxidising fluxes, almost any acid-forming element present may find its way into the aqueous extract of the melt. Further, the property of forming an insoluble silver salt is shared by a large number of acids. Unless, therefore, interfering elements are known to be absent (and this premises a qualitative analysis), the silver arsenate may be more or less impure and the results correspondingly high, whether the precipitate is weighed or the silver contained therein titrated after Volhard. Also, silver phosphate and arsenate are known to occlude small quantities of silver nitrates which cannot be removed by washing. A reliable arsenic

estimation should be based on a specific arsenic reaction, such as precipitation of the sulphide in strongly acid solution or the reduction of arsenic acid by iodide and hydrochloric acid. If this is not done, it is hardly surprising that the various methods should "unfortunately lead to widely differing results" (p. 376). The writer remembers an important reference assay in which he found an arsenic content of 0·39 per cent. against 0·57 per cent. by Pearce's method; the latter figure almost duplicated the disputed result. In the reviewer's opinion, the efforts of technical chemists should be directed towards the abandonment of Pearce's method.

A minor question of English terminology arises in the simultaneous use of the two expressions "iodometric" (pp. 51, 602) and "iodimetric" (pp. 65, 67). The former is used in German, whilst the latter appears to be the commoner English term.

W. R. Schoeller.

Fats: Natural and Synthetic. By W. W. Myddleton and T. H. Barry. Pp. xi+182. London: E. Benn, Ltd., 1924. Price, 25s. net.

A publisher once remarked to the reviewer that he regarded the preface of a book as of as much importance from his point of view as the book itself. The reviewer, he cynically remarked, always goes to the preface for his information and frequently does not get any further. Although a preface is seldom so useful as this, it is frequently of some help to the reviewer, for it generally indicates the scope of the book. In this instance the preface suggests that the book is intended for students, and it is from this standpoint, therefore, that it should be mainly considered.

This rather tends to disarm the criticism that the title seems to promise more than the book supplies, and that, in the main, it gives an account of the work of other chemists rather than the development of theoretical knowledge based on the authors' original work.

Much of the book is occupied with summaries of hydrogenation processes and accounts of hydrogenated fats, whilst only five pages are given to the true synthetic fats. This is to be regretted, for, whereas hydrogenated oils are dealt with in several excellent books, there is room for one giving an outline of the various methods of synthesising fats from glycerol and fatty acids.

The subject matter is divided into twelve chapters, which include a brief account of the nature of oils and fats, a somewhat detailed description of the methods of examining fatty acids, a useful and up-to-date summary of processes of extraction, a section on fat-splitting, and an account of the development of catalytic methods of hydrogenation, in which the differences between the ordinary processes and that of the Technical Research Works are clearly shown. This, by the way, is interesting to the technologist, but hardly suitable for students. The physical and chemical examination of hydrogenated fats is dealt with at some length, and results obtained by the authors are described. Then come three chapters on the uses of hydrogenated fats, including one on soaps, which is the best in the book; and finally there is the too brief account of true synthetic fats.

Much valuable information has been brought together in an attractive setting, and it is useful to have it in a form convenient for reference. Regarded as a whole, however, the work strikes one as somewhat disjointed, and the facts as presented will not be readily assimilated, especially by students.

C. Ainsworth Mitchell.

The Modern Soap and Detergent Industry including Glycerol Manufacture. By G. Martin, D.Sc., Ph.D. Vol. I. Theory and Practice of Soap Making. Pp. xii+384. London: Crosby Lockwood and Son, 1924. Price 36s.

This volume deals with the raw materials, both organic and inorganic, used in the soap industries, together with soap-boiling and the manufacture of household and laundry soaps. It includes also a section dealing with the essential oils used in the soap trade and also one dealing with the nature of soap and detergent action.

The arrangement of the sections is useful and convenient. The section which deals with the nature of soap and detergent action is to be noted for its very complete list of references to the literature dealing with the constitution and physical properties of soaps. This list is very extensive and covers the whole field of soap research from a theoretical point of view. It is evident that in this section the author is on his most familiar ground and if later sections dealing with the practical side of the soap industry had been written with the same amount of knowledge the book would be a most useful one. As it is, however, the practical section of the book is inferior to the theoretical and appears to have been compiled by the abstraction of various books and literature of a "practical" nature rather than to have been written by one who has had an extensive practical experience of soap-making under modern conditions. The practical sections are thus a curiously uneven mixture of modern processes and machinery and out of date or impractical methods of working. This would render it somewhat difficult for an inexperienced person to obtain a sound basis of practical knowledge from the sections of the book devoted to soap manufacture. On the whole, however, the book is one which can be read with interest.

F. G. Reynolds.

Chemical Encyclopædia. By C. T. Kingzett. Third edition, revised and enlarged. Pp. x+606. London: Baillière, Tindall and Cox, 1924. Price 30s.

The call for a third edition of this work of reference in the few years since its publication and its enlargement from 539 to 606 pages, as well as the provision of a larger page and better paper, show that it fills a need. Improvements have been made in each edition and much new information is now provided. Accuracy has been consistently sought for, and it is for this reason that the title of the work has been changed from that of the "Popular Chemical

Dictionary" to the present one. A wide range is covered, including minerals, proprietary products, apparatus, theoretical definitions, as well as chemicals of many kinds. It is evident that there is a public demand for information on the many chemical materials and subjects that are becoming more and more a feature of every-day life, and such information is supplied in abundance by the "Chemical Encyclopædia." The book is well presented in every way.

Aide-Mémoire pour L'Industrie du Caoutchouc et des Matières Plastiques. *By* A.-D. Luttringer. Pp. 225. Paris: A.-D. Cillard, 1923.

This book is designed to serve as a compendium of useful information for the rubber and allied industries, and the author states that it is the first of a series of monographs relating to various branches of these industries, which are to be published in conjunction with specialists.

The first chapter is a collection of mathematical tables, weights and measures, conversion tables and physical constants, whilst Chapter II consists of tables of formulæ and physical properties of inorganic and organic compounds. These tables cover the first 100 pages, and contain little information that cannot be found in the *Chemists' Year Book, Bayley's Chemists' Pocket Book*, or any similar work.

Chapter III is a useful dictionary of technical products and terms and trade names, though certain deficiencies may be pointed out. A number of the accelerator trade names, with which the list is replete, is qualified simply by the word "accelerator," and some notable omissions are "Catalpo," "Excellerex" and "Titanium White."

Chapter IV contains a miscellaneous collection of data referring to latex, raw rubber and fillers, and of these the table of densities of compounding ingredients, reprinted from Tuttle's "Analysis of Rubber," is probably the most useful. Its utility would, however, have been greatly enhanced if other physical properties such as refractive index and size of particle were included where possible. Again certain omissions are noted, *e.g.*, "Timonox" and "Titanium White."

Chapter V is devoted to the mechanical testing of rubber and fabrics, and deals almost exclusively with the Breuil dynamometer and elasto-durometer, whilst Chapter VI, on the chemical analysis of rubber and the principal compounding ingredients, is taken from the standard works of Pontio, Caspari and Tuttle.

A brief chapter follows containing statistics of rubber production and distribution, with a concluding chapter on the analysis and testing of a variety of plastic materials including cotton, camphor, nitrocellulose, celluloid, cellulose acetate and photographic films.

The author succeeds in presenting a large amount of material in a condensed form, though most of the useful matter is to be found in other books which are probably available to all who may be interested in the subject.

R. N. Johnson

Handbuch der biologischen Arbeitsmethoden. Lieferung 117: Die Blattfarbstoffe. By Richard Willstätter. Pp. 70. Berlin: Urban und Schwarzenberg. Price 3.40 Swiss francs.

Any volume on plant pigments with which the name of Prof. R. Willstätter is associated is certain to be worthy of the closest attention, for the isolation and investigation of chlorophyll and the carotinoid pigments, carotin and xanthophyll, are very largely due to the remarkable series of investigations which he and his collaborators have carried out. The main results of these extended researches have already been published in two volumes ("Untersuchungen über Chlorophyll" and "Untersuchungen über die Assimilation der Kohlensäure," R. Willstätter and A. Stoll), in which the whole subject is given the very fullest treatment both from the theoretical and experimental points of view. The present volume, which consists of a most lucidly constructed *précis* of these, will undoubtedly be of the greatest value to all workers in the border-line field of botany and chemistry. Full details of the process employed for the extraction and separation of the leaf pigments from one another are given, as also the methods adopted for the quantitative estimation of each. The question of the so-called crystalline chlorophyll is discussed, and exact details for the preparation of both ethyl and methyl chlorophyllid fully described. In addition, the isolation of a number of the more important chlorophyll decomposition products, such as phæophytin, phytochlorin "e," phytorhodin "g" and the unsaturated alcohol, phytol, are dealt with in such a manner as to render their preparation easy to the careful manipulator.

Although, as already stated, there is nothing essentially new in the present volume, the clear and concise manner in which an undoubtedly difficult subject is handled is bound to ensure its welcome reception by all active workers in this field of chemistry.

I. M. Heilbron

Organische Chemie. By Prof. R. Pummerer. Wissenschaftliche Forschungsberichte, Naturwissenschaftliche Reihe, edited by Dr. E. Liesegang. Vol. III. Second Edition, revised and enlarged. Pp. xii+210. Dresden and Leipzig: Theodor Steinkopff, 1923. Price, paper, 4s.

The first edition of this useful summary of the outstanding researches published since 1914 covered the work done up to the end of 1920 (*cf. J.*, 1922, 165 R.). In the new edition the treatment of the various subjects is brought up to date by the inclusion of work done in 1921 and 1922. There is every sign of a thorough revision: new paragraphs and footnotes have been added and others rewritten; the subject index has been condensed, but shows about 5 per cent. of new references, and the name index has grown by nearly one-half, the whole book showing an increase of 27 pages. The interest of the discussion is well maintained, and the revision has added to the value of the book for advanced workers in organic chemistry.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Safeguarding of Industries Act

In a written reply addressed to Mr. A. Williams. Mr. Snowden stated that the net revenue collected from the duties imposed under the Safeguarding of Industries Act, 1921, during each of the financial years 1921-22, 1922-23, 1923-24 was: £140,299, £567,097, and £587,000 respectively. For 1922-23 and 1923-24 the figures given relate to Great Britain and Northern Ireland only. The net amounts of duty collected in Great Britain and Northern Ireland to March 31, 1924, under the orders made under Part II. of the Safeguarding of Industries Act, are as follows: Under the Safeguarding of Industries (No. 1) Order, 1922, of August 8, 1922—£429,001; under the Safeguarding of Industries (No. 2) Order, 1922, of October 9, 1922—£50,436, the total being £479,437.—(Apr. 15.)

Soda Concession, Kenya

In a written answer, Mr. Thomas informed Mr. Ormsby-Gore that a scheme for the reconstruction of the Magadi Soda Co. was prepared during 1923, approved by the liquidator, and the Kenya Government, and circulated to the shareholders in January last. Messrs. Brunner Mond then came forward with an alternative scheme which the liquidator and the Kenya Government were prepared to accept, but after careful consideration it was decided that the first scheme should stand, as it offered better prospects of maximum production from Lake Magadi. In view of the recent order for compulsory liquidation negotiations on the whole question had been reopened.—(Apr. 29).

Nauru Phosphates

Replying to various enquiries, Mr. Thomas stated that the output of phosphate from Nauru and Ocean Island was 1,253,280 tons, distributed as follows:—United Kingdom, 32,300 t.; Australia, 794,570 t.; New Zealand, 126,800 t.; and to other countries, 299,610 t. The last shipment to the United Kingdom was made on November 11, 1921, the main factor in determining the amount shipped being the price. The f.o.b. price of Nauru and Ocean Island phosphate was now probably about 15s. a ton below that at which the last cargo was shipped to the United Kingdom. The present approximate c.i.f. price in the United Kingdom was about 42s. below that of the last shipment, which was 3s. above the pre-war price. The amount of interest on capital and sinking fund charges paid annually by the Nauru and Ocean Island undertakings to the owning Governments was £224,053, representing, up to December 31, 1923, a charge of about 12s. 6d. per ton. No guarantee could be given with regard to future readjustments between the three Governments concerned under Article 14 of the Nauru Island Agreement.—(May 5)

Dr. R. C. Wallace, professor of geology in the University of Manitoba, has been elected president of the Canadian Institute of Mining and Metallurgy.

COMPANY NEWS

CASTNER-KELLNER ALKALI CO., LTD.

It is proposed to distribute an interim dividend of 8 per cent. (actual) for the six months ended March 31. The same dividend was distributed last year.

BRUNNER, MOND & CO., LTD.

A dividend on the ordinary shares for the half-year ended March 31 is to be paid of 14 per cent. per annum, making 10½ per cent. for the whole year, less tax (against 11 per cent. in the previous year). A sum of £150,000 (£225,000) has been carried to suspense account, £88,000 (£62,215) to general reserve, and £86,000 (£91,911) is carried forward.

BRITISH CYANIDES CO., LTD.

The directors of the British Cyanides Company have issued a statement regarding the present position of the company. It is stated that since the last circular was issued, in December last, prices have fallen still further. At the same time, the fertiliser trade in America has suffered a complete upheaval, with the result that that source of income is temporarily suspended.

As a consequence of these trade conditions, the company has for the past few months been working at a loss, the standing charges being too heavy. The first unit of plant for the fixation of atmospheric nitrogen disclosed certain defects in course of working, and in the meantime a second unit had been erected. Both have now been closed down and a new furnace is being erected.

Recently an order has been made by the Court, on the petition of the Government, for the liquidation of the British Potash Co. It is not known at present what sum will be realised for the assets, and it will be necessary to deal with this position in the company's balance-sheet.

Sir Arthur Duckham has resigned from the board.

During the past few months a new chemical product for use in the motor tyre and other rubber industries has been manufactured at the works, and profitable business is anticipated.

ASSOCIATED PORTLAND CEMENT MANUFACTURERS, LTD.

The report states that although the demand for Portland cement in 1923 improved in the home and export markets, lower prices were realised. The company's export trade, which represented nearly 40 per cent. of its aggregate deliveries, was carried on at little or no profit, owing to the severe competition of Continental manufacturers, helped by the depreciation of their respective currencies. These factors resulted in a reduction of the profits earned, which at £582,328, including revenue from investments, compare with £675,396 in 1922. These results are obtained after setting aside the sum required to meet the estimated liability for taxation. After making provision for the interest and sinking funds on the Debenture Stock Issues, and for the

dividend for the year on the Preference shares, and after placing £125,000 to general depreciation reserve together with £15,000 to barge depreciation, there remains no balance available for the payment of a dividend on the Ordinary shares without encroaching on the balance brought forward from the previous year, which is not considered advisable in view of the general conditions of trade.

REPORT

Report on the Economic and Financial Conditions in Belgium and Luxemburg, December, 1923. By J. Picton Bagge, Commercial Secretary, Brussels. Department of Overseas Trade. Pp. 112. H.M. Stationery Office, 1924. Price 3s.

The improvement in the industrial activity of Belgium which became noticeable in 1922 was continued in 1923 (*cf. Chem. and Ind.*, 1923, 545), though it is generally recognised that with a return to normal exchange conditions the period of prosperity must cease.

In the first nine months of 1923 imports into Belgium (including Luxemburg) were valued at 9016 million francs, and exports at 6099 million fr. The country has large metallurgical industries, and as a result of the recent stoppage of German supplies attention has been drawn to the need of producing blast-furnace coke at home. The Campine coal basin, which furnishes a suitable coal, has therefore been developed, and in 1923 about 800,000 tons were obtained from this source. In general, coal production in the country made good progress in 1923, and the average monthly production is now about the same as before the war, 1,900,000 t. The metallurgical industries had a fairly good year. The average number of blast furnaces in operation was 37, with a total monthly output of 150,000 t. each of pig-iron and crude steel. The zinc industry has been very active and in the first nine months of 1923 57,000 t. of unrefined metal was exported; sheet zinc valued at 103 million fr., and zinc oxide valued at 40 mill. fr., were also exported in the same period. Imports included 418,244 t. of zinc ore, 22,084 t. of copper ore, 123,836 t. of manganese ore, and 24,118 t. of lead ore. Great Britain supplied only a small proportion of the metals imported.

Textiles enjoyed a prosperous year, the activity in the silk industry being phenomenal. The glass industry has also been prosperous, exports in the first ten months of 1923 being 50,900 t. The situation in the chemical industry is good. The demand for sulphuric acid has been greater than production, though hydrochloric acid has been over-produced. Superphosphates and Thomas slag were in demand in the spring, but stocks have been accumulating for this year. The soap industry has been prosperous in spite of strong competition at one period. Cement was in demand throughout the year for reconstruction purposes, and, later in the year, for export to Japan. The production of 275,000 t. of sugar estimated for the year will leave a good margin for export after after home demands have been met.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech. ..	£24 per ton. Fair inquiry.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5⅜d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76% ..	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton carr. paid.
Sod. Bichromate.. ..	4¼d. per lb.
Sod. Bisulphite Powder 60/62%..	£18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5⅜d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide ..	3s. 9d. per lb.

Carbon Bisulphide .. £24—£26 per ton according to quantity.
Carbon Black .. .. 6¼d.—6¾d. per lb. Market firmer. There is a possibility of legislation to control the amount of natural gas used in production of American black. This may mean higher prices, and manufacturers are not anxious to accept orders.
Carbon Tetrachloride .. £56 per ton, drums free.
Chromium Oxide, green .. 1s. 3d. per lb.
Indiarubber Substitutes, White and Dark: 4¾d.—6¼d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black .. .. 43s. 6d. per cwt., barrels free.
Lead Hyposulphite .. 7½d. per lb.
Lithopone, 30% .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. .. £15 10s. per ton f.o.r. London.
Sulphur .. .. .. £10—£12 per ton, according to quality.
Sulphur Chloride .. 3d. per lb., carboys extra.
Thiocarbanilide .. .. 2s. 9d. per lb.
Vermilion, pale or deep .. 5s. 1d. per lb. Much dearer, following rise in quicksilver.
Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—
Brown .. .. .. £14 10s. per ton d/d. Demand active.
Grey .. .. .. £19—£20 per ton.
Liquor .. .. .. 9d. per gall. 32° Tw.
Charcoal .. .. .. £7 5s.—£9 per ton, according to grade and locality. Market steady.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. „ „ 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 7d. per gall. Unrefined.
Wood Naphtha—
Miscible .. .. 6s.—5s. 3d. per gall. 60% O.P. market stiffer.
Solvent .. .. 5s. 6d.—6s. per gall. 40% O.P. Fairly good demand but little offering.
Wood Tar .. .. £5 per ton.
Brown Sugar of Lead .. £49 per ton.

TAR PRODUCTS

Acid Carbolic—
Crystals .. .. 7½d. per lb. Only limited inquiry.
Crude 60's .. .. 1s. 10d.—2s. per gall. Market rather flat.
Acid Cresylic, 97/99 .. 1s. 11d.—2s. 1d. per gall. Demand still good. Market firm.
Pale 95% .. .. 1s. 10d.—2s. per gall. Steady demand.
Dark .. .. .. 1s. 7d.—1s. 10d. per gall. Steady business.
Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—
Strained .. .. 10d.—11d. per gall. Very quiet.
Unstrained .. .. 8½d.—9d. per gall.
Benzole—
Crude 65's .. .. 10½d.—1s. per gall. ex works in tank wagons.
Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.

Toluole—90% .. .. 1s. 4½d.—1s. 7d. per gall.
Pure .. .. 1s. 10d.—1s. 11d. per gall.
Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 9¾d. per gall. Few inquiries.
Middle Oil / Heavy / Standard Specification: 7½d.—9d. per gall. according to grade and district. Market a shade firmer. Fair business.
Naphtha—
Crude .. .. .. 8d.—9d. per gall.
Solvent 90/160 .. 1s. 5d.—1s. 7d.
Solvent 90/190 .. 1s. 2d.—1s. 3d.
(Better demand. Prices firm.)
*Naphthalene Crude—
Drained Creosote Salts £6—£7 10s. Demand not so good.
Whizzed or hot pressed £9—£12 per ton. Not much inquiry.
Naphthalene—
Crystals and Flaked .. £17—£18 per ton.
Pitch, medium soft .. 52s. 6d.—57s. 6d. per ton. Market steadier. Few inquiries for forward delivery.
Pyridine—90/140 .. 22s.—24s. per gall. Demand well maintained.
Heavy .. 11s.—12s. Occasional inquiries: little business.

INTERMEDIATES AND DYES

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. .. 4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 3d. per lb. Steady demand.
Acid Sulphanilic .. 10d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 7¾d.—8½d. per lb. naked at works.
Aniline Salts .. .. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 3d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 19/31° C. .. 4¾d.—5½d. per lb. Demand moderate.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethyaniline .. .. 2s. 5d per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d.
Dinitrotoluene—48/50°C. 8d.—9d. per lb. naked at works.
66/68°C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 3s. 1d. per lb. d/d.
Monochlorbenzol .. .. £63 per ton.
β Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. 1s. 4½d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 5s. 3d. per lb. d/d.
p-Nitraniline .. .. 2s. 4d. per lb. d/d.
Nitrobenzene .. .. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol .. 2s. per lb. 100% basis d/d.
Nitronaphthalene .. 11¾d. per lb. d/d.
p-Nitrophenol .. .. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol 4s. 6d. per lb. 100% basis.
m-Phenylene Diamine .. 4s. 2d. per lb. d/d.

p-Phenylene Diamine	10s. 4d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 6d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 6d. per lb. naked at works.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£49 per ton.
Acid, Acetyl Salicylic	3s. 4d.—3s. 6d. per lb. Steady.
Acid, Benzoic B.P.	3s. 3d.—4s. per lb. Larger supplies available.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal. Market very steady.
Acid, Pyrogallic, Cryst.	6s. per lb., for 28 lb. lots.
Acid, Salicylic	Prices quoted from 2s. 2d. per lb. down to 1s. 9d. for ton lots. Market rather quiet.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 3d. per lb. for quantity. Very dull market.
Amidopyrin	13s. 6d. per lb. Neglected.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. 6d. per lb. Weak market.
Benzonaphthol	6s. per lb. Small inquiry.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Market firm. Continental prices advancing.
Potassium	9d.—10½d. per lb.
Sodium	9d.—10½d. „
Ammonium	10½d.—1s. „
Calcium Lactate	Demand not very active. Good English make can be had from 1s. 7d. to 2s. per lb.
Chloral Hydrate	3s. 9d. per lb.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Guaiacol Carbonate	11s. 6d. per lb. for cwt. lots. Supplies not plentiful.
Hexamine	3s. 9d. per lb. for foreign makes. Without much inquiry. Large stocks.
Homatropine Hydrobromide	30s. per oz.
Hydroquinone	4s. 9d. per lb. Foreign make.
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	70s. per lb.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Market rather flat, but prices unchanged.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. „
White precip.	4s. 7d.—4s. 8d. „
Calomel	3s. 11d.—4s. „
Methyl Salicylate	2s. 3d.—2s. 9d. per lb. for carboys. A slightly better market.
Methyl Sulphonal	24s. per lb. neglected.
Paraformaldehyde	3s. 6d. per lb., without much inquiry.
Paraldehyde	1s. 4d.—1s. 6d. per lb. in free bottles and cases. Better demand.
Phenacetin	6s. 3d.—6s. 6d. per lb. Shows slight improvement.
Phenazone	7s. 6d. per lb. for cwt. lots.
Phenolphthalein	6s. 9d.—7s. 3d. per lb. In more plentiful supply.
Potass. Bitartrate— 99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate—	
B.P. Crystal	8¾d.—9d. per lb. carriage paid. English make.
Commercial	8d.—8½d. per lb. carriage paid. English make.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 6d. per lb.
Salol	4s. per lb. Very quiet.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	3s.—3s. 3d. per lb. In more plentiful supply.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite— Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet
Sod. Salicylate	Market improved with good deal of inquiry. Powder 2s. 4d.—2s. 6d. per lb. Crystal at 2s. 6d.—2s. 8d. per lb. Flake 2s. 9d.—3s. 4d. per lb.

Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	.. 16s.—18s. per
Tartar Emetic ..	.. 1s. 4d. per lb.
Thymol	.. 13s. 6d.—15s. 9d. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.
Aubepine	.. 13s. 6d. ,,
Amyl Acetate ..	.. 2s. 9d. ,,
Amyl Butyrate ..	.. 7s. 3d. ,,
Amyl Salicylate ..	.. 3s. 3d. ,,
Anethol (M.P. 21/22° C.)	4s. 6d. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. ,,
Benzyl Alcohol free from Chlorine ..	.. 3s. 3d. ,,
Benzaldehyde free from Chlorine ..	.. 3s. 6d. ,,
Benzyl Benzoate	.. 3s. 6d. ,,
Cinnamic Aldehyde Natural.. ..	.. 15s. 6d. ,,
Coumarin ..	.. 20s. ,,
Citronellol ..	.. 16s. ,,
Citral	.. 10s. ,,
Ethyl Cinnamate	.. 15s. ,,
Ethyl Phthalate ..	.. 3s. 9d. ,,
Eugenol	.. 11s. ,,
Geraniol (Palmarosa)	.. 35s. ,,
Geraniol	.. 11s.—18s. 6d. per lb.
Heliotropine ..	.. 7s. 9d. per lb.
Iso Eugenol ..	.. 15s. 9d. ,,
Linalol ex Bois de Rose..	32s. 6d. ,,
Linalyl Acetate ..	.. 32s. 6d. ,,
Methyl Anthranilate	.. 9s. 6d. ,,
Methyl Benzoate	.. 6s. ,,
Musk Ambrette ..	.. 52s. 6d. ,,
Musk Xylol ..	.. 18s. ,,
Nerolin	.. 4s. ,,
Phenyl Ethyl Acetate	.. 12s. 6d. ,,
Phenyl Ethyl Alcohol	.. 16s. ,,
Rhodinol	.. 57s. 6d. ,,
Safrol	.. 1s. 10d. ,,
Terpineol	.. 2s. 9d. ,,
Vanillin	.. 25s. 3d.—26s. 6d. per lb

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 15s. 6d. per lb.
Anise Oil	.. 3s. per lb.
Bergamot Oil ..	.. 18s. 6d. per lb.
Bourbon Geranium Oil	.. 35s. ,,
Camphor Oil ..	.. 75s. per cwt.
Cananga Oil, Java	.. 10s. 6d. per lb.
Cinnamon Oil, Leaf	.. 6½d. per oz.
Cassia Oil, 80/85%	.. 9s. 3d. per lb.
Citronella Oil—	
Java 85/90% ..	.. 5s. 3d. per lb.
Ceylon	.. 3s. 9d. ,,
Clove Oil	.. 8s. 3d. ,,
Eucalyptus Oil 70/75%	. 2s. 2d. ,,
Lavender Oil—	
French 38/40% Esters	26s. per lb.
Lemon Oil ..	.. 3s 4d. per lb.
Lemongrass Oil ..	.. 3d. per oz.
Orange Oil, Sweet	.. 13s. 9d. per lb.
Otto of Rose Oil—	
Bulgarian ..	.. 27s. 6d. per oz.
Anatolian ..	.. 23s. 6d. per oz.
Palma Rosa Oil ..	.. 19s. per lb. Very short supply.
Peppermint Oil—	
Wayne County	.. 21s. 9d. per lb.
Japanese ..	.. 19s. 3d. per lb.
Petitgrain Oil ..	.. 10s. per lb.
Sandal Wood Oil—	
Mysore	.. 26s. 6d. per lb.
Australian ..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before June 30th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, 15 days after the date given.

I.—Applications

Aktiebolaget Separator. Preventing injurious reaction between centrifugated liquid and air. 10,094. Apr. 23. (Swed., 2.8.23.)

Avamore Engineering Co., Ltd., and Hetherington. Apparatus for mixing and thermal treatment of materials. 10,102. Apr. 23.

Denham, and Simon, Ltd. Apparatus for giving warning of escape etc. of gases. 9906. Apr. 22.

Edelstahlwerk Rochling Akt.-Ges., and Ziegler. Regenerative furnaces. 10,290. Apr. 25. (Ger., 12.7.23.)

Griscom-Russell Co. Evaporators. 10,005. Apr. 22. (U.S., 26.6.23.)

Jackson. (Royer Foundry and Machine Co.). Treating granular material. 10,128. Apr. 23.

Schloss (Rowe). Beaters for grinding-mills etc. 10,099 Apr. 23.

I.—Complete Specifications Accepted

941 (1923). Hurrell. Mixing, incorporating, and disintegrating machines. (214,308.)

2063 (1923). Cowles. Solidifying materials that solidify with a rise in temperature. (214,344.)

9725 (1923). Veitch. Mixing apparatus. (214,446.)

19,142 (1923). Carter, May, and Barradell. Film-mills for emulsifying and grinding solids. (214,521.)

II.—Applications

British Thomson-Houston Co., Ltd. Filaments. 10,311 Apr. 25. (U.S., 1.5.23.)

Duckham, and Woodall-Duckham, Ltd. Operating vertical retorts for carbonizing fuel. 10,313 and 10,364. Apr. 25 and 26.

Ledoga Soc. Anon., and Maimeri. 10,105. *See* XX.

Pyzel. Fractional distillation of oils etc. 9993. Apr. 22.

Pyzel. Fractioning oil vapours. 9994. Apr. 22.

II.—Complete Specification Accepted

23,232 (1923). Johnson (Badische Anilin und Soda Fabrik). Manufacture of fuel gas. (214,544.)

III.—Application

Pyzel. 9993-4. *See* II.

IV.—Applications

Ransford (Cassella & Co.). Dichlor-N-dihydro-1.2-2′1′-anthraquinoneazine. 10,000. Apr. 22.

Soc. Alsacienne de Produits Chimiques. Manufacture of sulphurized compounds of phenol etc. 10,366. Apr. 26. (Fr., 27.4.23.)

Soc. of Chemical Industry in Basle. Manufacture of arylidoquinones. 10,212. Apr. 24. (Swiss., 24.4.23.)

IV.—Complete Specifications Accepted

34,168 (1922). Tizard, Chapman, and Taylor. Halogenation of hydrocarbons and their derivatives. (214,293.)
6016 (1923). Poma. Manufacture of *p*-aminophenol. (194,694.)
18,008 (1923). Bloxam (Chem. Fabr. Griesheim-Elektron). Manufacture of corinth-coloured to black azo-dyestuffs. (214,516.)

V.—Complete Specification Accepted

1674 (1923). Clayton Aniline Co., Ltd., and Grundy. Treatment of acetyl cellulose in alkaline liquids. (214,330.)

VI.—Applications

Ashworth. Apparatus for dyeing etc. yarns in hanks. 9891. Apr. 22.
Hunt, and Hunt and Moscrop, Ltd. Open bleaching, dyeing, etc. machines. 10,061. Apr. 23.
Scottish Dyes, Ltd., Thomas, and Thomson. Dyeing processes. 10,176. Apr. 24.

VI.—Complete Specifications Accepted

2866 (1923). Stevens and Dyer. Treating fabrics with rubber compositions. (214,356.)
17,229 (1923). Scholz. Producing batik discharge patterns. (214,506.)
32,113 (1923). Hamburger and Kaosz. Bleaching vegetable fibrous material. (209,073.)

VII. Applications

Denham, and Simon, Ltd. Means for detecting etc. chlorine etc. 9908. Apr. 22.
Dubois. Production of hydrocyanic acid. 10,100. Apr. 23.
Dubois. Production of hydrocyanic acid. 10,101. Apr. 23. (Ger., 23.4.23.)
Elektro-Osmose Akt.-Ges. (Graf Schwerin Ges.). Manufacture of amorphous silicic acid. 10,365. Apr. 26. (Ger., 26.4.23.)
Imray. 10,022. *See* X.

VII.—Complete Specifications Accepted

1774 (1923). Bhopal Produce Trust. Recovery of calcium oxalate and other materials from trees. (201,131.)
2914 (1923). Naef. Production of compounds of sulphur with alkali or alkaline earth metals. (214,358.)
14,283 (1923). Chem. Werke vorm. Auerges., Sommer, and Ans. Production of titanic oxide from titaniferous iron ores. (214,483.)
14,663 (1923). Rhenania Verein Chem. Fabr. Production of soluble salts of barium and strontium from the residues of the manufacture of barium and strontium sulphides. (201,528.)
14,936 (1923). Urfer. Preparation of pulverised lithium nitride. (199,027.)

VIII.—Application

Battiscombe. Apparatus for drying china clay etc. 9884. Apr. 22.

IX.—Complete Specification Accepted

6386 (1923). Hatton. Manufacture of coloured tiles, slabs, bricks, etc. (214,394.)

X.—Applications

British Thomson-Houston Co., Ltd. Tungsten alloys. 10,187. Apr. 24. (U.S., 1.5.23.)
Electrolytic Zinc Co. of Australasia, Ltd. Recovery of zinc by electrolysis. 9947. Apr. 22. (Australia, 21.4.23.)
Flodin and Gustafsson. Methods of producing volatile metals from their sulphides. 10,152. Apr. 24. (Sweden, 25.4.23.)
Flodin and Nobel. Method for producing metals and metal alloys low in carbon. 9883. Apr. 22. (Sweden, 20.4.23.)
General Electric Co., Ltd. Manufacture of tungsten wires. 9979. Apr. 22. (Hungary, 21.4.23.)
Imray (Bellis Heat Treating Co.). Fused eutectic salt baths. 10,022. Apr. 22.
Talbot. Metallurgical furnaces. 10,210. Apr. 24.
Wittig. Method of producing metallic vanadium. 10,357. Apr. 26. (Ger., 7.5.23.)

X.—Complete Specifications Accepted

1975 (1923). Cleave. Apparatus for the electrolytic deposition of metals. (214,340.)
1983 (1923). Wandel. Cleaning rusty or corroded iron. (208,103.)
7076 (1923). Sejournet. Manufacture of powders of alloys of magnesium and aluminium. (195,064.)
11,981 (1923). Soc. Anon. des Brevets Berthot. Electrical process for obtaining metals of high melting-point, such as tungsten. (205,046.)
19,772 (1923). Robinson and Gray. Composition for moulds for steel castings. (214,526.)
20,700 (1923). Lombardi. *See* XI.

XI.—Applications

Banyay. Making active material for electric accumulators. 10,134. Apr. 24.
Barfield, Coleman, and Wild. Electric muffle furnaces. 10,174. Apr. 24.
Electrolytic Zinc. Co. of Australasia, Ltd. 9947. *See* X.

XI.—Complete Specifications Accepted

1975 (1923). Cleave. *See* X.
11,981 (1923). Soc. Anon. des Brevets Berthot. *See* X.
20,700 (1923). Lombardi. Electric furnaces, particularly for melting and treatment of composite metals and alloys. (211,532.)

XII.—Application

Naamlooze Vennootschap Koninklijke Stearine Kaarsenfabriek Gouda. Manufacture of soap. 10,205. Apr. 24. (Holl., 30.8.23.)

XII.—Complete Specification Accepted

14,054 (1923). Fauth. Continuous recovery of oils from oilseeds. (214,478.)

XIV.—Complete Specifications Accepted

2866 (1923). Stevens and Dyer. *See* VI.
3058 (1923). Lawes. Rubber composition. (214,361.)
13,750 (1923). Oltmans. Obtaining rubber from latex. (214,477.)

XVI.—Application

Garbin and Toniolo. Phospho-nitrogenous fertiliser. 10,178. Apr. 24.

XVIII.—Complete Specification Accepted

31,846 (1922). Barbet et Fils et Cie. Distillation and rectification of alcohols. (189,458.)

XIX.—Applications

Heyerdahl. Production of edible products rich in vitamines. 10,227, 10,228. Apr. 25.
Smallpeice. Methods of preserving decomposable fluids. 10,041. Apr. 22.

XX.—Applications

Ledoga Soc. Anon., and Mainneri. Preparation of diethyl sulphate from ethylene. 10,105. Apr. 23. (Italy, 23.4.23.)
Swartz. Anaesthetising gases. 10,183. Apr. 24.

XX.—Complete Specifications Accepted

34,168 (1922). Tizard, Chapman, and Taylor. *See* IV.
30,087 (1923). Merck. Preparation of synthetic *d*-ψ- and *l*-ψ-cocaine. (210,050.)

XXIII.—Application

Denham, and Simon, Ltd. 9908. *See* VII.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific number :—*Algiers*: Tinplate (492); *Australia*: Pottery, glassware and aluminium ware (470); Aluminium, enamel ware, agricultural and engineers' tools (Official Secretary, Commercial Bureau, Australia House, Strand, London, W.C. 2. Ref. No. 412/7/1/1/236); *British India*: Steel (The Directors of the Madras and Southern Mahratta Railway Co., Ltd., 25, Buckingham Palace Road, London, S.W. 1); *Canada*: Steel, Manganese castings (472); Drugs (476); Mining and engineering equipment (477); *Chile*: Glycerine, oils (494); *Denmark*: Magnesia slabs (481); Copper ingots (482); *Mexico*: Tinplate (495); *Netherlands*: Artificial silk (485); Stationery (486); *Peru*: Tableware, sanitary earthenware (496); *South Africa*: Rubber goods, stationery (478); *Spain*: Silk (490).

French Company News

The St. Etienne coalmines company is constructing 25 new coke ovens, thus bringing the number up to 100. Wishing to utilise the hydrogen produced from distilling coke for the production of synthetic ammonia, and to produce industrial gas of 1300 calories by using fuels of high ash content, arrangements have been made with the Société Chimique de la Grand Paroisse, the owner of the Claude Process, for the construction of a synthetic-ammonia factory capable of producing 5 m.t. per 24 hours. The factory, which will be ready in June, 1924, will in time produce 10 t. per 24 hours. To provide for the utilisation of the industrial gas, the company has made an agreement with the Société Franco-Belge de Fabrication Mécanique du Verre (which makes window-glass by the Libbey-Owens process) to utilise the gas for local glass furnaces. In 1923, the St. Etienne coal mines produced 608,190 tons of coal and 159,130 tons of coke, 3097 tons of tar, 1418 tons of ammonium sulphate, 912 tons of benzol, and varying quantities of other products such as heavy and light oils, naphthalene, anthracene and tar.

The Canadian Market

British manufacturers, particularly those producing mining and chemical machinery, apparatus and plant, will be interested in the recent Canadian budget. The customs tariff has placed on the free list many appliances used in mineral, metallurgical and chemical industries, and especially those not made in the country, or of such size or construction as are not generally manufactured. This will apply to such articles as filter presses, distilling apparatus, evaporators, driers, vacuum apparatus, grinding and dressing machinery, mining drills and many parts, and special machinery for chemical plants. The object of this reduction in the tariff is to encourage and facilitate the development of such industries as low-carbonisation of coal, coke and the recovery of by-products therefrom in the form of fuel, and motor oils, fertiliser, etc., oil shale and tar sands, mining and many industries which have been hampered by the excessive duties and sales tax (remitted) upon articles not made in Canada, or not available of proper construction and design to permit of economic application. The new tariff proposals may be seen at the office of the High Commissioner for Canada.

Trade Information

Midland Bank.—Mr. George McBain and Mr. A. Hall Wilson, Directors of the North of Scotland Bank, Ltd., have been appointed Directors of the Midland Bank, Ltd. The Right Hon. R. McKenna, Chairman of the Midland Bank, and Mr. Frederick Hyde, Joint Managing Director of that Bank, have been appointed Directors of the North of Scotland Bank, Ltd.

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during April has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 484, of which 380 were from merchants or importers. To these should be added 22 cases outstanding on April 1, making a total for the month of 506. These were dealt with as follows :—Granted—360 (of which 329 were dealt with within 7 days of receipt). Referred to British makers of similar products—84 (of which 63 were dealt with within 7 days of receipt). Referred to Reparation supplies available—30 (all dealt with within two days of receipt). Outstanding on April 30, 1924—32 (practically the whole of these were dealt with at meeting held May 2. Of the total of 506 applications received, 422 or 83 per cent were dealt with within 7 days of receipt.

PUBLICATIONS RECEIVED

Chemistry in the Twentieth Century. Prepared under the guidance of a Committee representing the Scientific Societies, with Dr. E. F. Armstrong, F.R.S., as Chairman and Editor. Pp. viii+281. London: Ernest Benn, Ltd., 1924. Price 15s.

Chemicals. By A. W. Ashe and H. G. T. Boorman, with a foreword by H.R.H. The Prince of Wales. Resources of the Empire Series. Pp. 207. London: Ernest Benn, Ltd., 1924. Price 21s.

A Dictionary of Applied Chemistry. By Sir E. Thorpe, C.B., LL.D., F.R.S. Assisted by eminent contributors. Revised and enlarged edition. Vol. V. Pp. viii+722. London: Longmans, Green and Co., 1924. Price 60s.

Principles of Electroplating and Electroforming (Electrotyping). By W. Blum and G. B. Hogaboom. Pp. xii+356. London: McGraw-Hill Publishing Co., Ltd., 1924. Price 20s.

Drying by Means of Air and Steam. By E. Hausbrand. Third revised English edition. Pp. viii+77. London: Scott, Greenwood and Son, 1924. Price 6s.

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY *&* INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

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EDITORIAL

It was neither diffidence nor laziness which prevented us last week from making a final comment on the relations between the French and German chemists. Editors of weekly journals are not expected to be either timid or dilatory; even when they are away on a holiday or stricken by illness, they must exercise their brains, that is, assuming with the sentry, they have got any. Some of the correspondence we received last week arrived so late that there was no time to comment upon it in these columns. This is the round, unvarnished tale we have to deliver. Nor have we been careless in alluding to the relations between the French and German chemists; this is in truth the whole essence of the problem. Various English chemists have written to us that our comments have shown too much hostility towards the Germans, or that we have shown much less hostility than was proper; in such matters a middle course pleases no one, we have shot neither the woodcock nor the pigeon. But the relations between the British and the German chemists are not the crux of the situation; it is the feeling between the French and the Germans which is this. In view of the recent elections in both countries, the possibilities of satisfactory arrangements about indemnities, the pourparlers now proceeding in Europe and some other more or less unknown and variable factors we are satisfied that any permanent improvement in the relations between the two neighbours will be due to changes in their own minds and not to any well-meant advice from ourselves or even from more distant inhabitants of the chemical community. There is a *tempus edax rerum* which cures many ills; a hundred years ago the French were the hereditary enemies of this country; sixty years ago Germany was regarded by many chemists as a sort of spiritual home; it is something like fifty years ago since Bismarck is reported to have said "Next time we defeat the French we shall insist upon paying them an indemnity." A few years later he is reported to have said, "If I could live again I should be a Republican; government by Kings is government by women, and if they are bad women it is bad, and if they are good women it is worse." The country which welcomed Hofmann and allowed him for paltry reasons to return to his fatherland, has altered its views in many respects; the aspirations of Germany ten years ago were different from those of fifty years ago; all has changed: the whole map of Europe has been reshuffled and we cannot yet tell whether it is in a state of stable or unstable equilibrium. There is some sort of radio-activity about the waters of the Rhine, some emanation, fatal to tranquillity. Whether Mr. Baldwin was indiscreet enough to sample it we know not. But from the time of Julius Cæsar to that of Clovis, from the period of Charles Martel to the reign of Hugh Capet, throughout the Middle Ages to the campaigns of Marlborough and thence to the defeat of M. Poincaré at the recent election the Rhine has been in a state of ionic activity. Some day mankind will look back on the relics of the disturbances just as Professor Joly sees in small haloes in archæan rocks the evidence of past disturbances resulting from activities of a character too great for the surroundings. We suppose the truth is the Rhine Valley affords no good boundary. Even when the Franks occupied both sides of it there was hardly a permanent peace; it is a poor frail thing compared with the North Sea. If only it could be converted into a Channel as stormy as ours! What could we not contrive if it were a range of mountains? *Que ne pourrait le lion, s'il était singe?* In America somewhere the authorities have dissolved iodides in the reservoirs; a few bromides dissolved in the waters of the Rhine Valley would calm a lot of turbulent spirits. But neither the French nor the Germans are notorious as water drinkers. We are afraid there is nothing to trust to except envious and calumniating time.

Cambridge witnessed what may well prove to be an event of the first importance in the opening of the Sir William Dunn Laboratories for Chemistry in its relations to Life, by the Chancellor, Lord Balfour, on Friday last. That a City merchant should leave the residue of his estate with directions to use it for the "alleviation of human suffering," and that his executors, the Directors of the Commercial Union Assurance Co., should have interpreted the instruction in the wise way they have, is a circumstance of happy augury. At last, we have the fact publicly recognised, that chemistry is a science to be thought of in connexion with medicine. The Chancellor was far-seeing enough to assert, that even that dread scourge of mankind, Cancer, may well have its secrets disclosed through chemical inquiry. Thus far, we know, the efforts of pathologists have been exerted in vain. Chemists throughout the world will desire to congratulate Prof. Gowland Hopkins that he has at last attained to this crowning position in his unwearied efforts to develop a declared school in the borderland regions of chemistry and biology. In accepting the gift, however, the University incurs a grave responsibility, as it is in some measure promoting the subdivision not merely of chemistry, but also of botany and physiology in an unhappy manner.

The new school can only be a success, if the workers are specially qualified both as chemists and biologists—double firsts, in fact. There is already obvious, in the school, an undesirable tendency to specialise at too early a stage; we will be open and also say, that it is probably too much the resort of women students, who cannot be expected to bring to the study of the subject that breadth and originality of outlook and the acute powers of observation that are essential to progress. After the ceremony, visitors engaged in an orgy of interesting demonstrations, beginning with "Enzyme Activities" (tea and toast), and ending with the "Electrical Determination of Acidity." Evidently, Cambridge has some store of sanity. We can only hope that "acidity" may long prevail, and flourish, in memory of Sir William Dunn and his altogether uncommon sense. The full-dress banquet, in the Great Hall of Trinity College, in the evening, was a fitting conclusion to the day. Henry VIII. looked down upon us, and we could not help feeling that the adoption of his attitude and methods might not be inappropriate, at times, even to-day. The Master, in proposing the health of Prof. Hopkins, was happy in his allusion to Tennyson's pregnant verse—which might well be inscribed on some one of the many whitened walls of the new building:—

Flower in the crannied wall,
I pluck you out of the crannies;
Hold you here, root and all, in my hand,
Little flower—but if I could understand
What you are, root and all and all in all,
I should know what God and man is.

CHEMICAL LITERATURE IN CHINA

By WILLIAM H. ADOLPH, Ph.D.

A chemical philosophy flourished in China in the ages gone by, but scientific thought has been dormant for as much as four or five centuries. A revival of interest in things chemical has been set in motion by a few sparks from the West. At the present time much thought and energy is being spent toward putting chemistry in China again on a basis where it can support itself. This is marked by the rapid development of a chemical literature.

For many years such research material as was not published abroad in European or American journals found its way into the *China Medical Journal*, the organ of the association of foreign medical men in China. The old numbers of this periodical, together with the early volumes of the *Journal of the North China Branch of the Royal Asiatic Society*, contain many interesting notes and observations on things chemical and on the chemical industries of old China. Ten years ago those conducting chemical research in China had great difficulty in finding appropriate means of publication. The *Far Eastern Review*, a monthly dealing essentially with the field of commerce and industry, became the repository for a number of these, and others were scattered about in directions that are now difficult to trace.

With the desire to foster more intensive work in scientific study and research, the Science Society in 1916 began the publication of *Science*. This appears monthly in Chinese; occasionally articles appear in English or in German. Last year appeared the first volume of the *Transactions of the Science Society*, all the articles being in the English language. Next in importance comes the *Journal of the China Society of Chemical Industry*. This was started in 1923, and is published twice yearly in Peking, also in Chinese. This society, like the Science Society, is largely composed of Western-trained Chinese and is organising sections throughout the country.

Mention should also be made of the new *China Journal of Science and Arts* which has become the official organ of the Shanghai Chemical Society. The *Lingnaam Agricultural Review*, started in 1922, published at the Canton Christian College, and the *Philippine Journal of Science* have served as media for a number of important chemical papers emanating from China. Several of the Government colleges have published science journals covering the field of chemistry. While much of the material that has appeared in these—and it has all been in Chinese—cannot be classed as original material, it has been very valuable in stimulating an interest in pure scientific investigation.

Omitting all mention of Chu-hsi, the great scientific writer of the Sung Dynasty, and his fellow labourers of 800 years ago, it can be said that the writing of modern chemistry text-books for China began with the appearance of Dr. Fryer's chemistry books about 1870. Dr. Fryer found his greatest difficulty in the terminology, but he boldly invented new names and new Chinese characters for elements and classes of compounds where necessary. Gillison's translation of Luff's *Chemistry* followed in 1905.

The ten-year period from 1905 to 1915 represents the period of Japanese influence, when students returned from Japan and translated the text-books which they brought back with them. Most of these Japanese texts were in turn descended from German prototypes, and the final result was an unrecognisable second-hand reproduction of an excellent original. This influx of Western science by way of Japan has had a lasting influence on the chemistry of China. Most of the inorganic terms in Chinese are those which came in this way from Japan. Practically all of the texts which were the product of this period have filled their usefulness and gone.

The period beginning with 1915 is the period of direct Western influence. American, British and German texts were introduced into the schools in large numbers and used in the original languages. But now many text-books are appearing which, while based on Western models, keep the special needs of the Chinese student in mind and attempt to weave into the text the Chinese background.

The present text-book situation is a poverty-stricken one. Most of the texts in use are of the imported type. There are as yet no text-books either for colleges or for middle schools which can be said to interpret the science of chemistry successfully in terms of the everyday life of China. Such texts could appear either in English or in Chinese, or companion volumes in both languages. Now that the fundamentals of the scientific terminology are settled, there is a desire to have an increasing number of the new text-books appear in Chinese. Because of a limited demand, only until very recently, however, has the publication of college texts in Chinese been considered a sound venture financially. Several of the efforts of the past were subsidised by scientific societies or were private ventures which resulted in considerable loss to the authors.

One of the very encouraging aspects of the chemical literature field is the increasing amount of research material which finds its way into the journals published in China. Seven years ago when the writer undertook to handle the abstracts of the China journal for one of the Western chemical societies, there were four periodicals on the abstracting list yielding an average of about six articles per year containing original material which could be considered of importance to the chemical world. Now, the number of periodicals has increased to eight, and the number of articles annually abstracted to about 30.

Probably the most outstanding accomplishment in the field of chemical literature during the last decade has been the fixing of the terminology. The General Committee on Scientific Terminology was started in 1915, and was organised in its present form when the Ministry of Education in Peking decided to make an annual grant toward the upkeep of its work and to add official approval to the lists of terms adopted by the committee. The section on chemistry numbers about 15, and consists of representatives of the leading scientific societies and a few additional members from the universities. The membership includes chemists and chemist-teachers trained in Britain, Germany, France, America, Japan and China.

Two outstanding principles have been followed in the terminology work. It was first resolved, as far as possible, to translate into the Chinese term in each case the fundamental meaning of the Western chemical term, and not simply to transliterate the sound. Second, it was decided to avoid the invention of new Chinese ideographs. This rule has been transgressed in a few cases for the names of the elements and for a few special radicals. It can be said that the general and inorganic terminology is complete. The organic terminology which was the more difficult piece of work, is practically in its final form, but it needs still the test of more vigorous use in the class room before it can be said to be absolutely satisfactory. The organic terminology follows the synthetic character of the Geneva system, and uses recognised Chinese characters for the different classes of compounds.

The stabilising of the terminology is reflected immediately in the increasing tendency to use the Chinese language as a medium of scientific instruction, and for text-book work. There is no doubt whatever that the use of the Chinese language for all these things is the ultimate goal of China. Many of the colleges and universities now give their chemistry courses bilingually, using both English and Chinese in the class-room, and in some places the college courses of the first year or two are given solely in Chinese. Given the text-book material and teachers of equal experience and training, there seems to be no essential difference as to the results obtained, whether the medium of instruction is one language or the other. At the present moment the greatest need for the development of chemical science in China is the preparation of practical text-books, written by Chinese, from the Chinese standpoint, and with Chinese colouring.

Shantung Christian University, Tsinan, China

PULVERISED FUEL

The Importance for Crude Gas Firing

(From a Correspondent)

A great deal is being heard just now about pulverised-fuel firing, with its many obvious advantages. Of particular importance, however, is the fact—perhaps not yet generally realised—that its extreme flexibility of operation has provided a method of burning at high efficiency crude and often low quality commercial gases. Gas firing, with gas of a uniform quality and pressure, is, of course, extremely efficient, equal, or perhaps even superior, to pulverised fuel, but is very rarely used for the obvious reason that it is too expensive.

With ordinary combustible gases given off as a by-product, the best example of which is blast-furnace gas, the matter is very different because such gas is not only low grade, dirty and dusty, but is violently erratic in supply. A somewhat similar problem, although a much easier one, is the burning of good quality coke-oven gas and the surplus very rich gas from low-temperature carbonisation. The flexibility possessed by pulverised-fuel firing, which

can be started up or shut down almost immediately, and the amount of the fuel burnt altered within very wide limits by merely turning valves, means that the fluctuations in a gas supply can be followed and allowed for without difficulty and all the gas utilised whilst maintaining a steady steam output.

The most remarkable example of this, of course, is the famous Ford plant at River Rouge, Dearborn, Detroit, which normally burns 70 per cent. blast-furnace gas and 30 per cent. pulverised coal on some of the largest water-tube boilers in the world, with a normal evaporation of 220,000 lb. of water (from and at 212° F.) each per hour and 350,000 lb. emergency overload. Owing to this great flexibility of pulverised fuel firing a volume of dirty blast-furnace gas of 90-100 B.Th.U. per cb. ft. amounting to about 70 million cb. ft. per 24 hours, and of course greatly fluctuating in amount, is being burnt at the highest efficiency. At the same time also coke-oven gas, tar, oil, or pulverised coke are used when necessary, and it is intended eventually to use pulverised low-temperature fuel.

The possibility of burning mixed fuels in this way, and of supplying pulverised coal to a furnace at enormous ratings is due to the solution of the practical difficulties of pulverised-fuel firing, especially as regards the furnace and the intense heat developed because of the efficiency of the firing with only 20 per cent. excess air. The difficulty is solved by the "Lopulco" water screen (a series of 4 in. steel tubes in the bottom of the furnace to prevent "slagging"), and a large combustion chamber with hollow air-cooled brickwork walls, the heated air being used to supply 90 per cent. of the air required for combustion.

THE CORROSION CAUSED BY PRODUCTS OF COMBUSTION OF COAL GAS

By U. R. EVANS, M.A.

It is now generally agreed that one of the most important causes of the marked corrosion observed in urban districts is the sulphur dioxide produced by the combustion of coal. It is pertinent to ask whether the practice of employing coal-gas in the place of the direct combustion of solid fuel tends to increase or to reduce damage of this character. Since coal-gas invariably contains less sulphur than the coal from which it is made, it is possible to argue that—as regards *outdoor* corrosion—the use of gas mitigates the trouble. But the question of *indoor* corrosion is somewhat different. Whereas no one dreams of burning coal in a room not provided with a chimney, the burning of gas—for illumination, for cooking, for boiling water and for the heating of rooms—is often allowed to take place without any provision being made for the removal of the products of combustion.

A short time ago, the writer had occasion to examine a case where very conspicuous corrosion had been set up in a private house[1]: the trouble occurred in a large, well-ventilated room heated by two hot-water radiators below which coal-gas was burnt directly. There had been special structural objections to the provision of flues, and, at the time of the installation of these radiators, which were the property of the Gas Company, a representative of that Company had advised that the absence of a flue would entail no nuisance of any kind. The radiators had been installed eighteen months at the time of the examination, but had only been used during the winter periods, and then only for a few hours in the day. It was found that the radiators themselves had suffered most severely. The whole of the lower surface of the iron was completely covered with a pale yellowish-brown incrustation, ⅛ inch thick or more, which analysis showed to be mainly ferric sulphate (both normal and basic); the sides of the radiators were covered with numerous great scab-like growths of the same salt, giving to the stove an appearance of having been splashed with mud. These scabs were close together at the lower part, but became less frequent as the top was approached—no doubt owing to the dilution of the moist sulphur dioxide by the air. On one stove a certain amount of ferric oxide was also present. The black "protective" composition had proved quite unequal to prevent attack by the products of combustion. The general appearance of the corroded surface was distinctly reminiscent of that of the specimens of iron and steel exposed to moist sulphur dioxide in the writer's laboratory experiments[2]; the main points of difference were the absence of ferrous iron, and the dryness of the incrustation, due, of course, to the higher temperature prevailing on the surface of the stoves.

Unfortunately the damage was not confined to the stoves. Bronze ornaments were found to be covered with a moist green incrustation, which proved to be basic copper sulphate, with a small amount of carbonate. Brass electric fittings had also suffered. Experience had proved that it was quite impossible to keep silver in the room, since it darkened almost immediately. A marble clock, which had stood in the room, was pitted by the acid fumes, and presented in patches a "frosted" appearance. Washing with water did not remove this frostiness; the patches partially disappeared when the marble was wetted (owing to the fact that the refractive indices of marble and water are less far apart than those of marble and air), but returned when the water evaporated. It was found possible to conceal the disfigurement to a large extent by coating the marble with a thin layer of vaseline, which, of course, did not evaporate.

There was not the smallest doubt that the damage was due to coal-gas; indeed, in no other way could the production of so much sulphate be accounted for; in other rooms of the same house, which were heated by coal-fires or by gas-fires provided with flues, no special corrosion was observed.

The Gas Industry of this country has for many years pursued a sensible policy in considering the interests of the consumers, and in extending help to them—in the form of gratuitous advice, cheap

[1] It would perhaps be unfair to the company supplying the gas to name the locality where the trouble occurred, since the sulphur content of the gas was probably not higher than that supplied in many other places; the town was *not* Cambridge.

[2] U. R. Evans, Trans. Faraday Soc., 19 (1923), 204.

hiring of stoves and in other ways. The growing use of gas is largely the result of this enlightened method of business. It appears, however, that the question of the possibility of damage caused by the products of combustion has, to some extent, been overlooked; it is generally assumed that so long as the combustion is complete (that is, so long as there is no carbon monoxide unburnt) the fumes produced will cause no rust. Since, however, the corrosive nature of the fumes of highly sulphurous gas must inevitably militate against the popularity of coal-gas as a fuel, gas companies might well find it in their own interest to consider whether the sulphur content of their products could not be cut down. Where this is impossible, it would surely be better policy, "in the long run," not to recommend the installation of flueless stoves in rooms where metallic articles are exposed. The question of protective paints for the stoves themselves is evidently a matter to which attention might advantageously be paid; the casual observation that gas is capable of raising huge boil-like excrescences on the metal may raise in the mind of the average man who is not a chemist the question as to whether the burning of such gas is healthy.

The sulphur content of gas varies considerably in different localities. According to Sutton[3], most companies in 1915 produced gas with about 30-40 grains of sulphur per 100 cubic foot. The South Metropolitan Company, since they commenced to decompose the carbon disulphide by the action of heated nickel[4], have produced a gas with only about 8 grains per 100 cubic foot of sulphur—mainly present as thiophene. This is a notable step in the right direction, and it is probable that if all coal-gas were of this standard, it would be true to say that the substitution of coal-gas for coal as a domestic fuel would tend to reduce—rather than to increase the total damage suffered by metal-work (indoors and outdoors) through acid corrosion.

THE POSITION OF THE NITROGEN INDUSTRY IN FRANCE

By MAURICE DESCHIENS

Speaking at the third Congress of Industrial Chemistry held last October by the Société de Chimie Industrielle, in Paris, Prof. C. Matignon said he had calculated that for an average pre-war year, the quantity of nitrogen removed from the French soil by crops amounted to a total of 1,360,000 metric tons, but neglecting the nitrogen removed by forage crops and the annual cuttings of timber, this total fell to 900,000 t. Agricultural experts consider that at present in France, with proper utilisation of various manures and waste products it is necessary to replace in the soil one-third of the nitrogen removed by the crop, *i.e.*, over 300,000 t. With a wheat crop of 103,753,000 quintals grown on 6,578,000 hectares, 50 kg. of nitrogen is removed per hectare, and 17 kg. of nitrogen should be replaced per hectare every year, making a total of 110,000 t. of nitrogen for wheat alone. Apart from wheat, however, all the arable land in France represents a total of 23,618,000 hectares, which, at the rate of 17 kg. per hectare, requires 400,000 t. of nitrogen.

Various workers have shown that French agriculture requires an average of 75 kg. of nitrogen per hectare for a normal crop, and 20 kg. for natural grassland, making a total requirement of 1,540,000 t. of nitrogen. Including, however, farmyard manure, organic waste and manufactured and imported fertilisers, actually 900,000 t. is supplied, leaving a maximum of 640,000 t. of nitrogen, which modern agriculture could employ were it available. As a contrast to these requirements, French agriculture utilised in 1922 only 70,000 t. of nitrogen, of which 82 per cent. was imported. In 1923, out of 66,000 t. utilised, 12,000 t. of nitrogen was supplied by ammonium sulphate from gas works, and 75,000 t. of sulphate of ammonia (15,060 t. of nitrogen), and 260,000 t. of nitrate of soda (39,000 t. of nitrogen) were imported. To these requirements industrial needs have to be added.

This unfortunate situation has led to a strong demand from the farming community for a national policy so that nitrogen can be supplied more cheaply per unit, so that political and economic conditions have strongly influenced the technical point of view. For this reason, at the close of the war (November 11, 1919), a Convention was agreed between the Minister of Industrial Reconstruction acting for the French Government and the Badische Anilin und Soda Fabrik, to guarantee the use of the Haber process in France. This Convention, after debate in the French Parliament, has been approved by the law of April 11, 1924. (This Convention was discussed in *Chemistry & Industry* in the issue of March 9, 1923, pp. 228-229.)

Private industry, however, after attempting to utilise the Haber process, has turned to other processes such as those of Claude, Casale and the cyanamide process. Of late the production of cyanamide has greatly increased, and as the result of an agreement with the Lannemezan factory, France will be in a position to produce 115,000 t. of cyanamide (25,000 t. of nitrogen). The Claude process is employed or about to be employed by a certain number of coal mines (Bethune, St. Etienne, Decazeville, Aniche), which will be producing by the end of 1924, 160 t. of ammonium sulphate daily, equivalent to 11,000 t. of nitrogen yearly, and are capable of producing double this amount by utilising hydrogen from coke oven gases, gases which are also important sources of liquid fuels and thus affect the solution of the national problem of liquid fuels. Utilising the same source of hydrogen, the coke-ovens of Dourches and of Lens, will, by means of the Casale process, produce 150 t. of ammonium sulphate daily, or a total of 11,000 t. of nitrogen per annum, which can be doubled.

Private industry could thus produce, by means of the Claude and Casale processes, 44,000 t. of nitrogen at the end of 1924, and if the cyanamide is included a total of 69,000 t. of nitrogen might be attained. Neglecting the new processes, however, the actual production is of the order of 19,000 t. of nitrogen.

[3] L. N. Sutton, J. Soc. Chem. Ind., 34, (1915), 14.
[4] E. V. Evans, J. Soc. Chem. Ind., 34, (1915), 9.

By means of the Haber process of which the installation at the Toulouse factory has been approved by Parliament, it is intended to produce 36,000 t. of nitrogen per annum at some future date. The law which made this possible has an important effect on the French nitrogen policy, for in addition to approval of the agreement with the B.A.S.F., it creates an industrial national office of nitrogen with the sole object of manufacturing and selling nitrogeneous fertilisers and products and compounds related to such manufacture. It could begin manufacture at any place considered suitable by its administrative council, and utilise all methods for producing nitrogeneous products of which the patents had been acquired, subject to approval of the ministers of public works and of finance. Such manufacture would not have any other character of monopoly than that conveyed by the patents acquired.

The National Industrial Nitrogen Office at Paris is under the authority of the Ministry of Public Works and administered by a committee of 18 appointed by that ministry, two representing the ministry of finance; 2 that of public works; 3 that of agriculture; 2 that of war; 3 representing agricultural associations: 2 chambers of commerce; 1 power stations; 1 coal producers; 2 specialists in the nitrogen industry; and supplementary members can also be appointed. The Committee is appointed for three years and can be re-elected. Bonds re-payable in fifty years can within certain limits be issued by the Office to cover the cost of establishing and developing the enterprise, interest and extinction of the bonds being guaranteed by the State, and any profits are to be paid into the Treasury. It will thus be seen that by the side of the rapidly growing privately-owned nitrogen industry, a State nitrogen industry is established under a form completely different from that intended in the first Bill placed before the Chamber of Deputies (a company with a capital of 50,000,000 fr., of which 30,000,000 was to be provided by the State and 20,000,000 by private groups). Only the future will show how these parallel industries will succeed. It appears probable that there will be an economic struggle, and it seems likely that this close competition will enable farmers to obtain the nitrogen that they at present lack, in great quantity and at cheaper rates.

THE "SAND-LIME" BRICK PROCESS

An Interesting Scienitfic Development

Scientific methods are spreading surely, if slowly in almost every industry, and good examples of this, particularly interesting to the technical chemist, are the sand-lime brick, and the similar products made from ashes, clinker and blast furnace slag. The sand-lime process consists essentially in mixing sand with 5-10 per cent. of slaked lime, according to the quality of the lime, forming this into a semi-dry mass with water, passing it into a brick moulding machine operating at two tons per square inch pressure, and then exposing for 10 hours in closed cylinders to steam at a pressure about 120 lbs. per square inch, that is, a temperature of approximately 350° F. The main factors in the process are that the lime shall contain no trace of unslaked lime, CaO and that the mixing is of a most thorough character. In these circumstances the lime combines with a portion of the sand to form hydrated calcium silicates, which bind the whole mass into an intense hard, close-grained, homogeneous product, the bricks somewhat resembling natural stone in appearance and mechanical properties.

The whole process can be carried out complete from the raw materials to the finished bricks, in 24-36 hours, a striking difference from the many months of ageing and maturing necessary in preparing ordinary burnt clay bricks, whilst the method is cheaper and has the great practical advantage that sand occurs almost everywhere. From a chemical point of view it is very curious that the lime must not contain the slightest trace of unslaked lime, as otherwise the bricks either expand or become distorted, or they are somewhat weak and friable, whereas with no free lime the "sand-lime" brick is unquestionably superior to the ordinary brick.

The important influence of thorough slaking of the lime appears to have first been realised by Mr. E. R. Sutcliffe, one of the pioneers of this process, of Messrs. Sutcliffe Speakman and Co., Ltd., of Leigh, Lancs, who are specialists on the sand lime and similar type of bricks.

For some unaccountable reason there has always been a prejudice in Great Britain against the use of these bricks. As regards the practical success of the sand-lime brick it may be stated in the first place the present output of such bricks in the world to-day, in the United States and Canada, and on the Continent, particularly Germany, France and Belgium, is about 2500 million per annum. Anyone can go to the Continent and see hundreds of public buildings and thousands of houses that have been built with them during the past 25 years.

From the point of view of chemical, mechanical and physical tests in the laboratory their valuable properties are even more convincingly proved. Thus they have greater resistance to crushing strain than ordinary bricks, and as an example the average crushing strain in a given series of investigations was 5132 lb. per square inch, that is, 330 tons per square foot, whilst the first slight cracking did not appear until the pressure reached 4877 lb. per square inch, that is, 313·6 tons per square foot. Also they are less absorbent to water than ordinary bricks: they possess equal porosity as regards air. Again there is the great practical advantage that every brick is a "facing" brick, that is to say, they are all what may be termed mathematically straight and of equal size, without any sign of twisting, bulging or distortion, so that less mortar is required to lay them, and it is much easier to obtain the most efficient results with plaster because of the smooth surface. Further, they are especially pleasing and artistic in appearance—the colour depending on the sand used—and a building constructed of them has a particularly distinctive look, which is aided by the uniformity of size, already mentioned, and the small amount of mortar.

CHEMICAL PRESERVATIVES IN FOODSTUFFS

By ALBERT E. PARKES, F.I.C.

The question of the use of chemical preservatives in foodstuffs is now under consideration, but before opinions are expressed concerning their harmlessness or otherwise, more definite knowledge is required as to how, and to what extent, they act on living matter and vital functions. The quantities of some chemical substances necessary to preserve different foodstuffs has often been stated, but the amount of information at present available regarding their effects on the human system is very small and is of so contradictory a character that it is of little value. In the absence of authoritative standards, with few exceptions, Public Health Officials when taking action against manufacturers for the excessive use of preservatives have been placed in the unfortunate position of having to prove liability of injury to health. This in most cases, owing to lack of scientific information, has been difficult, resulting frequently in the failure of the proceedings.

Local Authorities have, therefore, been placed in the position of having to consider seriously whether they were justified in instituting proceedings which could only be supported by evidence of doubtful value. Manufacturers of foodstuffs have in consequence been in some measure unrestricted in their choice of preservatives and the extent to which they could use them.

All naturally occurring non-living organic matter, including foodstuffs, is, in a varying degree, and under certain conditions, liable to decay or decomposition, the change being invariably caused by the action of living micro-organisms. The process of preservation consists in employing means to prevent this change, either by destroying the active organisms concerned and adopting methods of subsequent protection, or else such means as will arrest their action, which means may be either physical or chemical.

The principal life functions of all organisms are nutrition, growth and reproduction, and this applies to the individual cells of living tissue, animal or vegetable, and to unicellular micro-organisms. For these functions to be operative in the cell, suitable conditions of temperature and moisture are essential, and the food for nutrition must be in a soluble condition, capable of being diffused through the cell-wall. When micro-organisms are active the protoplasm of the cells secretes specific enzymes or digestive juices which break down by hydrolysis complex indiffusible organic matter into simpler forms suitable for their needs, and following nutrition, growth and reproduction inevitably occur. Some tissue cells specialise in enzyme secretion whilst others are concerned with growth and reproduction only, and in this way they differ somewhat from unicellular micro-organisms where there is no differentiation of functions. No change will occur if we keep organic matter under conditions of temperature unsuitable for the vital functions of micro-organisms. A similar state of stability may be obtained by decreasing the amount of moisture below that necessary, or by the addition of some substance toxic to the organism, in suitable concentration.

At sufficiently high temperatures all organisms and their enzymes are destroyed, and this ideal condition should be aimed at in cooked foods. If the food after cooking has to be kept for any length of time the access of fresh organisms must be prevented. This process has a certain limited application in the canning and bottling industries. Low temperatures do not destroy all organisms, but their activities are almost completely arrested, and enzyme action is at a minimum. This method, known as refrigeration, is largely employed for the wholesale preservation of raw foodstuffs. Chemical preservatives may be divided into two classes. Those substances which have, or may have, themselves, directly or indirectly, some definite food value or stimulative action, such as alcohol, sugar, glycerin, acetic acid, common salt, and essential oils, to the use of which in moderation no objection can be raised, and those substances which, whilst definitely toxic, will, when the concentration is sufficiently low arrest the development of micro-organisms without actually destroying them.

Many chemical substances have been tried at various times for this purpose. Amongst the commonest now used are:—boric acid and borax, formaldehyde, sulphur dioxide and its compounds, salicylic and benzoic acids and their salts. Some substances possess these properties, but are definitely prohibited for use in foodstuffs owing to their known affinity for, or action on, protein matter. By combining with the proteins of the tissue cells they would tend to become cumulative and produce toxic symptoms. Such are the compounds of lead, copper, mercury, arsenic, etc., and amongst these may also be classed substances like phenol, caustic alkalis and mineral acids. Whether any of the commonly used substances can be consumed without injury to health is still an open question. Undoubtedly the ideal chemical preservative has yet to be discovered.

There are two aspects of the main question to be considered. There is the action of the preservative, if any, on the constituents of the food itself, especially the proteins, and the action of the preservative after ingestion on the system, especially the effects on the enzymes of the digestive juices of the mouth, stomach, and intestines, which are of a protein nature. There is some evidence of the former. Formaldehyde, for instance, when added to milk combines with the casein rendering it less easily digested, and alum which at one time was occasionally added to flour had a similar action on the gluten. The action of like substances on the digestive organs can be easily imagined. From the point of view of health the question is not so much the degree to which preservatives will arrest the development of micro-organisms as the effect they will have on enzyme action, this being the basis of all digestive processes, and the extent to which they are absorbed and eliminated by the system. If the growth of the organism is arrested it can be safely assumed that the nutritive function

is also impaired, and the cell will cease to secrete enzymes. That this is so is shown by the fact that saccharine solutions after treatment with sufficient preservative, undergo practically no change, even although there may be dormant yeast cells present, the small amount of enzyme in each cell being too small to have any appreciable effect.

In the various tissues which help to make up the complicated mechanism of the digestive system are glands composed of the cells whose functions are to secrete the digestive enzymes and the question also arises as to how far these functions are liable to be arrested by the action of chemical substances taken in the form of preservatives. Very little is known about the real action of chemical preservatives and germicides on the cell and its contents, but it may be definitely assumed that substances having an affinity for protein matter will retard or arrest the action of the enzymes of the digestive juices and the use of these should be absolutely prohibited. The effect on cell growth and reproduction is also important and should be taken into consideration. If the death of the cell is caused definite injury to tissue will undoubtedly result. An exhaustive series of experiments by investigators of recognised authority should be undertaken to study the effect of any chemical substance possible to be used for food preservation, on enzyme action generally and on cell growth. It would probably be found that some substances now regarded as harmless, owing to their action ought to be prohibited, and it may be discovered that others, whilst arresting cell growth, have little or no effect on enzyme action and consequently could be permitted.

In this direction attention might be paid to some of the coal-tar dyes, (J.S.C.I., 1922, 134T), and to the newer synthetic antiseptic drugs, assuming a safe preservative for foodstuffs is necessary and desirable Wiley's classic experiments carried out on "living squads" though interesting, are inconclusive, conscious sensibility of the subject being an important factor. Until such a series of experiments as those suggested has been conducted successfully, opinions on the use of chemical preservatives in foodstuffs ought to be expressed with caution.

74, Foyle Road, Westcombe Park. S.E. 3
May 3, 1924

BINDING THE "JOURNAL"

As a number of inquiries relating to arrangements for binding the *Journal* have been received, it is desirable to call attention to the offer by Messrs. W. Speaight and Sons, Ltd., the printers of this *Journal*, to undertake the binding at the following prices per volume :- Complete *Journal*, full cloth 13s. 6d., half-leather 15s. 6d.; Chemistry and Industry Review only, full cloth 10s. 6d., half leather 13s. 6d. Those wishing to take advantage of this offer should send their *Journals* direct to Messrs. Speaight, at 98-99, Fetter Lane, London, E.C. 4.

FORTHCOMING EVENTS

May 15. CHEMICAL SOCIETY. Ordinary Scientific Meeting at Burlington House, Piccadilly, W. 1, at 8 p.m. "The Bromo-derivatives of 1-Methylglyoxaline and the Constitution of 'Chloroxalmethylin,'" by I. E. Balaban and F. L. Pyman. "Synthesis of Amygdalin," by R. Campbell and W. N. Haworth, and "Reactivity and Radiation. The Photochemical Union of Hydrogen and Sulphur," by R. G. W. Norrish and E. K. Rideal.

May 16. INSTITUTION OF MECHANICAL ENGINEERS, Storey's Gate, S.W. 1., at 6 p.m. Third Report of the Steam-Nozzles Research Committee.

May 21. BRITISH EMPIRE EXHIBITION. Conferences on "Heredity as the Basis of National and Industrial Efficiency.

May 21. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2, at 8 p.m. (Trueman Wood Lecture) "The Outlook in Chemistry," by Sir W. J. Pope, K.B.E., D.Sc., F.R.S.

May 21. UNIVERSITY OF LONDON, in the Physics Theatre, Imperial College, Royal College of Science, S.W. 7, at 5.15 p.m. "The Optical Effects of Motion," by Dr. P. Zeeman.

May 22. UNIVERSITY OF LONDON, University College Gower Street, W.C. 1, at 5.30 p.m. "On the Nature of Science," Lecture 1, by Prof. A. N. Whitehead, M.A., and Lecture 2, on May 29, by Prof. T. P. Nunn, M.A., D.Sc.

May 27. SOCIETY OF GLASS TECHNOLOGY. Joint Conference with the British Society of Master Glass Painters. Annual dinner in the Hotel Cecil.

May 27. ROYAL SOCIETY OF ARTS, at 4.30 p.m. "The Geology and Mineral Resources of Cyprus," by C. G. Cullis, D.Sc.

May 28. ROYAL MICROSCOPICAL SOCIETY, 20, Hanover Square, W. 1, at 7.30 p.m. "Use of the Microscope in the Examination of Paper," by F. Sheldon Leicester. "The Microscopy of Soaps," by K. MacLennan. "Technical Microscopy," by J. E. Barnard.

June 3. ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, 35, Russell Square, W.C. 1, at 7 p.m. "The Analysis of Motion by Kinematography."

June 3 to 6. EMPIRE MINING AND METALLURGICAL CONGRESS, to be held at the British Empire Exhibition Among other items, papers will be read on the following subjects: —Mining, Petroleum, Metallurgy of Iron and Steel, as well as Non-Ferrous Metallurgy.

June 4. INSTITUTE OF METALS, Annual General Meeting, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 1. "Atoms and Isotopes" by Dr. F. W. Aston, F.R.S.

June 13. UNIVERSITY OF LONDON, University College, Gower Street, W.C. 1, at 5.30 p.m. First of Three Lectures on Physics by Prof. R. A. Millikan. Lectures 2 and 3 to be delivered on June 17 and 19, respectively.

June 16. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2, at 4.30 p.m. "The Mineral Wealth of the pre-Cambrian in Canada," by C. V. Corless, M.Sc., LL.D.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 10.30 a.m.

A preliminary programme appears on this page.

In accordance with the provisions of by-law 23 intimation is hereby given that the following members of Council retire from their respective offices at the forthcoming Annual General Meeting: Dr. E. F. Armstrong, F.R.S., *President*; Mr. Julian L. Baker, Mr. C. S. Garland, Sir Max Muspratt, Bart., and Sir Wm. J. Pope, K.B.E., *Vice-Presidents*; Mr. John Allan, Prof. J. W. Hinchley, Dr. J. H. Paterson, and Mr. W. J. U. Woolcock, C.B.E., *Ordinary Members*.

Mr. W. J. U. Woolcock, C.B.E., has been nominated for election to the office of President under by-law 19; Dr. E. F. Armstrong, F.R.S., Prof. J. W. Hinchley, Prof. J. C. Philip, F.R.S., and Sir Richard Threlfall, K.B.E., F.R.S., have been nominated Vice-Presidents under by-law 20.

Mr. E. V. Evans has been re-elected Hon. Treasurer, and Sir Wm. J. Pope, K.B.E., has been re-elected Hon. Foreign Secretary.

Mr. W. A. S. Calder, Mr. W. H. Coleman, Mr. Wm Cullen, LL.D., Mr. F. W. Gamble, Mr. James MacGregor and Mr. J. Arthur Reavell, have been nominated under By-law 24 to fill four vacancies among the Ordinary Members of Council.

A Ballot List will be posted to every member entitled to vote.

J. P. LONGSTAFF,
General Secretary

The following is a Preliminary Programme of the meetings to be held in Liverpool on July 9-12 inclusive.

WEDNESDAY, JULY 9.—*Morning*: Council Meeting. Annual General Meeting in the Arts Theatre, the University. The President, E. Frankland Armstrong, Esq., D.Sc., F.R.S., will give a technical address entitled: "A Neglected Chapter in Organic Chemistry: The Fats." *Afternoon*: Business Session in the University. Visit to White Star Liner "Cedric," and tea on board by invitation of the White Star Line. *Evening*: Reception and Dance at the Town Hall by invitation of the Right Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.)

THURSDAY, JULY 10.—*Morning*: Messel Memorial Lecture by the Right Hon. Viscount Leverhulme, in the Arts Theatre, the University, and presentation to the Lecturer of the Society's Messel Medal for 1924. Visit to the works of Messrs. Joseph Crosfield & Sons, Ltd., Warrington. Luncheon by invitation of the Directors. *Afternoon*: Inspection of the Works. *Evening*: Annual Dinner of the Society at the Midland Adelphi Hotel.

FRIDAY, JULY 11. *Morning*: Business Session in the University. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of the United Alkali Co., Ltd. Visit to a Works of the United Alkali Co., Ltd. *Evening*: Dinner at Lady Lever Art Gallery by invitation of the Chairman and Directors of Messrs. Lever Brothers, Ltd.

SATURDAY, JULY 12.—Visit to Lake Vyrnwy. Inspection of Liverpool Corporation Water Works.

A detailed programme will be sent later to every member of the Society.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

MEETING OF COUNCIL

The monthly meeting of Council was held on May 9, 1924, the President, Dr. E. F. Armstrong, F.R.S., in the chair.

It was reported that the following had been nominated as Ordinary Members of Council:—Mr. W. A. S. Calder, Mr. W. H. Coleman, Dr. William Cullen, Mr. F. W. Gamble, Mr. James MacGregor and Mr. J. Arthur Reavell. There being six nominations for four vacancies, a ballot will be necessary.

The President stated that the Managers of the Royal Institution consider it desirable to celebrate on June 16, 1925, in association with the chief representatives of British chemistry—the Chemical Society, Society of Chemical Industry, and the Association of British Chemical Manufacturers—the centenary of the discovery of benzene by Faraday in the Institution. At the request of the Council, Dr. E. Frankland Armstrong, F.R.S., agreed to act as the Society's representative on that occasion.

The President reported that he had communicated with the President of the Chemical Society regarding "Chemistry House," and that the Federal Council had appointed a Committee to consider the scheme which he had put forward. This Committee has reported to the Federal Council, and the latter body will meet to discuss the report on May 14.

Reports of various Committees were submitted, and 15 members were elected: Home, 7; Overseas, 8.

The next meeting will be held on Friday, June 13, 1924, at 2.30 p.m.

OFFICIAL NOTICE

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The eighth volume of these Reports is now ready, and copies have been despatched to purchasers.

The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members, post free in each case.

A Member of the Society may purchase a set of Vols. II to VIII inclusive at the reduced price of £2 2s. 6d., and a Non-Member can procure a set at the reduced price of £3 15s., post free in each case.

LIST OF MEMBERS ELECTED, May 9th, 1924

Alcock, Horace E., The Knoll, Luton, Beds. Chemical Manufacturer.

Brelaz, Noel J. M., 71, Webster Street, Ballarat, Victoria, Australia. Distiller.

Culhane, Miss Kathleen, 34, Brook Green, London, W. 6. Chemist.

Eastaugh, Frederick A., University, Sydney, N.S.W., Australia. University Teacher.

Fakhoury, Nazim, Secondary School, Mansura, Egypt. Lecturer in Chemistry.

Garner, Walter B., c/o F. H. Faulding and Co., Ltd., 307/313, Murray Street, Perth, Western Australia. Pharmaceutical Chemist.

Gunton, John A., University of Western Ontario, University Library, London, Ont., Canada.

Hardy, Frederick, Imperial College of Tropical Agriculture, Trinidad, B.W.I. Professor of Chemistry.

Law, Herbert Edward, Lauriston, Palo Alto. Box 245, California, U.S.A. Research Chemist.

Sewell, William G., "Kingsmead," Selly Oak, Birmingham. Lecturer in Chemistry.

Tagg, Samuel, Gas Offices, Preston. Gas Engineer.

Uchida, Shojiro, c/o Mr. Mayard, 2 Moreton Terrace, Old Brompton Road, S. Kensington, London, S.W. 5. Engineer.

Van Schaack, Robert H. Jr., Van Schaack Bros. Chemical Works, 3358, Avondale Avenue, Chicago, Ill., U.S.A. Manufacturing Chemist.

Wallis, Edward, 20, Guildford Road, South Lambeth, London, S.W. 8. Assistant to Consulting Chemist.

Yuill, John L., 3, Hawthorn Place, New Earswick, York. Bio-Chemist.

SOUTH WALES SECTION

On Tuesday, April 29, members visited the Landore works of Messrs. Vivian and Sons, Ltd., by courtesy of the directors. The party, who were conducted by Captain Hugh Vivian and Messrs. Taverner and Hill, saw the copper smelting works, sheet mills, power house, fertiliser works, foundry and acid works. A new Garrett articulated locomotive was of much interest; it is capable of taking the same sharp curves as the ordinary four-coupled small works loco., but consisting as it does of two separate driving units (one at each end of the locomotive, but each mounted as a bogie) it is actually capable of hauling more than double the load of a single engine.

A special meeting of the Section was held, at which a vote of condolence with the widow of the late Mr. H. J. Bailey was passed. The party then visited the laboratory, where, besides the routine work, which occupies a staff of about 25, a large amount of research is conducted under Mr. Herbert J. Williams, F.I.C. (chief chemist) and Mr. L. Taverner (metallurgist). This concluded a very full, and interesting afternoon, for which members are much indebted to Messrs. Vivian and Sons, and in particular to Capt. Hugh Vivian, Mr. L. Taverner and Mr. Hill (chief engineer).

SOCIETY OF PUBLIC ANALYSTS

Mr. G. Rudd Thompson presided over the meeting held on May 7, five papers being read.

The "Estimation of Sugar in Urine by means of Fehling's Solution with Methylene Blue as Internal Indicator," was discussed by J. H. Lane, B.Sc., and Lewis Eynon, B.Sc. The sugar in urine can be accurately estimated by means of Fehling's solution with methylene blue as internal indicator, provided the urine be first rendered neutral to litmus. Defecation of the urine with normal lead acetate and removal of the excess of lead with potassium oxalate enables a sharper end-point to be obtained. This treatment does not remove any reducing sugar, but removes a small amount of reducing non-sugar substances (equivalent to about 0·02 to 0·03 per cent. of dextrose). The results obtained by the method agree closely with those given by Gerrard's cyano-cupric method, but are considerably lower than those given by Pavy's method, this difference being attributed to the estimation of non-sugar substances in the latter method. Methylene blue can also be used as an internal indicator with Pavy's or with Benedict's solution.

Mr. J. J. Considene described the construction of, and method of using three simple forms of hydrogen electrode, which can be readily made from apparatus used in every laboratory, including an electrode for general use, a "micro" modification of this, and a modification of the capillary form of electrode, which has been found useful for fluids of low conductivity.

A "Note on the Recognition of Hydrogenated Oils" was presented by K. A. Williams, B.Sc., and E. R. Bolton, F.I.C. During the hydrogenation of oils iso-oleic acid is formed. This acid does not occur in nature; it is an isomer of oleic acid, has an iodine value of 90, and is characterised by the insolubility of its lead salt in organic solvents, in this respect resembling the saturated fatty acids and not the unsaturated ones. The authors suggest that for the detection of hydrogenated fats the iso-oleic acid content of the fat should be determined. This is done by performing the ordinary lead salt ether separation of the fatty acids, by which the iso-oleic acid is separated from all other unsaturated acids, and appears in the fraction containing saturated acids: in this it is estimated from the iodine value. The effect of the use of various solvents for the separation is recorded, methylated ether or alcohol being recommended. Figures are given showing the amount of iso-oleic acid to be expected in fats hydrogenated to various degrees, and examples of the application of the method are discussed.

"Notes on the Analyses of Milk Powders and Condensed Milks" were given by Dan W. Steuart, B.Sc. The citric-acid content of full-cream milk powders averaged 1·16 per cent. and of skim-milk powders 1·55 per cent., equal to about 0·144 per cent of anhydrous citric acid in the original milk. The citric acid content of pure milk products is equal to about one-fifth of the ash. Analyses of milk powders and condensed milks are given. Lactose is estimated

by the reduction method of Lane and Eynon (using methylene blue as an internal indicator), after removing the protein and lime.

ROYAL MICROSCOPICAL SOCIETY

Mr. A. Chaston Chapman, F.R.S., presided over the meeting on April 16, when Dr. T. Goodey, D.Sc., read a paper on "Recent Work on Nematode Life History," describing recent investigations into the life-history of several nematode worms parasitic in plants and animals. The following came under review: *Tylenchus dipsaci*, causing stem diseases in a number of economic plants; *Tylenchus tritici*, causing "cockles" in wheat; *Allantonema mirabile*, from the body-cavity of a weevil; *Hæmonchus contortus*, the stomach worm of sheep; *Ancylostoma duodenale*, the human "hookworm"; *Syngamus trachealis*, causing "gapes" in chickens; *Ascaris spp.* of various animals, and *Habronema megastoma*, from the stomach of the horse. Prof. E. W. Carlier, M.D., B.Sc., communicated a paper by Mr. T. H. Rogers, on "Electric Methods of Staining the Radulæ of Mollusca."

At the meeting of the Industrial Applications Section, on April 23, the Hon. Sir Charles Parsons, K.C.B., D.Sc., F.R.S., took charge of the chair. Miss Annie D. Betts, B.Sc., read a communication on "The Practical Use of the Microscope in the Bee-keeping Industry," in which she showed that the principal use was in diagnosing diseases of bees, and in deciding questions such as colour inheritance and purity of breed. Probable changes in the Merchandise Marks Act might open up a wide field of work for the consulting microscopist in deciding the country of origin of honey samples. A knowledge of the forms of pollen-grains enabled the bee-keeper to determine, by examining the pollen collected by the bees, the times of the flowering of the local nectar and pollen plants, information of great practical value.

Mr. C. F. Hill read a communication by Mr. Sydney R. Wycherley, on "Fibres, Analytical and Economic." The study of fibres was of great interest, not merely to the research worker, but for practical purposes. From the analytical point of view it was desirable to make standard sets of slides, which would become the key slides from which materials to be tested could be judged. In examining various products the plant hairs, being difficult to destroy, and often characteristic in form, provided a means of investigating the purity of a compound and the amount, if any, of the adulteration. The study of fibres from the economic point of view was also of great value. Cotton fibres were characterised by a peculiar twist and the regularity of that twist together with the thickness of the hair itself, was one of the tests for the quality of the cotton fibre used. In addition, animal fibres, such as wool, formed important lines of investigation. The scale marks covering the outer cuticle of the wool were very constant in various qualities of wool, and formed an important character in testing for quality.

ACADÉMIE DES SCIENCES

On April 22, Dr. Roux communicated a paper by M. Ramon on "anatoxins," a name given by the author to products derived from toxins or from vegetable or animal toxic proteins, which, on undergoing suitable treatment, such as the addition of formaldehyde, lose their toxicity, but still act towards the antitoxin as if they were true toxins, and also confer active immunity. Mr G. Bertrand said that in studying snake poisons, he had obtained similar results.

On April 28, M. Mangin described the effect of thorium X on various vital phenomena, and M Branby discussed the theory of the formation of ozone by electrical action.

SOCIÉTÉ DE CHIMIE INDUSTRIELLE

On May 2 the metallurgical and mineral industries group met, under the presidency of M Gall, to hear a paper by Prof. C. Matignon, on "The new physico-chemical methods of qualitative analysis by means of X-rays. After paying tribute to the work of Sir J. J. Thomson and of Dr. Aston, the speaker described the extraordinary delicacy and sensitiveness of these new methods dealing with infinitesimal amounts of matter. Thus, the carbon atom weighs only one milliardth part of a milliardth part of one-hundredth of a milligram, yet so small a mass could be determined with the greatest precision. In a mixture, all the elementary constituents could be identified by their mass. In one c.c. of air, containing only 5 millionths of helium, the presence of that element could readily be distinguished; in fact the 5 millionths of one c.c. of air already contained 10^{14} molecules of helium, and thus furnished the material for identification. By mechanical methods it had been made possible to weigh particles that are more than 10^{10} times smaller than the smallest particles visible in the ultra-microscope. Atoms and molecules are ionised positively, and possess a magnetic and electric charge; when moving at a certain speed they undergo deviations depending on the speed and mass of the particle, so that when this double deviation had been measured, both speed and mass could be calculated, the deviations being determined by the points of impact on a photographic plate. No longer of purely scientific interest, these methods were now being utilised in metallurgy, paper-making, and tanning-extract making.

Monsieur A. Bigot then read a paper on the treatment of towns' refuse, first calling attention to the properties of "basic glass," a material which resisted ordinary acids, and was fairly hard, being more resistant to mechanical agents than most rocks. By treating the slags obtained on incinerating town's refuse, basic glasses had been obtained, and this led to a study of the methods of disposal of town's refuse. Part of this refuse was utilised by agriculture; another part was incinerated under boilers to raise steam for electrical generation, and the slag was discharged, but the process ran at a loss owing to the cost. Another part was utilised under a power plant,

but the residue was utilised in making sand-lime bricks, the gross profit being 3 fr. per ton of refuse treated, even if the process ran at a loss. The residue contained excess of sulphur and carbon, as the conditions of combustion were bad, and sand-lime bricks made from it blackened in the air, and became covered with efflorescences, and rusty-looking, consequently being of little use. By means of improved methods, the residues could be produced of a quality suitable for making bricks or cement; and by fusing with suitable materials at high temperatures, glasses could be obtained for the manufacture of bottles, glasses, recipients, insulators and the like. Such a process provided the means for the rational and profitable utilisation of town's refuse.

FINSBURY TECHNICAL COLLEGE

The London County Council has addressed a letter to the council of the City and Guilds of London Institute informing them that after consideration of all the circumstances the Council has reluctantly come to the conclusion that it will be unable to continue the financial grant in aid of the college after July 31, 1926. The County Council feels that it is difficult to justify the comparatively large expenditure which at present falls on public funds in connexion with the maintenance of the college, in view of the fact that there are a number of other institutions making provision for training in engineering and chemistry which could absorb, without difficulty, the number of students now attending the Finsbury Technical College. In these circumstances the Council of the Institute states, according to *The Times*, that there is no alternative but to make arrangements to close down the college in July, 1926, or possibly before that date.

NEW BIOCHEMICAL LABORATORIES AT CAMBRIDGE

On May 9, Lord Balfour opened the new Sir William Dunn Biochemical Laboratories at Cambridge, thus making it possible to concentrate all the activities of the School of Biochemistry in one building. The late Sir W. Dunn left the residue of his estate for the "alleviation of human suffering," and his trustees decided to allocate £210,000 for the new laboratories, which have cost £96,000 and contain a large general laboratory at the top of three stories as well as 20 well-equipped rooms for research.

The Council of the Institution of Civil Engineers has made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1923-1924:—A. Telford Gold Medal to Prof. C. E. Inglis, M.Inst.C.E.; Watt Gold Medals to Mr. H. N. Allott, M.Inst.C.E., and Mr. S. L. Pearce, M.Sc.Tech., M.Inst.C.E.; Telford Premiums to Mr. A. J. Martin, M.Inst.C.E., Dr. H. E. Hurst, Mr. D. A. F. Watt, D. H. Remfrey, B.Eng., Assoc.M.Inst.C.E., and William Burnside, Assoc.M.Inst.C.E.; a Crampton Prize to Mr. T. R. Nolan, B.E., M.Inst.C.E.; and a Manby Premium to Mr. H. T. Tudsbery, M.Inst.C.E., and Mr. A. R. Gibbs, Assoc.M.Inst.C.E.

FEDERAL COUNCIL FOR PURE AND APPLIED CHEMISTRY

DYESTUFFS INDUSTRY

The following letter was recently sent by Sir William Pope to the Rt. Hon. Sidney Webb, President of the Board of Trade.

Sir,—The Federal Council for Pure and Applied Chemistry is elected by the principal scientific and technical societies interested in chemical subjects—18 in number—and is concerned with those large corporate interests which are common to the electing bodies. The Federal Council desires to place before you certain views concerning the contemplated agreement between the British Dyestuffs Corporation and the German combine known as the Chemische Interessen Gemeinschaft.

It will be remembered that British Dyestuffs, Ltd., which later became the British Dyestuffs Corporation, was created with Government support, financial and otherwise, with the express object of rendering this country independent in future of German domination in the dyestuffs industry. It was recognised universally at the time, and nothing has since transpired to weaken the conviction, that a flourishing and independent coal-tar colour industry is essential to Great Britain.

Although no official information as to the nature of the agreement contemplated between the British Dyestuffs Corporation and the Interessen Gemeinschaft has been announced, yet it has been stated, and without contradiction, that the German organisation is to be under an obligation to render any available and technical assistance, and that the British Dyestuffs Corporation is to be granted a monopoly for the importation and distribution of German dyestuffs and intermediates not produced in this country.

The Directorate of the British Dyestuffs Corporation, though including a number of eminent personalities, is a lay board of which no member has achieved distinction in connexion with dyestuffs manufacture, whilst the directorates of the corresponding German organisations consist of men who have all made brilliant careers in the industry. It would seem to follow that under the arrangement outlined the technical part of the British organisation will ultimately fall under German control. The handicap to the future development of British technical chemical talent thus introduced will be obvious. The state of affairs which prevailed before the war will thus practically become re-established, and the British dyestuff market will be again under German domination.

The granting of a monopoly for importation to the British Dyestuffs Corporation can only result in the extinction of the firms outside the British Dyestuffs Corporation which also manufacture dyestuffs. In this connexion it must be remembered that certain of these firms have been very successful as manufacturers of high-class and other dyestuffs and have thus proved their ability to succeed in the absence of such a handicap as would be imposed by the suggested monopoly of importation.

The dyestuff factories in Germany have proved to be creative centres which have initiated and carried into practice, both profitable and utilitarian discoveries in organic chemistry which have had far-reaching beneficial effects in many important industries and professions. They have introduced large numbers of new substances which have proved valuable in photography and almost every other technological industry which uses organic chemicals; they have also produced great numbers of organic compounds which are of marked value in the treatment of disease. Only a year or so ago the firm of Bayer introduced the organic substance No. 205, which is claimed, and apparently with justice, to be an absolute specific in cases of sleeping sickness; the British Government sent a Commission of German scientific men to Africa to test the efficacy of this material, and at a meeting of the German Association for the Study of Tropical Diseases it was stated that the secret of Bayer 205 must be preserved and used for the recovery of the German Colonies.

The German dyestuff industry may be regarded as a kind of network which carries with it and supports many important technological developments in other branches of organic chemistry; in fact, the staple products separated from coal-tar not only serve in the manufacture of dyes but also constitute the starting materials for the preparation of great numbers of important organic compounds which are not colouring matters. The fact that the German dyestuff industry is under the control of scientific and technical chemists, fully alive to all the important possibilities of their ostensible industry, facilitates the developments of those ramifications which have made the dyestuff industry necessary to a number of industries with which, at first sight, it appears to have no connexion.

It is clear that if the scientific and technical sides of the colour industry again lapse into German hands, and the British organisation merely retains certain merchanting rights, as seems to be indicated by the suggested form of co-operation, all the technical and professional interests which use organic chemical substances will remain dependant on Germany for every detail of progress.

Scientific and technical chemists, of course, recognise that further great advances will occur in connexion with the manufacture and applications of synthetic organic compounds. Immediately after the war, and encouraged by official declarations to the effect that the dyestuff industry of Great Britain would never again be allowed to fall under German domination large numbers of young people took up the profession of chemistry; during the last few years the number of entries for chemical subjects in our Universities and colleges has greatly diminished. The student public is becoming disillusioned; it discerns a tendency towards once more surrendering supremacy in the development of technical chemistry to Germany. This view of the situation has found confirmation in the wholesale dismissals of research chemists from the employ of the British Dyestuffs Corporation; these dismissals are, of course, regretted by all, but they were doubtless necessitated by financial considerations. Large numbers of highly trained chemists are at present out of employment; this cannot but have a seriously depressing effect upon higher scientific studies in this country.

We fully realise that criticism without constructive suggestion is of little value, and we desire to put several propositions before you. These are as follows:—

(1) That any working arrangements which are made should respect the original object of the Government-supported dyestuff scheme, namely, to free the organic chemical industries of this country from foreign domination.

(2) That no one manufacturing concern which has received Government support should be granted monopolies which would enable it to crush other enterprises which have achieved a large measure of success on non-official initiative.

(3) That it should be realised that the coal-tar colour industry is not only an essential part of a widely extended organic chemical industry, but that it is a part of, and is largely dependent on, the whole chemical industry of the country; and that this realisation should be reflected in the composition of the directorate of the British Dyestuffs Corporation and its policy.

(4) That, quite apart from immediate questions of financial return, means should be adopted for developing technical research in organic chemistry in the laboratories of the British Dyestuffs Corporation, for the purpose of utilising the undoubtedly great potentialities as research workers of our chemical students. It may indeed be desirable to finance this educational object by some method independent of the British Dyestuffs Corporation. Our national well-being demands that every effort shall be made for promoting research in chemistry and that no step shall be taken which will tend to throw any part of this duty on any foreign country.

The Federal Council desires to call your attention to the great contributions which this country has made in the past to chemical science and to the manifold activities of our chemical schools at the present time. It expresses its conviction that, given encouragement, the magnificent results of British chemistry during the war are capable of translation into a flourishing organic chemical industry in the near future.

In conclusion we invite your earnest attention to the great progress which has been made in the organic chemical industry of this country under recent legislation; large numbers of organic compounds not previously made in this country on an industrial scale are now being produced as regular articles of commerce.

That this result has been achieved under the difficult conditions of recent years is a happy augury for the future of chemical industry in Great Britain. —I am, Sir, Your obedient servant,

(Signed) W. J. POPE.

President of the Federal Council for Pure and Applied Chemistry

April 8, 1924

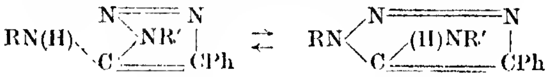
The Right Hon. SIDNEY WEBB, M.P.,

President of the Board of Trade

CORRESPONDENCE

THE AMINOTRIAZOLES

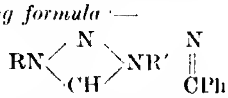
Dear Sir,—In the report (this week's *Chemistry and Industry*) of my remarks relating to Mr. Dutt and Miss Carnelly's aminotriazoles, the printers have garbled some of the formulæ, inserting a 4-membered ring in them in such a way as to suggest the negation of my actual meaning, or, at least, render it unintelligible. Formulæ (i) and (ii), p. 486, should read :—



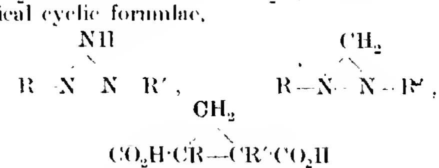
(i) (ii)

(R = phenyl ; R[1] = *p*-tolyl)

And my point, obscured by the misprints, was that this direct interchange is of known type, and that a proof of the effective equivalence in the molecule of R and R′ *does not necessitate a symmetrical 4-membered ring formula* :—

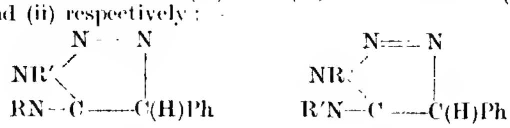


any more than a similar equivalence in such compounds as R—NH · N : N—R′, R—NH · CH : N—R′, or $CO_2H \cdot CHR \cdot CH : CR' \cdot CO_2H$, necessitates symmetrical cyclic formulæ,



for diazoamino-compounds, amidines and glutaconic acids respectively.

The two isomerides actually isolated, which were tertiary bases and were stated to have the properties of anils, are in my view actually anils—namely, the imino-tautomerides (iii) and (iv) of the enames (i) and (ii) respectively :—



(iii) (iv)

They are the more stable forms, but are reversibly convertible into the enames (i) and (ii), these secondary bases being favoured by strong mineral acids :

(iii) → (i) ⇄ (ii) ← (iv)
stable *unstable* *unstable* *stable*

(*excepting as salts in strong acid solution*).

These changes are all of thoroughly well-recognised types, and thus the complex system of polycyclic tautomerides imagined by Mr. Dutt and Miss Carnelly appears to have small foundation.

The question of the intervention of a cycloid in tautomeric change is of such importance that I think it is desirable to correct the confused report which has appeared.—I am, Sir, yours faithfully,

CHRISTOPHER INGOLD

QUALIFIED AND UNQUALIFIED CHEMISTS

Sir,—In your issue of the 9th inst. "Fuel Technologist" asserts that the Institute of Chemistry is right in insisting on chemistry as the essential in dyeing. It would be interesting to have the reasons for this assertion. As a pass B.Sc. with 25 years in the dyeing industry I beg entirely to disagree with him. If "Fuel Technologist" knew of the dyeing problems still awaiting solution, *e.g.*,

(1) The Theory of Dyeing ;

(2) The Action of Light on Dyed Fabrics ;

and had read recent literature thereon, he would at once realise that physics and mathematics are of equal importance in dyeing as in fuel technology, whilst in the industry a knowledge of engineering is also very useful.

In the industrial application of chemistry it is not only scientific qualifications which are required, but of far more importance is the requisite horse sense to adapt oneself to industrial conditions. A qualified chemist plus horse sense is a pearl without price, but failing him an unqualified chemist plus horse-sense is a very good substitute.

Whatever steps are finally taken regarding the necessary legal qualifications of a chemist, it will still be found that the qualified or unqualified chemist who graduates most quickly in the University of Horse-Sense who will secure the highest positions open to chemists. When this problem of qualifications is finally settled, I suppose the qualification test will to be applied to those gentlemen who are subsequently nominated to the presidential chair of the Society of Chemical Industry.—I am, Sir, yours, etc.,

Cheadle Hulme, C. M. WHITTAKER
May 11, 1924

Sir,—I was very interested to read "Fuel Technologist's" letter *re* "Qualified and Unqualified Chemists," and I heartily agree that the A.I.C. should, in most cases, be conferred only upon those who possess "practical" experience. To be a qualified chemist, it is not sufficient merely to possess a certain amount of knowledge ; one should also be able to apply it, either in industry or in imparting that knowledge to others. With this end in view I suggest the following amendment to qualification (2) proposed by "Fuel Technologist."

A.I.C. should be conferred upon those possessing (*a*) B.Sc. (Honours, 1st or 2nd class) ; (*b*) M.Sc. (*c*) D.Sc.—provided the applicant has been engaged in the application of chemistry for, say (*a*) 3 years ; (*b*) 1 year ; (*c*) ——.—I am, Sir, etc.,

AN A.I.C.-TO-BE

PALMA ROSA OIL

Sir,—In your issue of May 9, page 500, we notice you quote Palma Rosa Oil at 19s. per lb., very short supply.

As large importers of this Oil, we should like to point out that we have a good supply now in London, and the price is 17s per lb.—Yours, etc.,

D. WALDIE & COMPANY (LONDON) LTD.,
P. H. CRUICKSHANK,
Secretary

PERSONAL AND OTHER ITEMS

Notes from Canada

Sir William Ellis, G.B.E., D.Eng., has been elected President of the Iron and Steel Institute. The Bessemer medal of the Iron and Steel Institute has been awarded to Prof. Albert Sauveur; the presentation was made during the Annual Meeting on May 8.

The Daly-Alaska Company purposes erecting a mill at early date, at its mine on Portland Canal, B.C.

C. L. St. Clair, of Camden, New Jersey, representing Eastern American and Canadian capitalists, has announced the erection of a smelter, on a deep water site, in Vancouver, B.C. The plant is to cost five million dollars. Erection will commence at once, and will have a capacity of 1000 tons a day.

British Columbia's leading mine, the Premier, on Salmon River, Portland Canal, has declared its first quarterly dividend for 1924. The share capital of the company is $5,000,000, and the first dividend was declared three years ago. The total payments on dividends have been $5,400,000, thus exceeding the capital by $400,000. Stewart, B.C., is the shipping port.

A rich strike has been made at the Dunwell property on Bear Creek, Portland Canal district, B.C. The general run of the mine is equal to the Premier, the ore body having a width of 50 feet and valued at from $20 to $30 per ton, with some rich ore running into hundreds of dollar per ton.

The Dominion Tar and Chemical Co., Sydney, N.S., has an order for creosote, from the Canada Creosoting Co., Trenton, Ont., amounting to one million gallons, which is being forwarded, by tank cars at the rate of 10,000 gals. daily. There is a shipment being made of 4000 t. of pitch to France. The tar from the British Empire Steel Co. amounts to 20,000 gals. a day.

The maple sugar output of the province of Quebec, this spring, has not been as large as anticipated. The sap was not as high as usual in sugar content. The total yield will be about 22,000,000 pounds, valued at about $5,500,000. The sugar campaign extended over seven weeks.

C. E. Wallin, for some years superintendent of the coke ovens department of the British Empire Steel Co. has resigned his position, and will leave shortly for England, where he has accepted another position. He will be succeeded by D. W. Nicholl, formerly Assistant Superintendent.

Hon. Chas. McCrea, Minister of Mines, Ontario, is in England upon official business connected with the mining interests of the province.

Balmer Neilly, B.A., Sc., M.E., Secretary of the Mining Association of Ontario, has resigned and joined the management of the McIntyre-Porcupine gold mine.

The British Columbia Electric Railway is erecting an addition to the gas plant at Vancouver, B.C., costing $400,000, with a capacity of 1,750,000 cubic feet a day, which will be finished and operating before the close of the year. The contract has been awarded to the West Gas Improvement Co., of Manchester, England. The additional plant, of forty vertical retorts, will be placed by the side of the present twenty-four vertical, but of a new type. A bench of Spencer-Bonecourt water-heating steam boilers will be installed. A coke-briquetting plant of 25 tons capacity per diem will also be erected. A large number of subsidiary improvements will be installed to bring the plant up-to-date. A complete ammonia-recovery plant will be one of the features. The company will erect a new gasometer at its Victoria, B.C., works with a capacity of 500,000 cubic feet. The construction is in the hands of R. Dempster and Sons, of Elland, Yorkshire.

The Thunder Bay Paper Co., in which American interests at Appleton, Wis., are interested, is increasing the capacity of its mill from 65 tons a day to 160 tons. The enlargement is to be completed by August 1.

The Fourth International Conference on Soil Science

The International Conference on Soil Science, which is being held in Rome at the International Institute of Agriculture, from May 12 to 19, will be the fourth of a series. The first was held in 1909 in Budapest, the second in 1911 in Stockholm, and the third in 1922 in Prague. The number of communications and reports to be presented amounts to over 200, fundamental questions of soil science being treated in a way that shows the intimate relationship between soil science and agricultural industry.

The proceedings of the Conference will be published in the form of a volume of about 1000 pages, containing all communications, conferences, reports, memoirs, discussions, etc., illustrated with diagrams, graphs, figures and maps. The price to members for copies of the Proceedings is 15s., and to others 30s. Further particulars can be obtained from the Organising Committee of the IVth International Conference on Soil Science, International Institute of Agriculture, Villa Umberto I, Rome, 10.

Reported Spanish Metallurgical Syndicate

It is reported that nearly all the foreign companies that work metal mines in Spain are considering the formation of a mining and metallurgical syndicate, jointly with important foreign metallurgical interests.

Mining and Metallurgy in Canada

The extensive coal areas of Inverness County, Cape Breton, have been secured by the recently incorporated Eastern Collieries Ltd. The chief shipping port will be Port Hastings, and the general management of the mines will be conducted by Alfred J. Tonge, M.E., assisted by T. J. Brown, M.E., at present Deputy Commissioner of Mines for the Nova Scotia government. Both engineers were formerly employed with the predecessors of the British Empire Steel Co. The Canadian National Railway is operating the Inverness and Richmond Railway. Coal depots will be established in various cities in Eastern Canada. British financial men are interested in this undertaking and they will be associated with Canadians on the directorate.

The Coal Industry in France

Production has increased from 31,940,000 metric tons in 1922 to 38,540,000 t. in 1923, thus approaching the normal production of 1913 when 40,840,000 t. was produced. The daily output has risen from 136,147 t. in January, 1923, to 141,680 t. in January, 1924, the latter figure corresponding with an annual production of over 43,000,000 t. Similar improvements in the production of coke suggest that soon an output of 245,000 t. per month can be expected. The consumption of coal has also increased, rising from 59,321,000 t. in 1922 to 66,676,000 t. in 1923, compared with 63,978,000 t. in 1913. Of the consumption in 1923, 58 per cent. was produced in France, but imports of coal have increased from 22,421,000 t. in 1921 to 26,268,000 t. in 1923, whereas imports of coke have decreased from 5,142,000 t. in 1922 to 3,628,000 t. in 1923, and briquettes also show a decrease. The increased imports have come mainly from England, whilst imports from Germany have decreased and those from Belgium remain approximately stationary. Exports have increased from 267,900 t. in 1922 to 3,011,000 t. in 1923.

French Ceramic Industries Congress

The technical congress of the ceramic industry organised by the Syndicat des Fabricants de Produits Céramiques de France, will be held in Paris on June 2 and 3, 1924. The questions to be discussed will include the results obtained from continuous ovens, experimental methods for determining temperatures in ceramic ovens, theoretical and practical study of ventilation in ovens, pulverised fuel and heavy oil as heating agents, use of artificial drying, the plasticity of ceramic products, and many other subjects

Industry in Tonkin (Indo-China)

Anthracite is found abundantly near Hong-hai, and can be mixed with " fat " coals of Thai N'Guyen, the region where, owing to the presence of iron ores, a works is being erected to produce 150 tons of steel per day. Tungsten is also abundant, and although the presence of petroleum is known, actual working has not yet begun. The Société des Ciments Portland de l'Indo Chine manufactures 150,000 tons of cement yearly. Soda and chlorine are manufactured by the Société des Prodoits Chimiques d'Extrême Orient, at Hanoi, and there is a fairly large production of alcohol and bamboo paper.

Canadian Textile Industries

The woollen textile industry of Canada in 1922 was generally considered to have had an unprofitable and unsatisfactory business year. This is not confirmed in the bulletin of Dominion Bureau of Statistics just issued, covering the above period. The total value of products is given as $29,062,751, while the cost of production, including materials was $25,330,812, leaving a favourable balance of $3,731,939 or over 10 per cent. on a total investment of $37,102,382. The value added to their products by manufacture is placed at $15,202,772. Wages and salaries amounted to $7,190,544, of which $1,286,068 were paid in salaries. Cost of fuel $671,154, materials $13,859,979, and miscellaneous expenses $3,609,135.

Canadian Hydro-Power Development

The Hydro-Electric Power Commission of Ontario, is faced with a demand for 53,000 h.p. before the end of 1924, from the Nipigon power plant, near Port Arthur, Ont. It is now calling for tenders for the installation of units five and six which, when completed, will bring the total capacity of the Cameron Falls plant up to 72,000 h.p. The commission is considering raising the level of Lake Nipigon in order that the power requirements of Fort William and Port Arthur may be taken care of.

Natural Gas and Oil in Canada

The Rogers-Imperial Co., while boring for oil five miles north of the International boundary, in the Sweet Grass district about thirty miles of Coutts in South Alberta, struck gas at 2500 feet, and the flow is now estimated at 20,000,000 cubic feet daily. The gas will be tested for gasoline content. This gas well is situated about twelve miles north of the large oil producing district of Northern Montana.

Upper Silesia Zinc and Lead Works

As for some months, the blende roasting and zinc smelting works are producing crude zinc, zinc oxide, zinc sulphate, and cadmium sufficiently to supply the demand while stocks are being added to. The sheet-zinc works have barely been able to maintain their output, while the lead and silver works have been producing less lead, litharge, and silver lately than a few months ago.

LEGAL INTELLIGENCE

THE AFFIX A.M.Inst.C.E.

The Institution of Civil Engineers v. Dey and Roy.

Mr. Justice Tomlin heard a motion by the Institution of Civil Engineers against Birendra Nath Dey and Promod Nath Roy, for an injunction restraining them and each of them from using, or allowing to be used, after or in connexion with the name of B. N. Dey, or in connexion with any profession or business carried on by them, and from printing or writing on any document issued and published by them or either of them the words " Associate Member of the Institution of Civil Engineers," or any letters or words or designation to the same effect. The subject of the plaintiff Society's complaint was that the defendants had employed after the name of the defendant, Dey, the description A.M.Inst.C.E. in the printed headings of letter paper. That was not justified, and it was understood that the defendants were willing to treat the hearing of the motion as the trial of the action, and to submit to a perpetual injunction in terms of the notice of motion and pay the costs. This was

greed to for the defendants, and Mr. Justice Tomlin aid there would be an order accordingly.

For the defendants it was stated that the description had been inserted in the headings of a few letters by inadvertence.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

British Dyes

On the 13th inst., Mr. Sidney Webb (President of the Board of Trade), in reply to Mr. Black, said the values of German reparation dyestuffs received by this country for the years ending March, 1923 and 1924, were respectively £301,400 and, approximately, £94,000. The terms of agreement with the British Dyestuffs Corporation would be circulated in the official report.

Mr. Waddington asked whether any statement had been presented on behalf of the British Dyestuffs Corporation which embodied the heads of the proposed agreement with the German combine, and whether before the agreement could be further advanced the approval of the Government would be given to such statement.

Mr. Webb replied that negotiations between the parties to the proposed agreement were being continued. The Government had been made aware in outline of the terms now being further considered, but until the examination of them was completed he was not in a position to make any statement on the subject.

Mr Sandeman: Can we have an idea when full information will be given on this question, because it is causing a great deal of unrest in the industry?

Mr Webb: The Government is not a party to the negotiations and has no power to intervene except with regard to the exercise of the power given to it under the charter, and that can only be done when agreement has been reached.

Mr Sandeman: Will the House be consulted before agreement is made?

Mr Webb: I cannot say that because we are not parties to the agreement, but I can say that no action will be taken to put in force the powers of the Government without the House receiving notice.

British Exports to Poland

Sir J Brunner asked the President of the Board of Trade whether he was aware that British goods imported into Poland were subjected to higher import duties than French and Belgian goods and whether the Government were taking steps to rectify this discrimination.

Mr Webb replied that a commercial treaty securing the removal of this discrimination was signed at Warsaw in November last and would come into force fifteen days after ratification. He understood that it still awaited confirmation by the Polish President. When this was given immediate steps would be taken by his Majesty's Government to ratify it.

REVIEWS

Pharmaceutical Analysis. By Azor Thurston. Pp. 409. London: Chapman and Hall, Ltd. Price 21s. net.

The title of this excellently printed book is not a happy one. Whatever may be the precise significance of the words "pharmaceutical analysis," the contents of the work have little to do with medicinal drugs, and the range of foods dealt with is limited. Possibly the quite independent volume contemplated in the preface may be intended to fill up the gaps.

The first 78 pages are devoted to instruments, determinations of physical constants and general analytical methods, after which follow 95 pages on oils, fats and waxes, in which, logically perhaps but quite unexpectedly appear cocoa, chocolate, mercury ointment and "animal flour." After this are 89 pages on dairy products and six on eggs and egg products, including an awkward page on the use of egg albumin in baking powder, although that substance itself is not dealt with in the book. The remainder of the volume (109 pages) treats of the essential oils.

The book is primarily intended for the American worker, the official analytical processes, definitions, standards and limits being those of the U.S.P. and of the United States Department of Agriculture, and all the legal decisions are those of the "Federal notices of judgment."

The definition and standardisation of foods and drugs has been developed in America to an extent far beyond anything here, and the experience gained is certainly of value in this country, although hitherto the adoption of legally binding limits does not meet with universal approval. Amongst the substances dealt with in these pages, some are rarely, if ever, mentioned in our British text-books. Some because they do not reach our markets, and some perhaps because owing to our cumbrous laws or our outworn administration they are not readily amenable to legal control. Among these are "Crisco" and "Vegetole" (hydrogenated cottonseed oil products); "Natto" (a vegetable cheese): buttermilk tablets (a lactose inverting ferment): "Hamburgh steak" and homogenised dairy products. The oyster and its sophistications and the domestic egg and its substitutes have received special attention over there, even extending to what sounds like a work of supererogation—an "installation and equipment of an egg-breaking plant."

The general arrangement of the subject matter is unusual. Cocoa is dealt with under cacao butter, and dairy and egg products and flesh foods are sandwiched between the fatty and the essential oils.

The first four chapters on apparatus and methods are, as a whole, full and clear, but the treatment is somewhat unequal; the section on specific gravity, though interesting, contains too many references to semi-obsolete methods for a practical work, and yet is quite inadequate for a historical treatise.

The chapter on the polarimeter is on conventional lines, and along with most of our well-known text-books suffers by giving empirical directions which will be more easily followed than understood. Three pages devoted to figures for the optical rotation or

essential and fixed oils, alkaloids, etc., in this chapter are out of position, and in most cases are repeated over again under the appropriate headings in the main part of the book.

In spite of these slight defects in the arrangement of the subject matter, the actual utility of the book does not seriously suffer, as there is a very complete table of contents and the articles on individual substances are in alphabetical order.

An excellent feature is the bibliographical notes which include references to every modern original paper, from the chief English and American periodicals up to the end of 1921. They are most conveniently placed immediately after each article.

The writing is clear, terse and interesting, contains no serious misprints and, within the limits of the 400 odd pages, gives an excellent account of the various substances dealt with, and is liberally supplied with tables of physical constants and analytical data.

The type and general get-up are all that could be desired. CECIL H. CRIBB

MONOGRAPH ON CORROSION TESTS AND MATERIALS OF CONSTRUCTION FOR CHEMICAL ENGINEERING APPARATUS. *By* W. S. CALCOTT, J. C. WHETZEL, and H. F. WHITTAKER. *Published by the* AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. *Pp.* vi + 182. *New York*: *D. Van Nostrand Co.*, 1923. *Price* \$3.

This monograph contains two papers, namely, (1) "Laboratory Corrosion Tests," by W. S. Calcott and J. C. Whetzel; (2) "Materials of Construction for Chemical Apparatus," by Harold F. Whittaker, together with discussions on the same. Both the authors and the American Institute of Chemical Engineers express their indebtedness to the du Pont Company for permission to publish the information, some of which has been gained through practical experience in the works, the remainder having been collected from general scientific literature. The hope is expressed that the example of this firm will stimulate others to release like information.

The first paper deals exclusively with laboratory tests, on various commercial metals, both ferrous and non-ferrous. As the object has been to determine which metals are most suitable for construction of plants to withstand the attack of chemicals the problem of atmospheric corrosion is not dealt with. The authors define, for the purpose of their report, the corrosion of a metal as "the reaction between the metal and another chemical compound by which a metallic product is formed which, possessing no mechanical strength, decreases the usefulness of the metal."

After discussing theoretically a number of factors which affect the rate of corrosion, accounts are given of different methods that have been tried in the laboratories with a view to determining the resistance offered by various substances towards such corrosive agents as mineral and organic acids, alkalis, aldehydes, complex dyes, etc. The paper contains a large amount of useful information not generally obtainable elsewhere, and the bibliography, which occupies some 18 pages, is a particularly valuable compilation.

The second paper deals with the subject from the point of view of practical experience. An engineer who wishes to construct a plant must not only consider the initial cost of the material, but the rate of corrosion as well, because replacement and repair costs may be so heavy with unsuitable materials as to render less corrodible, but more expensive, metals by far the cheapest in the long run. Amongst other things it is stated that aluminium is gradually replacing copper for the concentration of pure acetic acid, although copper still remains the most suitable material in the distillation of the crude acid, owing to the presence of formic acid which has a very destructive action on the aluminium. Numerous other facts of practical experience are given. The book makes most delightful reading and the Institute is to be congratulated upon its production.

J. NEWTON FRIEND

COMPTES RENDUS DU TROISIÈME CONGRÈS DE CHIMIE INDUSTRIELLE (PARIS, October 21-27, 1923) Pp. 1000. Paris: Société de Chimie Industrielle, 49, Rue des Mathurins. Subscription price, 50 francs.

The "Comptes-rendus" of the third Congress of Industrial Chemistry, held in Paris in 1923, have been edited by Monsieur Maurice Deschiens, and are being published by the Société de Chimie Industrielle. The volume opens with introductory chapters describing the organisation of the Congress, its division into groups and sections, the receptions and formal meetings, other work of the Congress, and visits to works and excursions. Then follow in extenso the important addresses given before the whole society by Prof. Menozzi, Prince Ginori Conti, and Sir John Russell, F.R.S.; the address of Prof. L. Lindet, having already been published, is not included. The complete texts of 130 communications, together with full discussions dealing with the most varied questions of chemical science and industry, and with economic organisation, occupy the remaining 800 pages of the volume.

DIE KERAMIK IM DIENSTE VON INDUSTRIE UND VOLKSWIRTSCHAFT. *By* FELIX SINGER, D.Eng., Ph.D. *Brunswick*: *Fr. Vieweg & Sohn, A.-G.*, 1924. *Price* 50*s*.

Dr. Singer has adopted an exceedingly interesting means of celebrating the Jubilee of the very large firm of pottery manufacturers with which he is connected, inasmuch as he has asked all the leading authorities on clay and clay products to contribute to a volume on "Ceramics in Industry and National Economy." The result is a volume of well over a thousand pages, containing contributions from more than ninety contributors. Each section is written by an expert and can, therefore, be relied upon as authoritative.

The whole field of ceramics is well covered in an interesting as well as accurate manner and with that meticulous attention to detail which is characteristic of the best technical literature in Germany.

There is no book of the same character in the English language, the nearest being Bourry's "Treatise on Ceramic Industries," which is both older and much smaller. This is not due to any lack of knowledge on the part of English ceramists, but to the preference in this country for more highly specialised monographs dealing with a single part of the industry instead of with ceramics as a whole. At the same time, there ought to be a demand for a good book of this type in the English language to which students can refer.

The scientific part of this volume is well written, but there is a regrettable lack of reference to English ceramists, though American ones are more frequently mentioned by name. The English names are frequently quoted with reference to relatively unimportant matters, so that no reader of the book would have any idea of the extremely valuable work done in this country.

It is stated that the chemical constitution of clays is undeterminable and that no accurate method for determining plasticity has yet been discovered. In this and in other ways, it is clear that German ceramists are in no way more advanced than our own, though by greater attention to detail and by having greater facilities of scientific control in the works, some of them are able to produce some articles of better quality.

A. B. SEARLE

DIE PHYSIKALISCHEN UND CHEMISCHEN GRUNDLAGEN DES EISENHÜTTENWESENS. By WALTHER MATHESIUS. Second revised edition. Pp. xviii + 483. Leipzig: O. Spamer, 1924. Price, bound, 30 goldmarks, paper, 27 gm.

The general scheme of this book is a decidedly attractive one. The object of the author has been to place in the hands of those engaged in the manufacture of iron and steel a work in which the physical and chemical principles upon which their operations must be based are clearly set forth. Having regard to the knowledge to be presumed in his readers, the author has set out to deal mainly with the chemical processes and to avoid any description of the construction of the plant employed in the various operations except where this might be indispensable for a clear understanding of the chemical operations, and he has carried out his scheme with the sole exception that he has described and figured the various types of electrical smelting furnaces; it is not in the least clear why he should have made an exception in their favour.

The first portion comprises physical and chemical laws and data, and contains chapters upon oxidation and reduction, combustion and the development of heat, and the principal fuels used for this purpose. Here is included the chapter upon electric furnaces above referred to, and the other chapters deal with the heat of fusion, of evaporation and solution, and also with the specific heat of the various substances. The chemistry of iron, as far as it enters into the ordinary operations of its metallurgy, is next considered, and the combinations of iron with carbon, silicon, phosphorus, sulphur, and the various alloys of iron complete the chapter. The next part consists of a review of the fuels in general use, namely, coal, wood, coke, liquid and gaseous fuels and the various methods of applying these. The third section deals with the production of pig iron and includes chapters upon the available ores and materials, upon slags, the calculation of the furnace charge, the theory of the blast furnace and thermal balance of the blast furnace, in which the author considers separately thermal balances in the shaft and in the boshes. A few notes on special modifications conclude this section. The fourth section covers the manufacture of ingot iron and deals with the Bessemer process, the basic process and the open-hearth process, together with modifications of the last named. The various chemical processes involved are considered in some detail. The fifth section is devoted to iron and steel foundry practice, and certain detailed calculations are given in the Appendix.

It will be seen that the general idea underlying the work is an exceedingly good one. In order, however, that such a book may be really useful, it is necessary that it should be up to date and accurate, and in both respects it must be admitted that the present work fails hopelessly. As regards the former, the first edition of the work was published in 1915, and the author appears to have commenced a revision of the second edition in 1922. In order to show how utterly imperfect that revision has been, it may be sufficient to quote one sentence which refers to "the most important iron ore deposit of Germany, the Minette of Luxemburg-Lorraine"; surely in 1924 Prof. Mathesius must have known that the iron ore deposits of Lorraine had returned to their rightful owners! Throughout the author evinces a most lamentable ignorance of British literature; it may sound incredible, but it is a fact that there is hardly one reference to the Journal of the Iron and Steel Institute and not a single modern one. It can hardly be supposed that the author is ignorant of the existence of this journal or that he could not have known that he would find therein modern information in which he is painfully behind the times. It is impossible to cite all the passages in which this deficiency is made manifest, but some of them are sufficiently startling. For instance, we find such a sentence as the following: "Approximately from the year 1900 onwards the description of coaldust firing has disappeared from technical literature, and to-day the application of this method of firing is almost exclusively confined to the heating of rotating cylindrical furnaces, the great majority of which are used in the manufacture of cement." No one who has any acquaintance with the modern technology or the modern literature of fuel can fail to be aware that coal dust firing has received most important developments within the last few years. Again, the author devotes a few lines to the allotropism of iron and states baldly that pure iron possesses three different modifications, known as α iron, β iron and γ iron, and thus absolutely ignores the important work of Prof. C. Benedicks and his theory that the so-called β modi-

fication of iron is really α iron containing a certain amount of γ iron in solution. This theory is a dozen years old and has found numerous adherents among the leading authorities, so that it is hardly one to be passed over absolutely without reference in a textbook with any pretension to accuracy or completeness.

The author gives an elaborate graphic method for calculating the heat balance of the blast furnace and insists upon treating the shafts and the boshes as separate entities: he applied this method to the discussion of the working of a furnace of the Wisconsin Steel Company in 1915, as described by Mr. H. P. Howland (Trans. Amer. Inst. Min. Eng., vol. LVI., 1916, page 339); Prof. J. W. Richards in the subsequent discussion characterised it as "rather involved and strained reasoning," which not inaptly describes the method in question. If Prof. Mathesius had taken the trouble to consult a paper by Mr. F. Clements on "British Blast Furnace Practice" in the Journal of the Iron and Steel Institute for 1920, vol CI., page 325, he would have found a far more satisfactory method of calculating thermal balances. Again, he could with much advantage consult a subsequent paper (1922) by the same author on "British Siemens Furnace Practice," a study of which would greatly improve his chapter upon the open-hearth process. It is, by the way, somewhat incomprehensible why the author should insist upon looking upon the ore process as a mere modification of the Martin pig and scrap process, seeing that it was evolved quite independently and that although the modern open-hearth process is a combination of both, it is really based far more upon the work of Dr. Siemens than of Messrs. Martin.

It is perhaps unnecessary to discuss the book in any further detail; it might have been a good book twenty years ago; it is hopelessly out of date to-day. It is also regrettable that the work is disfigured by very numerous misprints. Altogether a thoroughly disappointing book. H. Louis

Solubility. By Joel H. Hildebrand. American Chemical Society Monograph Series. Pp. 206. New York: The Chemical Catalogue Co., 1924. Price $3.

Since Rothmund's book many years ago little of a systematic nature has been published on the subject of solubility as a phenomenon possessing a physico-chemical mechanism.

The spirit of Hildebrand's book is shown by the Preface, which manifests a liberal and philosophic mind. The author, as becomes one who resides at Berkeley, Calif., is evidently permeated by the concept of fugacity and its allied functions. An important aspect of the work, in fact, is the exposition of the rôle which such thermo-dynamic quantities play in solution and solubility problems. "Our fundamental problem, therefore, is to determine so far as possible how the escaping tendencies of the various components of a solution may be expected to vary, first with the composition of the solution, and second with the nature of the components. It is evident that this is a problem of great importance, both from the theoretical and the practical standpoints, and that much of modern physical chemistry is concerned with it." For the sake of brevity the author assumes considerable familiarity with the well-known book of G. N. Lewis and Randall; and as most physical chemists are, or ought to be, familiar at least generally with this work, the method adopted by Hildebrand is commendable.

The general nature and scope of the book will be gathered from the following, which is an abbreviated list of chapter headings: The ideal solution—Raoult's law; deviations from Raoult's law and their causes; polarity, internal pressure, and solvation; vapour pressure of liquid mixtures; solubility of gases, of liquids, of solid non-electrolytes, and of electrolytes; partition of solutes between immiscible liquids; metallic solutions; solubility and various related phenomena.

A perusal of this work impresses one very much with the advances which have been made within recent years in our understanding of the factors which govern solubility and the nature of the resulting systems. From a record of empirical fact there is gradually emerging a coherent body of concepts and generalisations. Naturally, the development has been very unequal along various directions, certain aspects being represented by little more than qualitative speculation. That the problem as a whole is still far from being understood is evident from the following quotation (p. 117): "The prediction of chemical combination is (however) the main goal of chemistry, and until it is reached the problem of solubility will likewise remain more or less unsolved."

The editors of the American Chemical Society Monograph Series have been particularly fortunate in certain of their contributors, and in none more so than in the present instance. W. C. M. Lewis

Pflanzenuntersuchungen, Handbuch der biologischen Arbeitsmethoden. Abt. XI. Part 2. No. 4. Edited by Prof. E. Abderhalden. Pp. 656-764. Berlin: Urban & Schwarzenberg, 1924. Price 5.25. s.f.

The part under review forms the 121st of the well-known Handbook published under the general editorship of Prof. E. Abderhalden and contains two essays—one entitled "Methoden der Viskositätsbestimmungen des lebenden Protoplasmas" and the other "Methoden zur Feststellung der Keimfähigkeit von Pflanzensamen" contributed respectively by Friedl Weber and Karl Müller. In the former the methods of determining the viscosity of living protoplasm are described under two headings—those designed for more or less accurate measurement and those intended to give approximate estimates only of the viscosity. Under the first are described methods based upon an adaptation of the falling sphere viscosimeter, in which the rate of movement of particles in protoplasm is determined under either centrifugal or gravitational force, or else the movement of small particles of iron introduced into the cell from without is measured when in a magnetic field. For the approximate estimation of viscosity the author describes in detail

the methods and apparatus of Kite and Chambers for micro-dissection; employing these methods the protoplasm can be pricked, kneaded, teased and drawn out into threads, etc., and the results are compared with those obtained under similar conditions from gelatin solutions of various known concentrations; other methods include those based upon observations of kataphoresis, Brownian movement, and plasmolysis. A perusal of this essay will convince the reader of the difficulty inherent in the determinations and the ingenuity of the methods employed.

In the second essay, dealing with the germinating power of seeds, the author begins by describing in detail the effect of various factors, such as oxygen, heat, cold, water and light upon germination and then proceeds to an account of the methods, media, and apparatus employed in experiments on germination, together with suggestions for the design of a germinating chamber. The article concludes with an alphabetical list of a number of common seeds in which are given, in tabular form, particulars of media, temperature and other details to be observed in determining germinating power in accordance with the technical instructions laid down by the German Verband landwirtschaftlicher Versuchsstationen. Those interested in the important subject of seed germination will find here a useful summary of the more important methods employed in the investigation of the subject.

P. Haas

Die Technische Chloralkali-Elektrolyse. By Dr. J. Billiter. Pp. viii+79. Dresden and Leipzig: Theodor Steinkopff, 1924. Price, 2·50 gold marks.

This little volume is the second in a series of monographs which is being published by Th. Steinkopff on recent advances in technical processes. Within the scope of about 80 pages the manufacture by electrolysis, of caustic soda, sodium carbonate and chlorine, hypochlorite, chlorate and perchlorate are described. About half of this is devoted to the description of alkali processes which employ solid (non-mercury) cathodes, another 14 pages being reserved for the advances that have been made in this branch during the last ten years. The book is well arranged. It gives a good survey of the whole field covered, and is clearly written and illustrated where necessary. Statistics are given, in most cases showing the extent to which the several processes are employed, as revealed by the horsepower used. Obsolete methods are not described. The very great extension which the solid-cathode processes for caustic soda have experienced in recent years will perhaps come as a surprise to many. The book will be useful, not only to students, but also to those engaged in the chemical industry who wish to obtain a clear idea of the advantages and difficulties inherent in the several methods of manufacture. Coming as it does from the pen of one who has himself contributed so conspicuously to the advancement of the subject described it should find a wide circle of readers.

Henry J. S. Sand

COMPANY NEWS

THE SALAR DEL CARMEN NITRATE SYNDICATE, LTD.

In presenting the Report and Accounts of the Salar del Carmen Nitrate Syndicate, Ltd., the chairman said that their net profit during the year ended December 31 last amounted to £78,053, and adding this to £16,218 brought forward from the previous year, there was a total credit on profit and loss account of £94,271. The directors proposed to set aside £20,000 to reserve account and to apply £7039 to reduction of plant and machinery account. It was recommended to pay a final dividend of 25 per cent. less tax, making the total distribution for the year 30 per cent., compared with 25 per cent. in respect of the year 1922. The amount carried forward was £16,949.

Considering the unsettled economic conditions which existed throughout the greater part of the world, the chairman thought that the position of nitrate was encouraging, the total consumption of nitrate during the year ended June 30, 1924, being estimated at about 2,180,000 tons, an increase of 30,000 t. on the previous year.

In Norway, owing to strikes, the manufacturers of nitrate of lime who had sold ahead, had been unable to deliver about 25,000 t. in time for the season's use, and an increase in Chilean nitrate business had consequently taken place in Scandinavia. In France the Government had voted a substantial sum of money for the exploitation of the Haber process, the rights for which were purchased from Germany some time ago, but the plant was not expected to be ready for two or three years. In the United Kingdom, at Billingham, the Brunner Mond plant had almost reached the production stage. The chairman finally referred to the Nitrate Producers' Association, formed in 1919, and due to terminate at June 30 next. Negotiations were, however, proceeding with a view to the renewing of the Association for a further period of six years, on the understanding that at the end of the first three years members of the Association may, if they wish, revert to free selling of nitrate. Already producers, representing 92½ per cent. of the total productive capacity, had voted in favour of renewing on these terms.

The meeting closed with the re-election of the Rt. Hon. Lord Forres and Mr. A. Naylor as directors of the company.

BRITISH COTTON AND WOOL DYERS' ASSOCIATION

The report of the above company for the year to March 31, 1924, shows a net profit of £150,233, as compared with £176,547 for the previous year. The amount brought forward was £37,132, making available £187,365. A dividend of 10 per cent. on the ordinary shares is proposed, as against 15 per cent. last year. The amount to be transferred to reserve is £50,000 (making that fund £81,459); £5,000 is to be placed to investment contingency fund (bringing that fund to £35,000); £10,000 to employees' benefit fund (£20,000 last year), and the sum of £44,949 has been carried forward.

SOCIETY OF CHEMICAL INDUSTRY IN BASLE

The directors of the above company state in their report that facilities for the export of their products have not improved, especially as regards England and the United States. The high restrictions and tariffs in force in these countries, although they do not prevent the sale of the company's goods, make business very difficult, and they were of the opinion that these highly protective measures would have to be modified. An improvement was shown during the year as regards sales in general, especially in the Far East, and this improvement is also continuing in the present year

EASTMAN KODAK CO.

This American company announces a regular dividend of $1\frac{1}{2}$ per cent on Preferred stock; a regular dividend of $1 25 per share on common stock; and an extra dividend of $0.75 per share (the same) on the common stock, all payable on July 1.

NITRATE PRODUCERS' ASSOCIATION

The Chilean Nitrate Committee announces that the above Association has been renewed from July 1 for a period of 6 years Prices of nitrate per metric quintal have been fixed at figures ranging from 19s. 3d. for delivery in July, to 20s. 9d. for delivery between January 1, 1925, to May 31, 1925. It is expected that the average price will show a reduction of about 7d. per metric quintal.

BRANDRAM-HENDERSON, LTD.

The annual financial statement of Brandram-Henderson, Ltd., for the financial year 1923 has been submitted. It shows an increase in sales of over 10 per cent. with net profits at $144 121, which is somewhat lower than last year with $163,703. The reason for this falling off in profits is attributable to the fact that the Alberta Linseed Oil Co., Ltd., a subsidiary, did not pay a dividend during the period, as the company had been called upon to pay a large amount of Federal Government income taxes retroactive for some years. The profit and loss account shows a balance of $854,585 brought forward from 1922, from which was deducted the preferred dividend of $35,000 and the common dividend of $47,196, leaving $772,389. To this amount was added the profits, after deducting usual charges, making a total of $916,511. Against this amount are debits for bond interest paid and accrued $63,460; reserve for depreciation $7,500; income tax 1922, $9,621; leaving a surplus to carry forward of $836,929.33. The balance sheet shows several changes, fixed asset are up $2,713,131.45 to $2,735,723.54, being in the plant account, the depreciation reserve is now increased to $95,000. Fixed liabilities and bonded statement shows bonds outstanding at $898,000. Working capital account shows considerable improvement over the past three years, increasing from $981,175 in 1921 steadily to $1,156,985 in 1923. A dividend of 7 per cent. has been declared on the preferred stock, and 4 per cent. on the common.

REPORT

Report on the Trade, Industries and Economic Conditions in Portugal, January, 1924. By S. G. Irving, H.M. Consul and Commercial Secretary, Lisbon. Department of Overseas Trade. Pp. 44. H.M. Stationery Office, 1924, Price 1s. 6d.

The financial situation in Portugal is still unsettled, but the low value of the escudo is not an indication of impoverishment of the country, which is at present in a prosperous condition, with little unemployment. The fluctuating rate of exchange has complicated commerce abroad, but purchases have been made from Great Britain under the credit scheme initiated in 1922, and Portugal takes a good position among the smaller European countries as an importer from this country. Great Britain is the largest buyer of Portuguese goods.

The war had the same effect on trade in Portugal as in other belligerent countries; 1919 and 1920 saw a boom period which gave way to a slump which has lasted till now. The bulk of imports into the country consists of foodstuffs, coal, oil, and manufactured goods. Imports in 1923 of petroleum products, which formed the most valuable item of imports were fuel oil, 63,665 t.; benzine, 28,920 t.; kerosene 26,400 t.; mineral oil, 7720 t.; paraffin, 1595 t. Coal imports in 1923 were 766,000 t.; valued at £1,004,600; this is supplied almost entirely by Great Britain, which is also the chief supplier of textiles. The iron and steel goods chiefly in demand from Britain are black and galvanised plates, tinplate, bars, tubes and wire; manufactured copper is obtained chiefly in Great Britain. Among heavy chemicals copper sulphate, ammonium sulphate caustic soda, and sodium silicate are largely imported from Great Britain; Germany and Belgium compete in these lines. Sulphur is obtained chiefly from Italy and the United States.

The principal exports from the country are wines, sardines, pit props, cork, textiles, fruit, copper, salt, and wolfram. About 180,000 t. of copper was exported last year, mostly from the British mine at S. Domingo.

In spite of recent troubles over payment British traders are advised not to abandon the market, business is there for those who seek it, and importers are advised to make a first-hand study of the market, taking care to appoint suitable agents and to accept only reliable clients.

The principal manufacturing industries of the country are textile, but other factories are established items of importance being cement, tiles, pottery and glass. But little mining is done in the country There is believed to be an abundance of good coal and anthracite is found in Central Portugal. From the vast deposits of iron ore only 30,000 t. is drawn annually. Water power is available in sufficient quantity to enable the imports of fuels to be considerably reduced, but insufficient capital is available to make any progress in the development of schemes which have been drawn up.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech.	£24 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	6¼d.—6¾d. per lb. Market firmer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	43s. 6d. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	5s. 1d. per lb. Much dearer, following rise in quicksilver.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s.—5s. 3d. per gall. 60% O.P. market stiffer.
Solvent	5s. 6d.—6s. per gall. 40% O.P. Fairly good demand but little offering.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£49 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	7d. per lb. Better inquiry at reduced price.
Crude 60's	1s. 10d.—2s. per gall. Market rather flat.
Acid Cresylic, 97/99	2s. 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—2s. per gall. Steady demand.
Dark	1s. 10d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	10d.—11d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 4½d.—1s. 7d. per gall.
Pure	1s. 10d.—1s. 11d. per gall.

Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	9½d. per gall. Few inquiries.
Middle Oil / Heavy / Standard Specification	7½d.—9d. per gall. according to grade and district. Market a shade firmer. Fair business.
Naphtha—	
Crude	8d.—9d. per gall. } Good demand. Prices firm.
Solvent 90/160	1s. 5d.—1s. 7d. } Good demand. Prices firm.
Solvent 90/190	1s. 2d.—1s. 3d. } Good demand. Prices firm.
Naphthalene Crude—	
Drained Creosote Salts	£7—£7 10s. Steady business.
Whizzed or hot pressed	£9—£12 per ton. Not much inquiry.
Naphthalene—	
Crystals and Flaked	£17—£18 per ton.
Pitch, medium soft	52s. 6d.—57s. 6d. per ton. Market steadier. Few inquiries for forward delivery. Very little business for prompt
Pyridine 90/140	22s.—24s. per gall. Demand well maintained.
Heavy	11s.—12s. Occasional inquiries: little business.

INTERMEDIATES AND DYES

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 6d. per lb.
Acid H.	4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 3d. per lb. Steady demand.
Acid Sulphanilic	10d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4¾d.—5¼d. per lb. Demand moderate.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	5s. per lb. d/d., packages extra, returnable.
Dimethyaniline	2s. 5d per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d.
Dinitrotoluene —48/50°C.	8d.—9d. per lb. naked at works.
66/68°C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. 1d. per lb. d/d.
Monochlorbenzol	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	4s. 2d. per lb. d/d.
p-Phenylene Diamine	10s. 4d. per lb. 100% basis d/d.
R. Salt	2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 6d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 6d. per lb. naked at works.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£49 per ton.
Acid, Acetyl Salicylic	3s. 4d.—3s. 5d. per lb. Good demand.
Acid, Benzoic B.P.	3s. 3d.—4s. per lb. Larger supplies available.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal. Market very steady.
Acid, Pyrogallic, Cryst.	7s. per lb. for 1 cwt. lots. Market firm: increasing demand.
Acid, Salicylic	Prices quoted from 2s. 2d. per lb. down to 1s. 9d. for ton lots. Market rather quiet.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 3d. per lb. for quantity. Easier market.
Amidopyrin	13s. 6d. per lb. Neglected.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. 6d. per lb. Weak market.
Benzonaphthol	6s. per lb. Small inquiry.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Market easier.
Potassium	9d.—10½d. per lb.
Sodium	9d.—10½d. „
Ammonium	10½d.—1s. „
Calcium Lactate	Demand not very active. Good English make can be had from 1s. 7d. to 2s. per lb.
Chloral Hydrate	3s. 9d. per lb.
Chloroform	2s. per lb. for cwt. lots. Market more active. Makers busy.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Guaiacol Carbonate	12s. per lb. for cwt. lots. Supplies not plentiful.
Hexamine	3s. 9d. per lb. for foreign make. Fairly steady.
Homatropine Hydrobromide	30s. per oz.
Hydroquinone	4s. 9d. per lb. Foreign make.
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate— Light Commercial	£36 per ton net.

Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £26 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 70s. per lb.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials ..	.. Market rather flat, but prices unchanged.
Red oxide ..	.. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. ,,
White precip. ..	.. 4s. 7d.—4s. 8d. ,,
Calomel ..	.. 3s. 11d.—4s. ,,
Methyl Salicylate	.. 2s. 3d.—2s. 9d. per lb. for carboys. A slightly better market.
Methyl Sulphonal	.. 25s. per lb.
Paraformaldehyde	.. 3s. 6d. per lb.. Better inquiry.
Paraldehyde ..	.. 1s. 4d.—1s. 6d. per lb. in free bottles and cases. Better demand.
Phenacetin ..	.. 6s. per lb. Somewhat cheaper.
Phenazone ..	.. 7s. 9d. per lb. for cwt. lots. Quiet.
Phenolphthalein ..	.. 6s. 9d.—7s. 3d. per lb. In more plentiful supply.
Potass. Bitartrate—	
99/100% (Cream of Tartar) ..	.. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate ..	.. 1s. 8d.—2s. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate—	
B.P. Crystal ..	.. 8¾d.—9d. per lb. carriage paid.
Commercial ..	.. 8d.—8½d. per lb. carriage paid.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 5s. 6d. per lb.
Salol	.. 4s. per lb. Very quiet.
Silver proteinate	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	.. 3s. per lb. In steady demand for good qualities.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite—	
Photographic ..	.. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	.. 77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet
Sod. Salicylate ..	.. Market easier. Powder 2s. 4d.—2s. 6d. per lb. Crystal at 2s. 6d.—2s. 8d. per lb. Flake 2s. 9d.—3s. 4d. per lb.
Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	.. 16s.—18s. per lb.
Tartar Emetic	.. 1s. 4d. per lb.
Thymol	.. 13s. 6d.—15s. 9d. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.	
Aubepine	.. 14s. 6d. per lb.	Advanced.
Amyl Acetate ..	.. 2s. 9d. ,,	
Amyl Butyrate ..	.. 7s. 3d. ,,	
Amyl Salicylate ..	.. 3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. ,,	
Benzyl Alcohol free from Chlorine ..	.. 3s. 3d. ,,	
Benzaldehyde free from Chlorine ..	.. 3s. 6d. ,,	
Benzyl Benzoate	.. 3s. 6d ,,	
Cinnamic Aldehyde Natural	.. 15s. 6d. ,,	
Coumarin ..	.. 20s. ,,	
Citronellol ..	.. 16s. ,,	
Citral	.. 10s. ,,	
Ethyl Cinnamate	.. 15s. ,,	
Ethyl Phthalate ..	.. 3s. 9d. ,,	
Eugenol	.. 11s. ,,	
Geraniol (Palmarosa)	.. 35s. ,,	
Geraniol	.. 11s.—18s. 6d. per lb.	
Heliotropine ..	.. 7s. 9d. per lb.	
Iso Eugenol ..	.. 15s. 9d. ,,	
Linalol ex Bois de Rose ..	32s. 6d. ,,	
Linalyl Acetate ..	.. 32s. 6d. ,,	
Methyl Anthranilate	.. 9s. 6d. ,,	
Methyl Benzoate	.. 6s. ,,	
Musk Ambrette ..	.. 52s. 6d. ,,	
Musk Xylol ..	.. 18s. ,,	
Nerolin	.. 4s. ,,	
Phenyl Ethyl Acetate	.. 12s. 6d. ,,	
Phenyl Ethyl Alcohol	.. 16s. ,,	
Rhodinol	.. 57s. 6d. ,,	
Safrol	.. 1s 10d. ,,	
Terpineol	.. 2s. 9d. ,,	
Vanillin	.. 25s. 3d.—26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 15s. 6d. per lb.	
Anise Oil	.. 3s. per lb.	
Bergamot Oil ..	.. 18s. 6d. per lb.	
Bourbon Geranium Oil	.. 35s. ,,	
Camphor Oil ..	.. 75s. per cwt.	
Cananga Oil, Java	.. 10s. 6d. per lb.	
Cinnamon Oil, Leaf	.. 6½d. per oz.	
Cassia Oil, 80/85%	.. 9s. 3d. per lb.	
Citronella Oil—		
Java 85/90% ..	.. 5s. 6d. per lb.	Dearer.
Ceylon	.. 3s. 9d. ,,	
Clove Oil	.. 8s. 3d. ,,	
Eucalyptus Oil 70/75% ..	2s. 2d. ,,	
Lavender Oil—		
French 38/40% Esters	26s. per lb.	
Lemon Oil ..	.. 3s. 2d. per lb.	Cheaper.
Lemongrass Oil ..	.. 3d. per oz.	
Orange Oil, Sweet	.. 13s. 9d. per lb.	
Otto of Rose Oil—		
Bulgarian ..	.. 27s. 6d. per oz.	
Anatolian ..	.. 23s. 6d. per oz.	
Palma Rosa Oil ..	.. 19s. per lb.	Very short supply.
Peppermint Oil—		
Wayne County	.. 21s. 9d. per lb.	
Japanese ..	.. 18s. 3d. per lb.	
Petitgrain Oil ..	.. 10s. per lb.	
Sandal Wood Oil—		
Mysore	.. 26s. 6d. per lb.	
Australian ..	.. 21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than July 7th. they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on May 22nd.

I.—Applications

Baglin. Centrifugal dryers. 10,815. May 2.

Bell. Disintegrating and mixing. 10,651. Apr. 30.

Borrmann. Distillation. 10,883, 10,884. May 2.

Brandwood and Price. Grinding or granulating machines. 10,729. May 1.

Ges. für Linde's Eismaschinen Akt.-Ges. Method of cooling and condensing gaseous mixtures. 10,664. Apr. 30. (Ger., 31.5.23.)

Grimm. Process for stabilising various materials. 10,890. May 2.

Kent and Sykes. Furnaces. 10,962. May 3.

Patentaktiebolaget Grondal-Ramén. Rotary etc. furnaces. 10,972. May 3. (Sweden, 12.5.23.)

Portes. Mixing liquids of different temperatures etc. 10,878. May 2. (Fr., 29.5.23.)

Sonsthagen. Mixing, compacting, and degassing viscid materials. 10,659. Apr. 30.

Velut. Filtering devices 10,847. May 2. (Fr., 12.5.23.)

I.—Complete Specifications Accepted

3388 (1923). Appareils et Evaporateurs Kestner. Apparatus for distilling water (208,503.)

8514 (1923) Volcker. Furnaces. (214,808.)

11,475 (1923). Senior and Atkinson Drying-machine. (214,830.)

II.—Applications

British and Foreign Lime and Power Corporation, Ltd., and Reid. Manufacture of gaseous fuel from lime-kiln gases. 10,989. May 3.

Donald. Peats etc. 10,955. May 3.

Fairbairn. Apparatus for sweating or crystallising paraffin etc. wax. 10,467. Apr. 28.

Farbwerke vorm. Meister, Lucius, und Brüning. Process of making methane. 10,794. May 1. (Ger., 1.5.23.)

Jolly. Carbonisation of bituminous caking coals 10,746. May 1.

Mureosche. Manufacture of agglomerated combustibles. 10,742. May 1.

II.—Complete Specifications Accepted

29,384 (1922). Neilsen, Laing, and Boocock. Manufacture of fuel briquettes. (214,668.)

34,052 (1922). Hellmann. Dry-distillation, de-gasification, or gasification. (214,675.)

1222 (1923). Algem. Norit Maatsch. Producing activated carbon. (198,328.)

2543 (1923). Anglo-Saxon Petroleum Co. (Hillman). Purifying mineral oils from sulphur. (214,733.)

14,368 (1923). Rutgerswerke Akt.-Ges. Production of arc-light electrodes. (199,018.)

16,162 (1923) V. L. Oil Processes, Ltd., and Lucas. Treatment of oils and spirits. (214,871.)

28,620 (1923) Algem Norit Maatsch. Producing activated carbon. (206,862.)

IV.—Applications

Durand and Huguenin Akt.-Ges Manufacture of disazo-dyestuffs. 10,882. May 2 (Ger., 2.5.23.)

Farbwerke vorm Meister, Lucius, und Brüning. Manufacture of halogenated oxythionaphthenes 10,479. Apr. 28. (Ger., 28.4.23.)

Scottish Dyes, Ltd., Smith, and Thomas. Dyestuffs and dyeing. 10,886. May 2.

IV.—Complete Specifications Accepted

3584 (1923). British Dyestuffs Corporation, Ltd., Perkin, and Clemo. Manufacture of bodies related to the acridines. (214,756.)

3828 (1923). Drescher, Thomas, and Scottish Dyes, Ltd Production of anthraquinone bodies. (214,765.)

15,071 (1923). Imray. (Soc. of Chem. Industry in Basle) Manufacture of indigoid dyestuffs. (214,864.)

V.—Applications

Dreaper. Manufacture of artificial silk. 10,849. May 2

Klugmann. 10,951. *See* X.

V.—Complete Specification Accepted

17,790 (1923). Wuensch and Köppel. Extracting from vegetable substances products for use in making paper etc. (214,882.)

VI.—Applications

Farbenfabriken vorm. F. Bayer und Co. Dyeing acetate silk. 10,791. May 1. (Ger., 1.5.23.)

Scottish Dyes, Ltd., Smith, and Thomas. 10,886. *See* IV.

VII.—Applications

British and Foreign Lime and Power Corporation, Ltd., and Reid. 10,989. *See* II.

Friedenthal, and Industrie-Verwaltung A.-G. Bromine solutions. 10,444. Apr. 28. (Ger., 27.4.23.)

Hooper. Applying deposits etc. of silicon etc. to surfaces. 10,958. May 3.

VII.—Complete Specifications Accepted

1775 (1923). Bhopal Produce Trust, Ltd., and Fraymouth. Obtaining oxalic acid or its salts. (207,489.)

2052 (1923). Bhopal Produce Trust, Ltd., and Fraymouth. Obtaining calcium oxalate from vegetable matter. (208,684.)

VIII.—Complete Specification Accepted

1697 (1923). Holden. Removal of the brown coloration in china clays. (211,699.)

IX.—Applications

British and Foreign Lime and Power Corporation, Ltd., and Reid. 10,989. *See* II.

Pioda. Manufacture of Portland cement. 10,556. Apr. 29. (U.S., 4.5.23.)

Tomlins. Building materials. 10,573. Apr. 29.

Zuttere. Impregnating woods. 10,793. May 1

IX.—Complete Specification Accepted

5423 (1923). Babcock and Wilcox, Ltd. (Babcock and Wilcox Co.). Cement-kiln systems. (214,779.)

X.—Applications

Beasley, Middleton, and Metals Production, Ltd. Reduction of ores. 10,805 May 1.

Garnett and Smith. Magnetic alloys etc. 10,977. May 3.

Hooper. 10,958. *See* VII.

Klugmann. Manufacture of cotton corduroy cloth for extraction of gold. 10,951. May 3.

Simon. Concentration of tin ores. 10,635, 10,636 Apr. 30.

Soellner Nachf. Reisszeugfabrik Akt.-Ges. Production of a weatherproof oxide layer on electron metal. 10,600 Apr. 29. (Ger., 1.7.23.)

Vanderstein. Cupola furnaces. 10,779. May 1.

Wittig. Method of making iron alloys. 10,567. Apr. 29. (Ger., 12.7.23.)

Wittig. Method of extracting vanadium. 10,699. Apr 30. (Ger., 7.5.23.)

X.—Complete Specification Accepted

13,755 (1923). Titanium Pigment Co. Treatment of titaniferous material. (206,809.)

XI.—Applications

Soc. Talco e Grafite val Chisone, and Ridoni. Manufacture of electrodes from natural graphites. 10,450 Apr. 28.

Stuart. Electrolytic cells. 10,551. Apr. 29. (U.S., 30.4.23.)

XI.—Complete Specifications Accepted

7762 (1923). Monnot. Electric storage batteries. (214,799.)

10,359 (1923). Helfenstein. Forming continuous electrodes for electric furnaces. (214,823.)

14,368 (1923). Rütgerswerke Akt.-Ges. *See* II.

26,140 (1923). Soc. Anon. le Carbone. Rendering porous electrodes impermeable to liquids. (211,832.)

XII.—Complete Specifications Accepted

34,885 (192). Petroff. Production of soap. (214,679.)

2591 (1923). Aische. Manufacture of solvent soaps from sulphonated oils. (214,735.)

XIII.—Application

Potter (Soc. Anon. L'Oyonaxienne). Manufacture of plastic material. 10,413. Apr. 28.

XIII.—Complete Specification Accepted

13,755 (1923). Titanium Pigment Co. *See* X.

XV.—Application

Long. Treatment of vegetable ivory. 10,705. Apr. 30.

XVI.—Application

Telfer. Fertiliser. 10,974. May 3.

XIX.—Application

Chapman. Treatment of frozen meat. 10,587. Apr. 29

XIX.—Complete Specifications Accepted

3388 (1923). Appareils et Evaporateurs Kestner. *See* I.

10,342 (1923). Bull. Insecticides, vermifuges, sheep-dips, and the like. (214,822.)

XX.—Application

Johnson (Badische Anilin und Soda-Fabrik). Process for transforming oxides of carbon into organic compounds. 10,435. Apl. 28.

XX.—Complete Specifications Accepted

11,971 (1923). Rausford (Cassella u. Co.). Manufacture of *p*-dialkylaminoarylphosphinous acids. (214,836.)

15,324 (1923). Howards and Sons, Ltd., and Blagden. Manufacture of benzene derivatives containing carbon side-chains, particularly thymol. (214,866.)

17,256 (1923). N. V. Vereen. Fabr van Chemische Producten. Obtaining organic super-oxides in a finely divided condition. (200,508.)

27,340 (1923) Merck, Wolfes, and Maeder. Manufacture of synthetic *l*-cocaine (214,917.)

XXI.—Complete Specification Accepted

9530 (1923). Pathé Cinema. Obtaining direct photographic positives by reversal. (211,431.)

XXIII.—Complete Specification Accepted

2104 (1923). Hilger, Ltd., and Ord. Polarimetric apparatus (214,712.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W.1.) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific number: *Argentina*: Scientific and optical instruments, glassware, (21722/F.W./C.C./2); *Australia*: Artificial silk yarns, (497); Electrical machinery, (499); *British West Indies*: Mining supplies, (501); *Canada*: Builders' hardware, cutlery, crockery, (502); *Cochin-China*: Iron and steel hollow-ware, (853/9/F.G./E.C./2); *Esthonia*: Sugar, (508); *France*: Sulphate of copper, (509); Italy: Silk, (511); *Netherlands*: China, earthenware, glassware, (514); Silk, (516); Paint, chemicals, pharmaceutical specialities, surgical rubber goods, (517); Hardware, crockery, paper, (519); Cement and bitumen roofing, (22816/F.W./M.C./2); *Poland*: Photographic materials, (521); *Smyrna*: Skins, hides, tinplate, iron (525); Agricultural machinery, (12883/F.E./E.C./2); *South Africa*: Cutlery, (505); Linseed oil, (13613/E.D./C.C./2): Varnish and enamel (529); *Switzerland*: Galvanised and black sheets and tubes, (524); *United States*: Perfume, (529).

Trade Information

The H.R. Gear is a most interesting device the object of which is to provide, in a compact space, means for increasing or decreasing the speed between a prime mover and a working object. Although involving no new engineering principle, the gear constitutes undoubtedly a new application of the worm gear, of which it retains both the efficiency and the strength but in enhanced form, the efficiency having been found to be 75 per cent. in one case, compared with 50 per cent. for an ordinary worm gear. Any gear ratio from 1 to 1 upwards to 10,000 to 1 or very much more can be obtained in a small space, as the system allows of an almost infinite variety of speed ratios with little change of the actual gear. In addition it presents various interesting advantages, such as the possibility of obtaining from one gear more than one source of drive, each source furnishing power simultaneously at different speeds and at different angles from the prime mover, as for instance two separate conveyor belts at right angles. In addition the gear can furnish one source of drive, the speed of which can be varied in steps as required, *e.g.*, in a mechanical stoker. As a further instance of its adaptability the gear can be mounted for use in a lifting drum. Ordinary gears are rarely free from "chatter," but the H.R. gear is noiseless and, as it works in an oil bath, it should have a long life. The largest gear yet made is that for the Bleachers' Association, being designed to deal with 150 h.p. at the very slow speed of 9·6 revolutions per minute. The smallest gear is for one-fiftieth of a horse-power. A number of H.R. gears can be seen at the British Empire Exhibition at Wembley.

Metallisation is the name given to a process by means of which any solid can be coated with an impervious layer of any of the useful metals or alloys. Zinc, tin, lead, aluminium, copper, iron, nickel, brass, bronze and other metals or alloys can be deposited by the process in layers of any thickness from 0·001 in upwards. In a general manner, metallisation can be said to be useful for the prevention of corrosion, for the production of an artistic effect, or for improving the appearance of manufactured articles. No vehicle is used in depositing the metal, which never cracks or chips off, and it is deposited in such a cool state that fabrics are uninjured and thin metallic articles are not warped in any way. The metal coating can be left in a matt state, and can then be painted or lacquered, or it can be coloured and polished. Applications of metallisation that are of particular interest to

the chemical industry, are the coating, externally and internally, of iron and steel structures, tanks, vats, pipes, and mixers with metals such as lead, aluminium, tin, copper, etc., to prevent corrosion by specific acids, vapours and gases. For instance, containers for foodstuffs can be coated with a non-poisonous metal such as aluminium without the use of a poisonous flux. Metallisation, Ltd., undertakes to advise on coatings for use in any industry and invites those who are interested to see the practical demonstrations of metallisation given daily at the company's stand in the Palace of Engineering in the British Empire Exhibition.

PUBLICATIONS RECEIVED

TEXT-BOOKS OF PHYSICAL CHEMISTRY. Edited by Sir W. Ramsay, K.C.B., D.Sc., F.R.S., and F. G. Donnan, C.B.E., M.A., Ph.D., F.R.S. Vol I. Spectroscopy, by Prof. E. C. C. Baly, C.B.E., F.R.S. Pp. xi+298. London: Longmans, Green and Co., 1924. Price 18s.

MANUFACTURE OF ACIDS AND ALKALIS. By Lunge and Cumming. Vol II. Manufacture of Sulphuric Acid (Chamber Process), by W. Wyld. Pp. xii+424, and Vol. III. The Concentration of Sulphuric Acid, by J. W. Parkes. Pp. xii+394. London: Gurney and Jackson, 1924. Price 31s. 6d. each.

PUBLICATIONS OF THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH. H.M. Stationery Office:
THE THERMAL PROPERTIES OF METHYL CHLORIDE. By D. N. Shorthouse, M.A. Food Investigation Board, Special Report No. 19, by the Engineering Committee of the Board. Pp. A2+16. 1924. Price 1s.
PULVERISED COAL SYSTEMS IN AMERICA. By L. C. Harvey. Fuel Research Board, Special Report No. 1. Third edition. Pp. 131. 1923. Price 5s.

REPORT ON THE COMMERCE AND INDUSTRY OF BULGARIA. By C. B. P. Peake. Department of Overseas Trade. Pp. 20. H.M. Stationery Office, 1924. Price 9d.

MINERALS OF THE EMPIRE, BRITISH EMPIRE EXHIBITION, WEMBLEY. Imperial Mineral Resources Bureau. Pp. 328. 1924. Price 5s.

OILS, FATS, WAXES, AND RESINS. By E. R. Bolton and R. G. Pelly. With a foreword by H.R.H. the Prince of Wales, K.G., and general introductions by the Rt. Hon. Sir E. Geddes, G.C.B., and J. H. Batty. Pp. 275. London: E. Benn, Ltd., 1924. Price 21s.

ANNUAL REPORT OF THE EXPLOSIVES DIVISION OF THE DEPARTMENT OF MINES FOR THE CALENDAR YEAR 1923. Department of Mines, Explosives Division. No. 13. Pp. 20. Ottawa: F. A. Acland, 1924.

REPORT ON THE INDUSTRIAL AND ECONOMICAL SITUATION IN CZECHOSLOVAKIA, dated February, 1924. By E. C. Donaldson Rawlins. Department of Overseas Trade. Pp. 42. H.M. Stationery Office, 1924. Price 1s. 6d.

REGULATIONS AND ORDERS RELATING TO MINES UNDER THE COAL MINES ACT, 1911. Pp. ix+157. London: H.M. Stationery Office, 1924. Price 1s.

RÉSINES ET TÉRÉBENTHINES ET LES INDUSTRIES DÉRIVÉES. By M. Vèzes and G. Dupont. Encyclopédie de Chimie Industrielle. Pp. 656. Paris: J. B. Baillière et Fils. 1924. Price: Paper 60 fr., bound 70 fr.

SOME STUDIES IN BIO-CHEMISTRY. By Dr. G. J. Fowler, D.Sc. Pp. iv+197. Bangalore: The Phœnix Printing House, 1924.

FIFTY-SIXTH ANNUAL REPORT OF THE DOMINION LABORATORY, NEW ZEALAND. By J. S. Maclaurin, D.Sc., F.R.S. Department of Internal Affairs. Pp. 58. New Zealand: W. A. G. Skinner, 1923.

EASTMAN ORGANIC CHEMICALS LIST, No. 11. Pp. 62. Rochester, N.Y.: Eastman Kodak Company, 1924.

MONTHLY REPORT OF COAL STATISTICS FOR CANADA. Canada Dominion Bureau of Statistics, Mining, Metallurgical and Chemical Branch. Vol. III., No. 1. Pp. 20. Ottawa: F. A. Acland, 1924.

YEAR BOOK, 1924, OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Pp. lx+724. New York: The American Society of Mechanical Engineers, 1924.

PUBLICATIONS OF THE U.S. BUREAU OF MINES, DEPARTMENT OF THE INTERIOR. Washington: Government Printing Office, 1924. Price 10 cents.
CARBON MONOXIDE HAZARDS FROM HOUSE HEATERS BURNING NATURAL GAS. By G. W. Jones, L. B. Berger, and W. F. Holbrook. Technical Paper 337. Pp. iv+31. 1923.
QUARRY ACCIDENTS IN THE UNITED STATES DURING THE CALENDAR YEAR 1922. By W. W. Adams. Technical Paper 353. Pp.+61. 1924.
STONE DUSTING OR ROCK DUSTING TO PREVENT COAL-DUST EXPLOSIONS, AS PRACTISED IN GREAT BRITAIN AND FRANCE. By G. S. Rice. Bulletin 225. Pp. iv+57. 1924.

PUBLICATIONS OF THE U.S. GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR, MINERAL RESOURCES OF THE UNITED STATES, 1922. Part II. Washington: Government Printing Office, 1924.—
CARBON BLACK PRODUCED FROM NATURAL GAS IN 1922. No. II:29. Pp. 345–346. By G. B. Richardson.
STONE IN 1922. By G. F. Loughlin and A. T. Coons. No. II:28. Pp. 261–344.

EDITORIAL NOTICES

The Society as a body is not responsible for statements and opinions appearing in the JOURNAL.

Members of the Society, and others, are invited to submit original articles, news, notes and other relevant information to the Editor of *Chemistry & Industry*. Such contributions should be clearly written (preferably typewritten with double spacing), and be accompanied by a stamped and addressed envelope. They will be paid for if inserted. Sources of information should always be given, not necessarily for publication.

Hon. Secretaries of Local Sections and of other Societies are asked to forward notices and reports of meetings as early as possible, and publishers to send books for review, direct to:—THE EDITOR, *Chemistry & Industry*, SOCIETY OF CHEMICAL INDUSTRY, CENTRAL HOUSE, FINSBURY SQUARE, E.C. 2. [Telephone: Clerkenwell No. 2429.]

Hon. Secretaries of Local Sections and of other Societies are asked to note that announcements of forthcoming events cannot be inserted in the next issue of the JOURNAL *unless they are received not later than Tuesday in any week.*

Matters relating to the Transactions and Abstracts, including Papers intended for insertion as Communications, should be addressed to THE EDITOR OF TRANSACTIONS, at the same address.

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

Vol. 43 NEW SERIES — LONDON, MAY 23, 1924 — No. 21

EDITORIAL

An interesting contribution from Prof. Vegard, of the University of Christiania, appears in *Nature* for the 17th inst. Prof. Vegard has for several years been engaged in the study of the aurora borealis and its spectrum: observations have been made at Tromso, at Bossekop, in Christiania and lately at Leyden. Those who have visited the North of Norway in the autumn know how magnificent a spectacle the aurora may be. Those exhibitions of the phenomenon which we occasionally see in the northern parts of the British Isles, interesting as they are, have not the brilliancy of the sights to be seen north of the Arctic Circle. The auroral spectrum contains lines in the blue and violet identical with prominent lines in the negative band spectrum of nitrogen and a line in the green of wave-length 5577A, which has been a puzzle to chemists and astronomers for a score of years. Vegard concluded several years ago that this line also should be attributed to nitrogen, and he suspected that the nitrogen at the very low temperature of the upper atmosphere was condensed into clusters of small crystals. At Leyden, in the Kamerlingh Onnes laboratory, Vegard investigated the light produced when solid nitrogen is bombarded by cathode rays. He found two green lines, one of them a broad and strong one of wave length about 5577A, and another of wave length 5230A, and other lines proving that the typical auroral spectrum is emitted by solid nitrogen in these circumstances. Liquid nitrogen has been investigated by Dewar, by Baly, Donnan and other chemists. Solid nitrogen melts at $-210°$ C., and the detection of solid nitrogen in the upper reaches of the atmosphere is an interesting contribution to our knowledge of temperatures in regions perhaps a hundred miles above the earth's surface.

* * *

The letter from a Californian correspondent on the English language appeals to us in our editorial sanctum. The written language is a tool which may be made remarkably efficient; the use of this tool is an art comparable with that of the engraver or the sculptor. A weekly journal dealing with chemistry is not suited to the practice of this art in its highest form. In too many cases the writing and the proof correcting must be done hurriedly and of our thousands of readers many are content to learn the new facts and value but little the form in which they are presented. Besides, the training of our chemical writers and our chemical editors does not tend to elegance in expression. We wish it were otherwise; to write a simple style, setting down in a suitable manner the story one has to tell, is not a difficult art; it is like skating on the outside edge, perfectly easy to do tolerably with a little practice; it is nothing like so difficult as making losing hazards on a billiard table, which involves great nicety of touch, unusual accuracy and considerable practice. We often wonder that scientific people are not more fastidious in the art of writing: our correspondent gives an instance: he says, the use of etc., although common and accepted as "good English"—common enough it is, but not, we trust, accepted as good English except in very rare instances. Scientific articles and books are not to be taken as standards; every time we read a paper in a chemical or physical journal, we ought so soon as possible to read as an antidote a chapter of the Bible, one of Lamb's essays or a poem by Calverley or Milton. It is now several weeks since we praised the book of an American author, Mr. T. A. Rickard, on "Technical Writing." We offer no excuse for doing this; if an Englishman, a Scotsman, an American or a Welshman, yes, indeed, can show us how to make the tool more efficient or to use it more neatly we are very glad and we are grateful to him. That there is much good sense in Mr. Rickard's book we are satisfied; we have read it through from beginning to end. Whether it is difficult to write well, in a really good style, we do not know; we have never attempted it: we do not write *au grand sérieux*. On the other hand we are satisfied that to write chemical articles, on a variety of topics, in simple language that may be easily understood, is very easy. Many men and women and some children can achieve this. The only trouble is getting the necessary information into one's head; we understand there are some gifted people who can write articles without having their memories charged with the facts. We envy them; for us, learning is,

or rather was, one process, writing another, not to be confused with the first. Mr. Allen's letter, like Mr Rickard's book, comforts us with this reflection great as are the differences between the American and the British journalese, unintelligible as are to us the accounts in the New York papers of baseball matches, there is yet that common language which is used by all those who on either side of the Atlantic make any attempt to write standard English The language of Mr. Abbott, Sir Clifford Allbutt, and Mr. Rickard is the same. If the Americans choose to spell color without the letter "u," they may be forgiven Every English lawyer does the same in his legal documents: we must admit that it is more meritorious to spell it in this way because that is the tradition in your profession, than because you make an innovation of greater simplicity. The one reason is a due regard to precedent, the other a total disregard to the feelings of your fellow creatures It is the difference between orthodoxy and heterodoxy, the one is our doxy, the other is yours

* * *

We see in the columns of the *Manchester Guardian*, which is usually well-informed in such matters, that a decision on the agreement between the British Dyestuffs Corporation and the Interessen Gemeinschaft may be expected within a few days This decision will be eagerly and even anxiously awaited: it is easy to conceive an agreement which would be acceptable to the shareholders of the British company and yet be fatal to the progress of British chemistry and all the industries which depend on it. The views of chemists in this country and of manufacturers here, other than the Dyestuffs Corporation, have been laid before the Government by numerous deputations, of which one from the Federal Council is perhaps both the latest and the last The nature of this particular deputation seems to have been misunderstood by a correspondent who has written to the *Chemical Age*. As the point is of interest, we may remark that the deputation tried to set forth the views of the Federal Council only, not the views of any particular individual, nor those of any society or club in which such individual might be supposed to be specially interested. The Federal Council has no political views and its spokesmen scrupulously and obviously avoided any discussion of the political aspect of the problem It seems to us absurd that anyone should comment on the inclusion in the deputation of someone who has other interests in life besides the Federal Council There is no single member of the Federal Council who has not other important interests, and no just cause of complaint exists that a man, who is able and willing to spare the time, should assist the Federal Council to put forward opinions which represent the collective views of that Council. Suppose the Society of Chemical Industry decided to advocate a particular policy with regard to Chemistry House, has a shareholder in a company any reason to complain that one of the directors who happens to be on the Society's Council has meddled in a controversial and difficult question? In the chemical world an ounce of encouragement is worth a ton of criticism

THE OIL SHALES OF SOMERSET*

By Dr. W. FORBES-LESLIE

The vital need of all industry is cheap fuel. Indeed it is the basic element in human progress and civilisation for upon the form of fuel largely depends the evolution of the human species. Wood was the first fuel used by human beings and has descended to us from primitive man—the splendid civilizations of the ancient world of Persia, Egypt, Greece, Rome and Mediæval Europe belong to this age. Coal followed, bringing into being and subserving the need of the mechanical age. Less splendid and perhaps less durable but more practical and more productive of those essentials for human comfort than the latter. Already the coal age is passing and a new and more potent fuel has seized the imagination of the world and is superseding it in all the realms of industry and commerce. Coal brought the steam engine, the railroad, the steamship. Hitherto the world of the wood age relied for swiftness on the horse, for transport on the wind driven ship. But petroleum, or mineral oil, the new fuel, has increased the utility of the steam engine and the steamship and added speed and ocean range to the latter undreamt of hitherto. Petroleum has also given us the internal combustion engine, the motor car, and, above all, has endowed man with another power over Nature the power of flight, so that he is now bird and man. The characters of fuels vary—wood is solid and flexible, coal is solid and friable, but petroleum is liquid. But petroleum was coal, or in a sense so, and it was wood. Petroleum is only a step further in the complicated process of organic decomposition.

The origin of petroleum oil is to be sought in vegetable and animal remains of past geological periods, which have been entombed in muds and silts with exclusion of oxygen. The same process is seen in action to-day in the deltas of great rivers and in estuaries. These will ultimately become the oil fields of future geological ages. These areas usually occupy subsiding basins and as the load of sediment descends the isotherms, or earth heat units, increase till the organic matter resulting from decomposition is distilled, and escapes as oil, gas and water into adjacent porous rocks, called reservoir rocks, especially if they are flexed or folded, as happens through dynamic action. The oil may remain caught in these tectonic structures for ages and only escape when the drill penetrates them, or through post orogenic changes it may be dissipated in the ensuing convulsions.

Coal also has its origin in vegetable remains of past geological periods, entombed in silts and muds with partial occlusion of oxygen. By artificial means tar oils and benzols can be extracted from it.

But another fuel exists in Nature which is more nearly related to petroleum than coal, both physically and chemically, and that is "oil shale."

Oil shale was known before Colonel Drake discovered the first petroleum well in 1859. Oil shale was known in England in 1694 when a patent was

* Read at a special meeting of the Bristol Section, on May 6

granted for its treatment. It was obtained for medical purposes in 1761 and the first plant was established in England in 1815 at Sunderland. In 1834 oil shales were worked at Autun in France. In 1864 thirty-eight plants were working in Scotland, and as early as 1860 there were fifty to sixty plants working in America. The discovery of well petroleum caused the shutting down of the American plants and ultimately of the French plant at Autun, but Scotland has continued to work throughout the early days of competition and later has been producing about 3,000,000 tons annually with a value of from £750,000 to £2,081,000.

The origin of shale oil is the same as that of petroleum. It arises from vegetable and animal remains entombed in the silts and muds of past geological ages. It may be said that all petroleums were at first in their decompositional evolution oil shale and that dynamical and thermic causes were responsible for their ultimate difference.

Since 1859 petroleum products have gradually usurped the position of coal, and that in a world where industrial development, through increase of population, and more perfect methods of production, has exceeded all previous estimates. Progress in the last 50 years has rushed forward and upward with ever increasing velocity and range of curve till the future appals us by the immensity of its possibilities. How much do we owe this to petroleum and its allied fuels? Much, for the form of fuel underlies the evolution of human progress and creates environment.

The discovery of petroleum in 1859 destroyed the beginning of the oil-shale industry in America and in France, and checked any development of this fuel in other countries, Scotland excepted. To-day the position is reversed. Hear what a leading exponent of the petroleum industry has to say in an article as late as Monday, March 31, 1924, in the *New York Commercial Journal*:—

> "The manufacture of oil and its byproducts from shale rock can now be established profitably in the United States and it is likewise necessary that it be started."

In 1923 the United States of America produced 72·7 per cent. of the total world production of petroleum, or roughly 122,500,000 tons. In 1914 she produced only 44,333,333 tons. In less than ten years the production has increased by nearly 180 per cent. Motor vehicles have increased by nearly 3900 per cent. during the last twelve years and the production of gasoline has only increased by 900 per cent. David White, Geologist of the United States Geological Survey, testified recently before the Senate Public Lands Committee that within five years the United States Navy would have to depend upon foreign oil fields or on oil shale for its supply of oil. Other eminent authorities estimate that the known reserves of petroleum left in the ground in the United States amounts to no more than 9,150,000,000 barrels, approximately 1,525,000,000 tons, and that in ten years or less America will be purchasing oil for her Navy. The United States has 15,000,000 motor cars or 80 per cent. of the world's total, and she uses two-thirds of the world's oil production—a production only kept to its present level by the fortunate discovery of the big Southern Californian Pools in 1921 and 1922. A leading Industrialist of Great Britain reviews the situation as follows:—

> "If their present curve of consumption, especially of high-grade products, is maintained, the Americans, in ten years time, will be importing 500,000,000 barrels of oil a year."

It may also be recalled that while America is consuming two-thirds of the world's oil production she has only 12 per cent. of the known oil reserves remaining in the ground.

The above statements are of serious import and are made by many of the greatest geologists, chemists and statisticians of the United States. The position of the petroleum industry to-day indicates that unless stabilising factors are found demand will exceed supply with the introduction of all the delimiting and degenerating elements which are inherent to such slip backs in industrial progress.

Can these factors be found? The eminent American expert quoted at the beginning of this paper frankly states that the oil shales of America can be profitably worked even on a standard of comparison of prices as finely cut as the oil prices of 1922, which cannot possibly, for lowness of price, ever again recur, the flush production being due to over-drilling and the discovery of the great pools of Southern California. It is stated on good authority that oil shales can be treated in Colorado, Utah and Kentucky for about \$1·50 or about 6s. 6d. per ton, and refined for another \$1·25 or 5s. 3d.—a total of \$2·75 a ton of shale. This will give about a barrel of oil or 42 American gallons, which sells at \$6 per barrel, leaving a profit of \$3·25 net, or about 14s. This is in competition with oil-well production in the same country. Colorado and Utah alone have an estimated oil content in their shales of 12,000,000,000 tons, or 12 times the known oil reserves of the United States.

Here then is the stabilising factor to supplement and to succeed the uncertain oil-well supplies of the present day. If it is possible to work the American shales in competition with idigenous petroleum how much more profitable is it to work oil shales in countries where there is little or no indigenous petroleum like Canada, France, England, Esthonia, Sweden, Germany, Spain, Brazil and Australia.

Although new oil fields have been discovered in other parts of the world, many of those already producing being only in their infancy, still the ratio of demand over supply is such an increasing one that exhaustion even here is foreshadowed.

From these remarks it will be obvious that oil shale and petroleum are not rivals but relatives, seeking to meet conjointly the needs of the industrial world.

This review of petroleum and its position to-day, is also necessary in treating a basic object for any description of the new oil shale discoveries in Somerset. How these appeal to the American mind is best expressed in the words of a well-known oil authority, writing in the American press:—

> "In England, large deposits of oil shale have been known for many years in Norfolk and Dorsetshire, but owing to the large sulphur content about

7 per cent.—they have been unavailable up to this time. A few weeks ago a discovery was reported which undoubtedly will have a most important influence on the industry and commerce of Great Britain."

In such a sense do these Somerset oil-shale discoveries appeal to the American mind.

Now, what are they? They consist of an immense deposit of liassic sediments, concentrated by dynamical causes and chemical interactions into alternate beds of black, blue and brown laminated shales and argillaceous limestones. A great and massive formation. For centuries it has been worked for limestone for making hydraulic limes, but the shales (called locally "scale") were thrown away as waste product.

This massive assemblage of beds extends from Blue Anchor on the West to Combwich on the River Parrett a distance of about 14 miles. It is divided into two dynamical basins by the Devonian ridge of the Quantocks and the Marginal Triassic rocks, viz., the Watchet basin and the Lilstock basin. The latter has a breadth of from 1 to 3 miles, being roughly triangular, and a surface area of about 17 square miles. The former has approximately an area of 3 to 4 square miles, making a total of about 20 square miles. Two main ridges run East and West—one forming the coastal cliffs, the other the inland outcrops. The coastal section dips landwards 25–35 degrees to the south. The inland outcrop dips seawards about 25 30 degrees to the north. The valleys between these being synclinal. The faults are principally in type apical fractures belonging to an anticlinal and synclinal system. Viewed obliquely from N.W and N.E. they appear as a series of step faults with throw downs to the east. The stratigraphy varies in the different series, but a general type is met with throughout. The lithology likewise differs, and these differences are sharply confined to the life zones. The shales are blue, black and brown They have a thickness of from 1 foot to 25 feet and over, are finely laminated or massive, but on weathering even the massive varieties exhibit fine laminations. The fracture is conchoidal, and the note woodeny, the streak brown, the jointing square or triangular A type of flagstones is common in the lower beds. The effect of thermic action is most remarkable Resistance is great and temperatures of even 1000 C., and more, do not flux the rock or cause it to run. It can be burnt under a steam boiler like coal, providing the air currents are kept free Under marine weathering, the oil shales retain their texture, hardness, colour and oil contents for considerable periods. Long atmospheric weathering causes severe oxidation changing the colour to yellow and the rock becomes friable and loses its oil contents.

The formation is divided into seven main series of life zones. This is the most accurate method of division, stratigraphical sequence with lithological equivalents being now relegated to formations where the remains of life are absent. The formation containing the oil shales belongs to the Rhaetic division of the Trias and the Lower Lias division of the Jurassic. An oil shale seam, 10 feet thick, exists in the black shale series of the Rhaetic. It belongs to the life zone of the *Pteria Contorta*, and is the first oil shale discovered in the English Trias.

The basement beds of the lower lias, distinguished by *Ostrea Liassica*, contain several thick oil-shale seams- also called the Contorted beds from the wavy character of its folio planes.

The next is the flagstone oil shales of the *Planorbis* zone. Rich and valuable seams.

The fourth series, called the Lilstock beds, is represented by the *Am. Johnstonii* and consists of black oil shales.

The fifth is formed by thick black and more argillaceous beds of oil shale represented by *Schlotheimia Angulata*, and called the Benholm beds—where best studied.

The sixth, called the Kilve Fill beds, is a thick series containing many seams of rich brown oil-shale, distinguished by the fossil indicator *Am. Arinoceras Walcotti*, and containing at its head a subordinate interlude called Berry's series.

The seventh and superior series is called the Priory beds and consists of about 300 feet of oil shales and limestones representing the zone of *Coroniceras Bucklandi*, and including several subordinate zonal interludes. Superimposed upon this superior oil shale series there are 325 feet of *Gryphaea arcuata* marls with small *Coroniceras Bucklandi* to within 47 feet from the surface, representing the head of the *Bucklandi* zone.

Both the oil shale seams and the divisional planes of the main palaeontological platforms are composed of, and separated by, limestones, the limestones of the divisional planes being constituted of several small paviors with alernating thin mudstones. The whole forming a divisional stage which is usually distinguished by a type of *Am.* resembling *Agoceras megastoma* Wagen whereas the oil-shale seams are separated from each other by thicker beds of pure lias limestones.

The origin of the sedimentation resulting in the deposits above described is now obscure. There is no lithological proof that it was derived from the waste of coal fields occupying the South Wales areas or from the eroded coal measures of Devon. The sediments do not seem to contain mica, fragments of felspars or the partial or unchanged elements of the igneous or plutonic rocks. The texture is so fine that the shales resemble the retrituration of sedimentary rocks They are, moreover, strongly calcareous and weakly argillaceous, whilst their siliceous content is low for this class of rock. There is some difference lithologically between the series The Rhaetic shale is very fine grained, with weaker calcareous content and more argillaceous than the basement lias beds which are weakly argillaceous but strongly calcareous and silicious. The fineness of grain, although great, is not equal to the Rhaetic The *Planorbis* beds are coarser in grain and more strongly calcareous with about equal silicious content The *Johnstonii* beds are of finer grain than the latter and slightly more argillaceous. The *Angulata* beds are of fine grain and are still more argillaceous with considerable calcareous content. The *Arinoceras Walcotti* beds are fine in grain and have about equal

percentages of calcareous and siliceous matter with weak and varying argillaceous content. The Priory beds are less calcareous and more siliceous with stronger argillaceous content.

These differences in lithological texture among the series indicate variation in the quality of the derived sediments and also variation in distance from the source, or changes in the sea floor.

Examination of outcrops West to East give little indication of the derivation of origin. If anything there is growing fineness of grain met with as one goes further East, but so slight that one is led to infer that the outcrops indicate a lateral section of the sedimentation and the cone of it lies either North or South.

The *Ostrea Liassica* beds show some lithological change southwards. Shales thin out and mudstones and thin limestones take their place and fossil indicators and indeed fossil forms of all kinds are rare or absent. Owing to post Liassic or inter Liassic denudation of the southern edges, the upper shale series beyond the Lilstock basin is not available for examination.

Jukes Brown in a redrawing of land and water areas in the Rhaetic and Lower Lias age shows that all Western England was sea and that Cornwall and Dartmoor extended eastwards as a Promontory from an Atlantic or Western Continent. Two wide bays existed extending westwards, one north and one south of the Promontory. These bays are shown to be the debouchment areas of two great rivers draining the border lands of the great Western Liassic Continent. The sedimentation of the Lower Lias was possibly derived from the waste of this continent now lying buried beneath the Atlantic, for the physical character of the deposits and their lithology appear to infer a western system of sedimentation rather than any other.

Chemical Composition of the Somerset Shale

It is, like all oil shales, composed of :— (a) an organic content and (b) an inorganic content.

On treatment by destructive distillation in a retort the shale yields oil, gas and ammonia water and a residue called shale ash. Providing the ultimate temperature is high enough, namely, 800 to 1000° C to volatilise the fixed carbon and drive off the balance of the nitrogen, the ash represents the inorganic content.

The physical characters of the Somerset oil shales *in situ* have already been described. Examination of the shale in the laboratory corroborates these characters and in addition demonstrates that the specific gravity is remarkably high. The ordinary oil shale standard of weight was originally 1·2 from Scotch torbanite and 0·9 to 1·0 from Australian paraffin shales. Owing to poor qualities of shales being now worked in Scotland the sp. gr. has risen above 1·2 to about 1·6 to 1·7. Spanish shales have 1·7 sp. gr. and Kimmeridge shales from 1·2 to 1·7. The Somerset shales have an average sp. gr. of 2·4: the lowest sp. gr. is 1·88, the highest about 3·0. It has been usual to determine the value of an oil shale by percentage of vol.: hydrocarbons to the weight ton. In shales of 1·2 sp. gr. and under, this method is accurate enough, but in higher sp. gr. shales it is obviously misleading. It might be presumed that if the mineral complex was largely composed of lead, the percentage of vol. hydrocarbons would be infinitesimal to the weight ton. It appears that the only accurate standard of percentage ratios is the amount of hydrocarbon in the cube ton. Let the standard be oil shale at 1·0 sp. gr. or the weight of water. A ton of shale of this gravity will weigh 2240 lbs. and measure 1·0 cubic yards. But an oil shale of 2·0 to 2·4 sp. gr. will weigh double, or more than double, of this or 4480 lbs. and still only measure 1·0 cubic yards. Therefore the standard applicable to both is the cubic standard not the weight. Oil is lighter than water and has nothing to do with the atomic weights of the mineral complex. In commercial treatment oil shale is mined or open cast by the cubic yard, retorting is by cubical capacity and Royalties are paid by cubic measurement.

Moisture in oil shales varies. The highest moisture content is met with in the Kimmeridge shales of Norfolk, as high as 25 per cent., also in Esthonian shales and some American shales. Moisture in Scotch shales is low, about 5·7 per cent. and in Somerset shales 4 to 5 per cent.

Unlike most oil shales, Somerset oil shales when freshly broken out give off a strong odour of paraffin. The action of solvents on Somerset oil shales resembles that on American shales, a small percentage of the hydrocarbon being soluble.

The sulphur content of the Somerset oil shales is about the same as that of the Scotch oil shales. Little or no pyrites is met with in the middle series of shales—pyritised fossils being commoner in the Rhaetic beds and in the Upper Liassic or *Coronicras Bucklandi* beds. Retorted oil from the Rhaetic oil shales contains about 2·0 to 3·0 per cent. of sulphur, whilst the Liassic middle shales contain from 0·8 to 2·2 per cent. The sulphur contained in the oil is principally in the form of thiophanes and quite easily washed out, unlike the large percentage of sulphur (7 per cent.) in the Kimmeridge shale oils which is in the form of a thioether, a substance most difficult to eliminate.

The residue, or ash, of the shale after retorting, unless the temperature has been raised sufficiently to volatilise them, contains in the mineral complex 50 per cent. of the nitrogen and all the fixed carbon. The nitrogen content, which has been worked out principally in the middle shale series, is about 0·8 per cent., or a theoretical yield of 80 lb. per weight ton of sulphate of ammonia. On a commercial basis this will give about 50 lb. per ton. On the cube ton a theoretical yield of 160 lb. will be obtained, or a commercial yield of 100 lb. A return of 60 lb. may very well therefore be looked for in commercial production. The amount of fixed carbon in the ash is about 20 to 25 per cent. or equivalent, in a fuel value to one ton of coal in every five tons of oil shale ash. The percentage of fixed carbon depends, up to a point, on the suitability of the retorting apparatus. The more oil obtained the less fixed carbon there will be, the less oil, the more fixed carbon. The object of an operator is to increase the oil yield at the expense of the fixed carbon. Free carbon does, however, exist

in every oil shale in the form of carbonised filaments of plants, algæ, ferns, etc., which have not, and have never been, in combination with hydrogen to form hydrocarbon.

The mineral complex composing the residual ash remains to be examined. Oil shale ash comprehends differing percentages of silica, alumina, iron, lime, magnesia.

The Norfolk Kimmeridge Shale Ash contains :—

	Per cent.	
SiO_2 ..	46·10	
Al_2O_3 ..	19·90	
FeO_2 ..	2·88	8·08%
Fe_2O_3 ..	5·20	
CaO ..	19·60	
MgO ..	1·55	
Sulphuric anhydride ..	3·60	
Alkalis and loss ..	1·17	
	100·00	

Analysis of Scotch Oil Shale Ash yields the following percentages :—

	Per cent
SiO_2 ..	49·70
Fe_2O_3 ..	16·80
Al_2O_3 ..	18·80
CaO ..	2·40
MgO ..	2·20
Alkalis, sulphur and loss ..	10·10
	100·00

Analysis of American Shale (Indiana), including carbon :—

	Per cent
Carbon ..	11·00
SiO_2 ..	59·20
FeS ..	12·20
Al_2O_3 ..	17·50
CaO ..	0·10
MgO ..	0·14
	100·14

Analysis of Somerset Oil Shale exhibits the following compositions :—

	Per cent
SiO_2 ..	26·56
Al_2O_3 ..	13·22
Fe_2O_3 ..	10·26
CaO ..	36·83
MgO ..	1·10
SO_3 ..	10·52
Alkalis CO_2 and Loss ..	1·51
	100·00

Total organic volatile matter averages 33%.

A study of these ultimate analyses of various shale ashes show that the Somerset oil shales differ from Scotch, American and Norfolk Kimmeridge in the silico-calcareous ratio, whilst closely approximating to Scotch, American and Norfolk Kimmeridge ash in the Al_2O_3, Fe_2O_3, and MgO contents; the difference in SiO_2 and CaO is most marked. SiO_2 forms invariably the highest percentage in oil shale ash residue and Al_2O_3 is generally the next highest—CaO commonly forms one of the subordinate percentages. But in the Somerset oil shale CaO is the major percentage, SiO_2 being subordinate by one-third. Only one oil shale of the Green River Formation, Wyoming, approaches the Somerset in the silico-calcareous ratio, viz., as follows :—

	Per cent
SiO_2 ..	38·9
Al_2O_3 and Fe_2O_3 ..	12·4
CaO ..	38·3
MgO ..	4·9
	94·5

But even here the silico-calcareous ratio is reversed, SiO_2 being still a plus quantity. This silico-calcareous ratio therefore is remarkable, and marks Somerset shale as an uncommon oil rock. The peculiar character of the mineral complex may have an influence in determining the high quality of the Somerset oil. The best petroleum oils are usually found in calcareous rocks, as in the Pennsylvanian and Persian fields.

When an oil shale is destructively distilled oil, gas and ammonia water are obtained. The water is largely the result of steam used in the distillation. But water of combination is also a product. The ammonia is a product of the decomposition of nitrogen, and about 50 per cent. of the nitrogen content of an oil shale is recovered from the ammonia water—the other 50 per cent. being recovered from the residue.

The gas is composed of permanent gases such as CO and CO_2, but also contains a percentage of the more volatile hydrocarbons of the methane series with hydrogen and nitrogen. The gas is scrubbed being driven through scrubbing towers, and the light hydrocarbons or scrubber spirit is absorbed by heavier oils, which, on being distilled, yield up the spirit—about 2 gallons of scrubber spirit may thus be recovered to the ton of oil shale.

The amount of permanent gas does not vary much in oil shales of equal or comparative richness in oil content—being about 2500 to 3500 cb. ft per weight ton of shale.

Origin, Composition and Properties of the Oil

Oil shales, with the known exception of the Montery shales of California, do not contain oil as such. Oil is obtained as a product of pyrolysis in the destructive distillation of the shale. The mother substance of oil in shale has been described by Prof. Crum Brown, who called it "Kerogen." Little information is available on the chemical composition of kerogen, but in Scotch shales it has been found to consist of 73·05 per cent. carbon, 10·62 per cent. hydrogen, and 16·33 per cent. oxygen. This composition corresponds to the formula $C_6H_{10}O$, which is believed to be the empirical formula of kerogen. Although the empirical formula of kerogen has been determined as $C_6H_{10}O$, it is nevertheless probable that kerogen is composed of different types and sizes of molecules, and this may serve to explain the difference in the shale oils. Besides oxygen, hydrogen and carbon, kerogen contains small percentages of nitrogen and sulphur. Kerogen is only slightly soluble in carbon disulphide, and for this reason is classed as a pyrobitumen. Certain of the pyrobitumens, on being treated, change into bitumen, becoming soluble in organic solvents.

The oil-producing substances of shale are therefore considered to be asphaltic pyrobitumens, and on

being treated they change into a bitumen which is largely soluble in organic solvents and after extraction from the shale becomes a semi-fluid or asphalt-like substance. The decomposition or conversion of the pyrobitumen into a bitumen is not clearly understood. Perhaps it may be due to complete or partial polymerisation. It proceeds at a temperature of 400° C. and over, and produces gas, oil, vapour and fixed carbon, but the change of kerogen into bitumen will take place at much lower temperatures if sufficient time be allowed. There are therefore two stages in the distillation of oil shales :—

(*a*) The conversion of kerogen into bitumen.
(*b*) The decomposition of bitumen into gas, oil, vapour and fixed carbon.

Both of these stages probably occur at the same time or relatively so.

Destructive distillation of oil shale is effected in closed chambers called retorts. There are two types of these—vertical, of which the Scotch retorts are an example, and horizontal, of which the Neilson and Fusion are present examples. The vertical are oval-shaped iron and fire-brick lined towers about 65 feet high. The Neilson is a revolving horizontal fire brick lined tube about 100 feet long. The Kimmeridge shales, and most of the American and Australian, are unsuited to present types of vertical retorts owing to their sensitiveness to thermic changes, but a lead jacketed retort, the New York retort, that was invented in America is claimed to preserve a regular retorting temperature. If so, it will revolutionise American oil-shale practice. Those classes of oil shales which are resistent to irregular and high temperatures are eminently suited for treatment by the Scotch vertical type of retort. Among such the Somerset oil shales are prominent, an oil being obtained 80 per cent. saturated by vertical retorts. On refining, such oil resists cracking even at temperatures of 410° to 450° C. This quality confers an enhanced value on an oil because this quality is passed on to the various fractions into which a crude oil is split and increases their market value and range of utility correspondingly.

Properties of Crude Shale Oil.

A shale oil should be fluid or semi-fluid at ordinary temperatures. Scotch crude is semi-solid at ordinary temperatures, and so are most American shale oils. Crude shale oil is usually of a dark rich brown or greenish brown colour. It rotates the pole of reflected light to the right. The index of refraction is increased in shale oils of large unsaturated percentage, it is also increased by an increase in viscosity, whilst the presence of wax in lubricating oil lowers it. Somerset oil is fluid at ordinary temperatures, but its viscosity quickly increases in winter temperatures. The sp. gr. of Canadian shale oil varies from 0·891 to 0·977, on an average about 0·900. American shale oils vary from 0·877 to 0·975 and the average about 0·898. French crude oil has a sp. gr. of 0·912. Kimmeridge Norfolk 0·990. Scotch crude shale oil varies from 0·8750 to 0·9032, average about 0·8917. The sp. gr. of Somerset shale oil varies from 0·933 to 0·940.

The chemical composition of a crude shale oil varies in different fields. The variation largely depends on the relative percentages of saturated and unsaturated hydrocarbons. The saturated series are the paraffin (C_nH_{2n+2}) and naphthenes (C_nH_{2n}): the unsaturated are the olefines (C_nH_{2n}), diolefines (C_nH_{2n-2}), acetylenes (C_nH_{2n-2}) and aromatic benzenes (C_nH_{2n-6}). Crude shale oils usually contain fairly large amounts of pyrrol (C_4H_5N), pyridine (C_5H_5N) and quinoline (C_9H_7N). Sulphur compounds are also present such as hydrogen sulphide, carbon disulphide, alkyl sulphide or thioethers such as $\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!S$, thiophenes, thiophanes ($C_nH_{2n}S$) and mercaptans.

American shale oils are from 41 to 65 per cent. unsaturated; Kimmeridge (Norfolk) from 85 to 90 per cent. unsaturated; Esthonian shale oils from 90 to 95 per cent. unsaturated. Scotch shale oils contain from 30 to 40 per cent. unsaturated hydrocarbons. Somerset shale oil, on the contrary, is only 20 per cent. unsaturated. The unsaturated hydrocarbons in the Kimmeridge shales belong largely to the olefine and acetylene series; Somerset largely to the olefine series; American to the olefine, diolefine and acetylene series. Among these percentages of saturated and unsaturated hydrocarbons are contained the organic sulphur compounds. Thiophanes occur as the sulphur compound in Somerset shale oil and thioethers in the Kimmeridge shale oils. The thiophanes are easily washed out; the thioethers are obstinate to eliminate. Nitrogen occurs as pyridine in the American shale oils, as pyridine and quinoline in the Kimmeridge (Norfolk) shale oil, and probably as pyridine in the Somerset.

On refining, a crude oil, whether petroleum or shale oil, is broken up into fractions by a series of thermic cuts. The lighter gaseous hydrocarbons are driven off first and condense as a spirit, followed in series by the liquid and solid hydrocarbons.

Description of the Fractions

The petrol in American shale oil is usually in large quantity, up to and over 35 per cent. This is very high, even for the best Californian or Pennsylvanian petroleums, but it is "cracked": that is, it contains large percentages of unsaturates, and in the refining treatment which requires desulphurisation and subsequent washing in caustic soda a large part of the unsaturates are lost. The same applies to Esthonian shale oils and Kimmeridge: as much as 70 to 75 per cent. may be lost in a shale oil of high unsaturation. A shale spirit will change in sunlight to a straw-coloured liquid, and even to a red ruby liquid, due to decomposition of unsaturated hydrocarbons. Gums and resins may be thus precipitated, and will cause mechanical trouble in the motor car. Consequently it is necessary to free the spirit from all decomposible unsaturates. Sulphur also is always present, and in its most objectionable form, in cracked oils. Scotch oils contain smaller percentages of petrol than either American, Esthonian or Kimmeridge oils, but the Scotch oil is more largely saturated than most of the American and than the Kimmeridge and Esthonian. The Somerset shale oil contains

9·9 per cent., and with the scrubber spirit the percentage is increased to about 13·9 per cent. This spirit contains no unsaturates, or only a small amount and is "water white" on being refined, keeping its colour equal to the best petroleum petrols.

The kerosene fraction from 180 degrees C. to 240 degrees C., is equally high in crude American petroleums or shale oils, as much as 27 per cent. in Utah shale oil; in Scotch, about 14 to 23 per cent.; in Kimmeridge (Norfolk) it reaches a point even higher than American shale oil, viz., 33 per cent. In Esthonia it is higher still, about 44 per cent. Somerset shale oil contains only 11·9 per cent. of

Fractionation of an American Shale Oil from Utah in this country gave the following:—

		Per cent.
50° C.–180° C.	Petrol	35
180° C.–240° C.	Kerosene	27
240° C.–280° C.	Gas oil	15
280° C.–320° C.	Light lubricating oil	10
320° C.–340° C.	Heavy lubricating oil	5
Wax and loss		8
	Crude sp. gr. 0·885	
Fixed carbon in shale		26·90
Nitrogen in shale		0·88
Sulphur in shale		0·90
Unsaturated hydrocarbons		28
Saturated hydrocarbons		72

which is the highest percentage of saturated hydrocarbons the author has obtained from American shale oil.

Amount of permanent gas from distillation, 3000 cu. ft.

Distillation of Norfolk Shale Oil, December, 1920. Average oil yield, 30·4 gall. per ton:—

		Per cent.
0° C.–180° C.	Motor spirit	15
180° C.–280° C.	Kerosene	31
280° C.–300° C.	Gas oil	11
300° C.–360° C.	Light and heavy lubricating oil	32
Bituminous residue and loss		11
	Crude sp. gr. 0·990	
Fixed carbon in shale		19·0
Nitrogen in shale		0·8
Sulphur in crude oil (largely thioethers)		6·8
Sulphur (after desulphurisation and washing), in fractioning to .		
180° C.		0·2
280° C.		0·3
360° C.		3·4
Unsaturates		85
Saturates (paraffinoid bodies)		15

Amount of permanent gas from distillation, 3500 cu. ft.

kerosene being the smallest percentage of the above quoted examples.

The gas oil fraction is 15 per cent. in Colorado shale oils, 30 per cent. in Scotch, and only 3·5 per cent. in Kimmeridge (Norfolk). In Esthonia 5·7 per cent., and in Somerset, 28·2 per cent. High percentages of gas oil are not considered an advantage in a shale oil or petroleum, owing to the prices being so much less than for petrol, kerosene, or light lubricating oil. The 28·2 per cent. is too high in Somerset shale oil, and by careful refining it has been found possible to reduce this percentage to about 5·7 per cent.—increasing the kerosene and light lubricating fractions correspondingly. Most gas oils are solid at ordinary temperatures, but Somerset gas oil is fluid, and forms a high-grade Diesel oil for naval use.

Of all fractions, however, in ... shale oil the most valuable are the light and heavy lubricating oils. The Scotch shale oil usually contains 14 ... per cent. of light, and 15 per cent. of heavy lubricating oil, but since 1922 it produces only 8 per cent. of light and heavy lubricating oils. Kimmeridge shale oil, 31 per cent. light and heavy, and Esthonia 25 to 27 per cent. but these latter are of poor grades, due probably to the high percentage of unsaturates. A ... (Colorado) shale oil has about 10 per cent. lig... 5 per cent. heavy lubricating oil of sp. gr. ... 0·959, but these likewise appear to be of poor ... The principal value in the Somerset shale o... oil.

Distillation Tests from Crude Somerset ... Oil, 40 gall. per ton:—

		Per cent.
0° C.–180° C.	Motor spirit	[illegible]
180° C.–220° C.	Kerosene	[illegible]
220° C.–280° C.	Gas oil	[illegible]
280° C.–340° C.	Light lubricating oil	[illegible]
340° C.–410° C.	Heavy lubricating oil	[illegible]
Wax, residue and loss		[illegible]
	Crude sp. gr. 0·940	
Fractionating to:—		
180° C.		0·78–0·790
280° C.		0·83–0·850
410° C.		0·96–0·990
Fixed carbon in shale		[illegible]
Nitrogen in shale		[illegible]
Sulphur in oil (average)—in the form of thiophanes ($C_nH_{2n}S$) easily washed out		[illegible]
Unsaturates in oil		[illegible]
Saturates in oil (paraffinoid bodies)		[illegible]

Amount of permanent gas from distillation, 35[illegible] cu. ft.

Approximate Fractioning of Scotch Shale Oil gives the following:—

		Per cent.
0° C.–180° C.	Petrol	[illegible]
180° C.–240° C.	Kerosene	[illegible]
240° C.–280° C.	Gas oil	[illegible]
280° C.–320° C.	Light lubricating oil	[illegible]
320° C.–340° C.	Heavy lubricating oil	[illegible]
Wax		[illegible]
Loss		[illegible]
	Crude sp. gr. 0·9032	
Fixed carbon		[illegible]
Nitrogen		0·35–[illegible]
Sulphur		0·50–[illegible]
Unsaturates		[illegible]
Saturates		[illegible]

Amount of permanent gas from distillation, 35[illegible] cu. ft.

... and the large percentage of its lubricating fractions, a... first-grade quality possessed by them. It has 2... 27·5 per cent. light lubricating oil, and 18·7 per cent. heavy lubricating oil. The resistance of the shale to heat has been transmitted to its lubricating oils, so that no cracking of the heavy lubricating oil takes place up to 410 to 450 degrees C. A remarkable and most valuable quality, especially when, in addition, it has the quality of "oiliness" and semi-fluidity at ordinary temperatures. It is certainly one of the purest, if not the purest, high-speed lubricant found in shale oils. In commercial practice it has been applied to "seized" red hot bearings; it has cooled them off, and when collected has been found, and unchanged. It compares favourably with the best Russian lubricating oils, and its discovery in this country may be regarded, in the words of a naval

authority, "as a miracle." The sp. gr. of lubricating oil is 0·960–0·990.

Paraffin wax is found in most of the American shale oils, and in such percentages in some as to make the oil solid at ordinary temperatures. Scotch oils are somewhat similar, but Kimmeridge oils (Norfolk) have low percentages. Utah (American) shale oil contains about 5 per cent. paraffin wax: Scotch shale oil contains about 12 per cent. paraffin wax; Somerset shale oil contains about 3 per cent. paraffin wax.

The "still coke" obtained from the ultimate distillation of the Kimmeridge (Norfolk) and Somerset shale oils is of fine quality, suitable for varnishes. Norfolk shale oil possesses another by-product of great value in its large ichthyol fraction, which is closely connected with its high sulphur content.

A combination of the residual shale ash with the Lias limestone, and subjected to a special process, gives a high quality Portland cement. It sets within seven hours, and it seems as if the age of cheap high-grade cements were at hand. The shales can be used for the manufacture of high-class bricks and tiles, and for, it is believed, the manufacture of excellent fire bricks.

But what we would impress upon our hearers most of all is that there is between Watchet and the Parrett one of the most stupendous sources of cheap fuel, heat and power in Europe. You may forget the oil, the cement, the nitrogen, the by-products, but you cannot forget that there are thousands of millions of tons of high-grade fuel open for blasting down, each ton or every two tons of which is equal in evaporating value to a ton of the best coal.

What a national asset.

What industrial expansion does this discovery indicate?

MINERALS OF THE EMPIRE

The Imperial Mineral Resources Bureau has an inquiry office at the British Empire Exhibition for the purpose of answering queries and of directing inquirers to various Empire exhibits. To assist in this useful work, the Bureau has compiled a special descriptive and statistical account of *The Minerals of the Empire*, a well-printed volume of 314 pages, which is on sale, price 5s., at the Exhibition. The volume is provided with a frontispiece showing the proportion of the world's output of the more important minerals that were produced in the British Empire in 1922, and there are chapters devoted to the various minerals. Each chapter contains a succinct account of the principal occurrences of each mineral within the Empire, information enabling the visitor to locate the exhibitors of the mineral and its chief products, notes on commercial grades and uses, and statistics of production and trade. The volume will be indispensable to all visitors wishing to study the exhibits of minerals and their products at the Exhibition.

THE PHENOMENA OF ROTATION DISPERSION—A REPLY TO PROF. PATTERSON

By HAROLD HUNTER

In an article published in *Chemistry and Industry* of May 2 (p. 454), Prof. Patterson subjects the views of those who regard dynamic isomerism as the cause of anomalous rotatory disperson to somewhat trenchant criticism. It is far from being the writer's object to reply to these criticisms—in fact, in the main he agrees with them—but the views put forward by Prof. Patterson appear to call for comment.

In the first place, it can hardly be said that the empirical period in the development of our knowledge of optical activity has come to an end. There is no theory extant which will explain any of the facts of optical activity, still less is there one to account for rotatory dispersion in anything but a very incomplete manner. Both Prof. Patterson (*loc. cit.*) and Prof. Baly (*ibid.*, 331) appear to regard the Drude dispersion theory with a certain amount of suspicion and distrust. In the writer's opinion, however, no progress whatsoever can be made by chemists in the field of optical activity until a physicist of Drude's genius shall arise and give the matter his attention. It is significant of the difficulty of the subject that since the deaths of Drude and Voigt, no scientist has proved capable of approaching the subject from the theoretical side.

The attitude of the writer and his colleagues of the Battersea Polytechnic towards this problem is mainly experimental. The views of both Professors Lowry and Patterson have been subjected to the acid test of experiment, and have been found wanting. It is not correct, therefore, for Prof. Patterson to say "that Dr. Pickard now also supports the views which were put forward by me in 1916."

The first suggestion put forward by Prof. Patterson, with the object of generalising the subject of optical activity was published in 1913, and may be termed the "sine curve" theory. The suggestion was made that the temperature-rotation curve for any active body is periodic in character, but variable in period, amplitude, and phase. As a first approximation, "mainly as a concrete example and for purposes of illustration," he proposes an equation of the form $a = e^{at} \sin (bt + c)$, where a, b and c are the parameters of amplitude, period and phase, respectively (*J.C.S.*, 1913, **103**, 156). There are three obvious objections to this expression. First, no physical significance can be assigned to the sine of a temperature. Second, the exponential term e^{-at} is, in itself, suspicious. The exponential equation is beloved of the empiricist because it may be made to fit so many experimental results. But the fact that it can be made to fit a given set of figures is no guarantee that it is the correct equation to apply—no theoretical deductions whatever can be drawn from its use. It is a tower of strength to the engineer who frankly admits his ignorance of the function with which he is dealing, and who uses the equation only as a means of interpolation between his experimental results. This is its legitimate sphere (unless, of

course, there is other evidence that the function really is an exponential one), and it is utterly useless as a method of extrapolation. Indeed, unless it is very guardedly employed, it may become a source of positive danger because it tends to assume a spurious appearance of accuracy, and may therefore be accepted as a natural "law" by the unwary. The third objection is more of a practical nature. The temperature-rotation curves of many substances are very nearly linear over a temperature range of nearly 200° C. The period of a sine curve of the above type must be very large in order to accommodate a linear curve for this great temperature range. This objection alone robs Prof. Patterson's suggestion of most of its claim to be regarded as a valuable contribution to our knowledge of the subject.

But he proceeds to develop his hypothesis still further. Having decided on his fundamental temperature-rotation curve, he assumes that the effect of some solvents is to bring hitherto inaccessible portions of the curve into the region of experimental observation. Still bolder, he imagines that a family of chemical compounds has one fundamental temperature-rotation curve—the curve, so to speak, of the parent substance—and that the derivatives of this parent compound have temperature-rotation curves which form part of the fundamental. Further, the greater the difference between the chemical constitutions of the parent compound and the derivative, the farther apart will be their observed temperature-rotation curves on the fundamental one.

So far, light of one wave length only has been considered. Prof. Patterson considers that the temperature-rotation curves for light of other wave lengths are similar ones which, however, differ considerably in amplitude, and sometimes also slightly in period and in phase. He then points out that anomalous rotatory dispersion occurs when the temperature-rotation curves for light of different refrangibilities are displaced slightly in phase, so that they do not intersect at one point.

It must be confessed, however, that this "sine curve" theory has very little to recommend it. Not only does it fail to co-ordinate the observed experimental facts, but it also requires a good deal of faith for its acceptance even when limited in its application to very few compounds. The periodicity pointed out by Prof. Patterson is very difficult to observe, even in his own results; no trace of it is to be found in the results obtained by other investigators. The practice of extending, for example, the temperature-rotation curve for a substance in the homogeneous condition by grafting on to it the temperature-rotation curve for the same substance in some solvent is entirely indefensible, more, it is impracticable. There is no guarantee that the scales of temperature and rotation respectively are the same in each case. Furthermore, it can be shown that closely related compounds do not always have similar temperature-rotation curves; *d-sec.* octyl formate (*J.C.S.*, 1923, **123**, 1) and acetate (*J.C.S.*, 1914, **105**, 861) form a case in point. The former compound has not been observed to exhibit anomalous rotatory dispersion in the visible region of the spectrum, but consideration of its temperature-rotation curves for light of different wave lengths shows that it may do so at a temperature in the neighbourhood of -50° C.; *d-sec.* octyl acetate, on the other hand, has been observed to show anomalous rotatory dispersion in the visible spectrum in the homogeneous state at a temperature of about 160° C. That is to say, the change in constitution produced by proceeding from the formate to its next higher homologue has caused the point of intersection of the temperature-rotation curves for light in the visible region of the spectrum to move over a temperature range of about 200° C.

For the purpose of this discussion, however, the chief interest of Prof. Patterson's work lies in two papers published in 1916, which he quotes in his article. In these papers he puts forward some views on the subject of rotatory dispersion, and criticises those supported by other workers. His remarks on the rational zero are interesting.

The Rational Zero

"In the early days of optical activity it was supposed that the specific rotation of a compound would be a genuine constant independent of external conditions, and although this expectation was grievously disappointed, there still exists a hope that dispersive power may prove to be sufficiently independent of external conditions to serve for the definite characterisation of the substance to which it pertains" (*J.C.S.*, 1916, **109**, 1176).

This idea underlies the first of these papers. Prof. Patterson, of course, uses a dispersion ratio as a measure of dispersive power. But he finds, as indeed every worker in this field has found, that dispersion ratios are by no means independent of external conditions in every case. Instead of accepting this fact, however, and endeavouring to determine the conditions under which dispersion ratios *are* constant, he sets out to find a way of calculating dispersion ratios in order to *make* them constant. He says that "the dispersive power, in order really to be useful, must remain constant, or at least approximately so, with varying circumstances, and not have arbitrary normality or anomalousness (*sic*) in accordance with purely accidental circumstances, such as a very slight change of temperature, or solvent, or concentration" (*Ibid.*, 1177). The wisdom of this statement is very much open to question. There is very little merit or use in constancy *qua* constancy; that is, a constant is useful only when we know what it means, for only then can a meaning be assigned to any particular deviation. Now, no meaning can be assigned to a dispersion ratio—it is entirely arbitrary. It is true, of course, that the ratio is constant for substances exhibiting simple rotatory dispersion, but for those with complex, and especially for those with anomalous rotatory dispersion, it can, and does assume many values. However, Prof. Patterson, having decided that dispersion ratios are not sufficiently constant for his purpose, proceeds to calculate them anew with a view to the introduction of the necessary constancy. To do this he introduces the new conception of the "rational zero." From a consideration of various temperature-rotation curves and characteristic diagrams, he comes to the conclusion that the zero of the polarimeter has little or no

physical significance, and proposes to substitute for it the rational zero, which is the rotatory power of the particular substance under consideration at which the lines on the characteristic diagram for these two wave lengths intersect. Then, as Prof. Patterson points out, if this point be regarded as the zero of rotation, dispersion ratios calculated from it are found to be much more constant than if calculated in the usual way from the physical zero of the polarimeter. Of course, they are: provided that the lines on the characteristic diagram are straight, which is very often found to be the case, it follows that this suggestion is merely a piece of geometrical legerdemain, in which the properties of similar triangles are employed to obscure the real scientific issue.

The announcement of the fact that the use of the rational zero imparts constancy to the dispersion ratio is thus the rediscovery in a particular form of facts which have been known to science for at least two thousand years. But the main objection to the proposal is far more serious. Prof. Patterson cannot be unaware of the fact that there are two kinds of characteristic diagram; those in which all the lines intersect at one point, the zero of rotation: and those in which the lines do not intersect in one point. These two types correspond to substances with simple and complex rotatory dispersion respectively. Furthermore, it follows from the Drude equation with two terms that in characteristic diagrams of the second type, no more than two lines can intersect at one point, and no two lines can intersect on the axis of zero rotation. Therefore, for substances of the second class, Prof. Patterson's suggestion leads logically to the postulation of an infinite number of rational zeros, depending on which particular two of the infinite number of wave lengths at his disposal he chooses for the calculation of the dispersion ratio. And all this for one substance only; for any other, the rational zeros will be different. Even if the validity of the Drude equation be not admitted, we cannot get away from the undoubted experimental fact that substances *do* exist, for which the lines on the characteristic diagram do not all intersect at one point, and for which, therefore, a large number of rational zeros would be required. The conception of the rational zero, then, must be dismissed as unworthy of further consideration; it was designed for a purpose which has been shown to be unscientific, and its adoption leads to a labyrinth of arithmetical computation from which there is no escape.

In the second of these papers, Prof. Patterson criticises the Drude equation and the conception of dynamic isomerism as an explanation of the phenomenon of anomalous rotatory dispersion. His objections to the Drude equation are twofold. He says that it "is based on very hypothetical grounds, and is already gravely suspect by reason of the fact that it ignores the influence of temperature on rotation." (*Ibid.*, 1193.)

The first objection is very easily met. The electronic theory of light, like many other theories, is certainly hypothetical, but its success in correlating the very varied phenomena of optics is such that it will require more than mere assertion to shake it. The second objection is ingenuous in the extreme. The Drude equation certainly ignores the effect of temperature on rotation. It is a dispersion equation, pure and simple, and does not pretend to deal with temperature effects. It is tacitly assumed, naturally, that rotations for different wave-lengths are to be compared at one and the same temperature. Would Prof. Patterson seriously assert, for instance, that Boyle's law "is already gravely suspect," because "it ignores the influence of temperature" on pressure or volume? Yet the two cases are exactly similar. Just as Boyle's law was extended to include the influence of temperature by the discovery of the law of Charles, and the combined equation was modified subsequently by Van der Waals to introduce the effects of mutual attractions and the volumes of molecules, so, it is hoped, will the rotation constants and dispersion constants of the Drude equation be modified to express the change of temperature and of solvent. For the present, however, this is merely an aspiration; much work must be done before the effect of experimental conditions on the constants of the Drude equation is even dimly understood; for the time being we must be content with the knowledge that the modifications we seek must surely be found because the search is being conducted in a logical manner.

Prof. Patterson does not approve of the postulation of dynamic isomerism in order to explain anomalous dispersion, and here, perhaps, his attitude is understandable. A dynamic isomeride of a compound is essentially one which cannot be isolated and put into a bottle. Postulation of the existence of such isomerides immediately denies an opponent the right of challenging one to produce the compounds duly labelled and analysed. But to ignore the fact that dynamic isomerism does occur in many cases known to chemists is hardly scientific. It is known, too, that labile isomerism is sometimes accompanied by complex rotatory dispersion, and further, in some cases where complex rotatory dispersion has been observed, the occurrence of dynamic isomerism is certainly not improbable, and in many of the cases it has been shown purely on chemical grounds to be highly probable. The following, which seems to the writer, to be the really important objection to this hypothesis is not, however, mentioned by Prof. Patterson. It is difficult to understand why a very slight change in constitution—often merely the redistribution of the valency forces amongst three or four of the atoms in the molecule—should have in some cases such an enormous effect on the optical properties of the molecule as not only to cause its rotatory power to change sign, but also to alter the value of its rotatory dispersive power.

But the fact remains that the Drude equation forms what is at present the only means of explaining anomalous rotatory dispersion—its nature, and under what conditions it may occur. It is not merely the most accurate formula extant—it is the only one. Its opponents have not yet proposed a substitute. They are at present in the vague stage, and are content with statements such as "the potentialities of the asymmetric carbon atom and of the most simple physical conception of those intermolecular forces to which liquefaction is due are ample to

account for all the observed behaviour" (*J.C.S.*, 1913, **103**, 173), and the like.

It is certainly unfortunate that of all the causes which may give rise to a multi-term Drude equation, and hence to complex and possibly anomalous rotatory dispersion, dynamic isomerism has been singled out almost to the exclusion of the others. It must not be forgotten that for complex rotatory dispersion to occur, all that is necessary in the medium is the presence of two rotatory electrons of different period. We are not compelled even to assume that these electrons exist in different molecules, much less that the different molecules are dynamic isomerides. Association, dissociation, solvate formation, ionisation, and the superposition of the partial rotations produced by different asymmetric complexes within the same molecule may also be causes giving rise to optical heterogeneity, such as determines complexity of rotatory dispersion. The fact remains, too, that by means of these phenomena we are able to explain with remarkable success the varied aspects of rotatory dispersion. It is true, of course, that the hypotheses are incapable of direct proof, or even, at present, of direct experimental test, but it is maintained that they are not inconsistent with facts observed in other branches of chemical science, and that they provide what is at present the only satisfactory explanation of the facts of rotatory dispersion.

Chemical Department
Battersea Polytechnic,
London, S.W. 11

MEETING OF THE INTERNATIONAL UNION IN COPENHAGEN

As we have already announced, the meeting of the International Union of Pure and Applied Chemistry will be held this year in Copenhagen from June 26 to July 1. The following is the provisional programme:—

On Thursday, June 26, there will be a reception of the delegates at the Raadhus (Town Hall) by the Municipality of Copenhagen. The Council meeting will be held at 9 a.m. on June 27, followed by the general meeting at 11 a.m., meetings of the various committees at 2 p.m., and a reception at 8.30. On Saturday, June 28, there will be meetings of the committees and addresses will be read at 4 p.m. On Sunday there will be an excursion, followed by a lunch given by the organising committee. The committees will meet again on Monday morning, June 30, and in the afternoon there will be addresses and a visit to the Carlsberg brewery. More meetings follow on July 1, and the final general meeting will be followed by a banquet given by the organising committee. British chemists who wish to attend this meeting should communicate at once with the Hon. Secretary of the Federal Council, at Central House, Finsbury Square, London, E.C. 2.

NOTES FROM HEATHFIELD V.

By the Rector, Rev. B. V. WHITE

Dear Mr. Editor,—A few days ago I was walking to Middlesmoor in pursuit of natural knowledge, when I fell in with a young man who was recently a sergeant in the British Army in the north of France. He was, for a period, under the command of a Captain Wimperis or some such name, in a baking establishment near Boulogne, and when discharged from the army he returned to his native village, Ramsgill, in this dale. I have had more than one talk with him about the scientific methods of baking and have also learned additional facts from an acquaintance of mine at Arncliffe in Litton dale, and think you may be interested in the observations I have been able to collect. In this part of England everyone bakes at home, and though I have been a considerable traveller and have visited nearly every village in the dales, and, in addition, Cambridge, London, Carlisle and Durham, I can truthfully say that no one bakes better bread than we do in Nidderdale, and very few do it as well.

The chemistry of bread-making is not remarkably simple. It is well known that flour is mixed with nearly half its weight of water and a little salt. To this is added some milk and water mixed with yeast and the whole thoroughly kneaded; there is no magic in the kneading—this is merely thorough mixing. After kneading, the bowl of dough is placed in front of the fire and the dough gets gradually warm and rises. Here the chemical actions begin; the flour generally contains some 2 or 3 per cent. of sugar, the milk also contains a small percentage of sugar, and the enzymes present in the flour convert a portion of the starch in the flour into sugar. The yeast ferments the sugar, forming carbon dioxide and alcohol; while the dough is rising the carbon dioxide forms bubbles of gas, separated from each other by thin walls of gluten and more or less gelatinised starch. When the due time has elapsed the bread is put into the oven; this should have a temperature of 450° or 500° F., which ensures that the outer layer of the loaf is made into a dry and nearly impervious crust of a brown colour due to the heating of the sugar in the dough. The inside of the loaf, when properly baked, seems never to have attained quite the temperature of boiling water, which has always seemed strange to me. The baking dries off water from the outside of the loaf but not the inside; it causes the carbon dioxide to expand and make larger bubbles, it drives off the alcohol caused by the fermentation and some of the carbon dioxide and it assists the water to gelatinise some but not all of the starch in the flour, making an elastic colloidal substance—using the word colloid to mean glue-like, as it did when I was a boy. The effect of the salt is to increase the elasticity of the gluten and the gelatinised starch; no doubt soda or alum or green vitriol would have a similar effect, though bread made by such means would not be very palatable. The loaf when it comes out of the oven contains very nearly as much water as when it was put in, that is, about 40 per cent.; the les

of weight in baking is about 10 per cent., and this is almost entirely due to the conversion of starch and sugar into carbon dioxide and alcohol.

The loaves are now allowed to cool slowly in front of the kitchen fire. Sudden cooling weakens the partitions between the bubbles of gas and so spoils the loaf. I am not aware that any chemical change of importance goes on during the cooling, but if the cooling is too quick some of the water vapour which should disappear into the air is apt to condense on the loaf as a sort of dew and the bread may turn mouldy.

If the bread is kept too long before it is eaten, it goes stale; the bread tastes dry in the mouth and is not so pleasant to the taste. Now stale bread is not really drier than fresh bread; it only seems so. Analysis shows that it still contains about 40 per cent. of moisture, just about the same as when first drawn from the oven. The change which occurs when bread goes stale is not loss of moisture but rather some kind of redistribution of moisture within the loaf. Flour is mainly composed of starch, a carbohydrate of the type $(C_6H_{10}O_5)_n$ where n is a large number, perhaps 200 in the case of ordinary starch. Starch may, by suitable means, be converted into a soluble variety less complex than the ordinary variety. Starch, as found in flour, seems to contain two substances, one of which is probably a polymer of the other; these are known as amylopectin and amylocellulose. It is the more complex amylopectin which assists the elasticity of the dough; it is the amylocellulose which forms soluble and semi-soluble starches of comparatively simpler constitutions. These, in fresh bread, remain in a gelatinous state and contain a notable proportion of soluble starch. When the bread becomes stale the proportion of soluble starch in it becomes much less, the solid part of the loaf becomes dry and insoluble instead of an easily swallowed jelly. I have sometimes observed in a paste-pot which I keep on my writing table a change in the appearance of the paste which I take to mean the conversion of a soluble into an insoluble variety.

I take it that starch and inulin and similar substances, perhaps even sugars, in plants are stores of foodstuffs and raw materials which the plants can make use of in times of need, as animals are said to be able for a short time to live partly by absorbing their own fat. As to the nature of enzymes, I remember, as Shakespeare says in *Othello*, a mass of things but nothing distinctly. I regret that I do not even really know whether enzymes are substances or merely complex phases of a substance. If we could isolate an enzyme, would it have a definite molecular constitution or is it merely a singular complexity which may arise in a variety of large molecules? I feel sure that many of your readers can answer this question. My friend the sergeant was, I gather, too busy with the supply of loaves to the troops to devote his spare time to enzymic niceties. I fear that I draw out the thread of my verbosity finer than the staple of my argument, and remain, with all due deference and regard, etc., etc.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 10.30 a.m.

A preliminary programme appears on this page.

In accordance with the provisions of by-law 23 intimation is hereby given that the following members of Council retire from their respective offices at the forthcoming Annual General Meeting: Dr. E. F. Armstrong, F.R.S., *President*; Mr. Julian L. Baker, Mr. C. S. Garland, Sir Max Muspratt, Bart., and Sir Wm. J. Pope, K.B.E., *Vice-Presidents*; Mr. John Allan, Prof. J. W. Hinchley, Dr. J. H. Paterson, and Mr. W. J. U. Woolcock, C.B.E., *Ordinary Members.*

Mr. W. J. U. Woolcock, C.B.E., has been nominated for election to the office of President under by-law 19; Dr. E. F. Armstrong, F.R.S., Prof. J. W. Hinchley, Prof. J. C. Philip, F.R.S., and Sir Richard Threlfall, K.B.E., F.R.S., have been nominated Vice-Presidents under by-law 20.

Mr. E. V. Evans has been re-elected Hon. Treasurer, and Sir Wm. J. Pope, K.B.E., has been re-elected Hon. Foreign Secretary.

Mr. W. A. S. Calder, Mr. W. H. Coleman, Mr. Wm. Cullen, LL.D., Mr. F. W. Gamble, Mr. James MacGregor and Mr. J. Arthur Reavell, have been nominated under By-law 24 to fill four vacancies among the Ordinary Members of Council.

A Ballot List is being posted to every member entitled to vote.

J. P. Longstaff,
General Secretary

The following is a Preliminary Programme of the meetings to be held in Liverpool on July 9-12 inclusive.

Wednesday, July 9.—*Morning*: Council Meeting. Annual General Meeting in the Arts Theatre, the University. The President, E. Frankland Armstrong, Esq., D.Sc., F.R.S., will give a technical address entitled:—"A Neglected Chapter in Organic Chemistry: The Fats." *Afternoon*: Business Session in the University. Visit to White Star Liner "Cedric," and tea on board by invitation of the White Star Line. *Evening*: Reception and Dance at the Town Hall by invitation of the Right Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.).

Thursday, July 10.—*Morning*: Messel Memorial Lecture by the Right Hon. Viscount Leverhulme, in the Arts Theatre, the University, and presentation to the Lecturer of the Society's Messel Medal for 1924. Visit to the works of Messrs. Joseph Crosfield & Sons, Ltd., Warrington. Luncheon by invitation of the Directors. *Afternoon*: Inspection of the Works. *Evening*: Annual Dinner of the Society at the Midland Adelphi Hotel.

Friday, July 11. *Morning*: Business Session in the University. Luncheon at the Midland

Adelphi Hotel, by invitation of the Chairman and Directors of the United Alkali Co., Ltd. Visit to a Works of the United Alkali Co., Ltd *Evening*: Dinner at Lady Lever Art Gallery by invitation of the Chairman and Directors of Messrs. Lever Brothers, Ltd.

SATURDAY, JULY 12.—Visit to Lake Vyrnwy. Inspection of Liverpool Corporation Water Works.

A detailed programme is being sent to every member of the Society.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

OFFICIAL NOTICE

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The eighth volume of these Reports is now ready. The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members, post free in each case.

A Member of the Society may purchase a set of Vols. II to VIII inclusive at the reduced price of £2 2s. 6d., and a Non-Member can procure a set at the reduced price of £3 15s., post free in each case.

FORTHCOMING EVENTS

May 26 INSTITUTE OF PHYSICS, Rooms of the Royal Society, Burlington House, Piccadilly, W. 1, at 4.30 p.m. Annual General Meeting. Presidential address by Sir Charles Parsons.

May 26 SOCIETY OF CHEMICAL INDUSTRY, *London Section*. Joint Meeting with the Institution of the Rubber Industry, at the Engineers' Club, 39, Coventry Street, W. 1, at 8 p.m. "Latex: its Chemistry and the Development of its Industrial Applications," by A. Van Rossem. Discussion to be opened by Dr. H. P. Stevens.

May 27 SOCIETY OF GLASS TECHNOLOGY. Joint Conference with the British Society of Master Glass Painters. Annual dinner in the Hotel Cecil.

May 27 ROYAL SOCIETY OF ARTS, at 4.30 p.m. "The Geology and Mineral Resources of Cyprus," by C. G. Cullis, D.Sc.

May 28 ROYAL MICROSCOPICAL SOCIETY, 20, Hanover Square, W. 1, at 7.30 p.m. "Use of the Microscope in the Examination of Paper," by E. Sheldon Leicester. "The Microscopy of Soaps," by K. MacLennan. "Technical Microscopy," by J. E. Barnard.

June 3 ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, 35, Russell Square, W.C. 1, at 7 p.m. "The Analysis of Motion by Kinematography."

June 3 to 6 EMPIRE MINING AND METALLURGICAL CONGRESS, to be held at the British Empire Exhibition. Among other items papers will be read on the following subjects:—Mining, Petroleum, Metallurgy of Iron and Steel, as well as Non-Ferrous Metallurgy.

THE BIOCHEMICAL SOCIETY

A meeting was held in the Department of Physiology, University of Manchester, on May 10, Prof. H. S. Raper in the chair, and the following papers were read:—

"Note on the Constitution of Evodiamine," by Prof. R. Robinson. In spite of observations which were apparently irreconcilable with the view expressed by Kermack, Perkin and Robinson that evodiamine contains the norharman nucleus, it has now been shown by Asahina (*J. Pharm. Soc. Japan*, 1924, No. 503, 1) that this is actually so. Norharman has been obtained from the base and all the difficulties removed by corrections. A considerable number of complex alkaloids may now be recognised as related to tryptophane and this circumstance is regarded as suggestive in connexion with the theory of phytochemical synthesis.

"The Methylation of the Cerebrosides of Ox Brain," by J. Pryde and R. W. Humphreys. The cerebrosides kerasin and phrenosin, isolated from ox brain by Rosenheim's method, may be methylated by means of silver oxide and methyl iodide in a suitable solvent medium. Kerasin yields pentamethyl kerasin, whilst with phrenosin the process is arrested at a stage slightly below that corresponding to a hexamethyl derivative. After hydrolysis of pentamethyl kerasin with dry hydrogen chloride or sulphuric acid in methyl alcohol, the methylated sugar (galactose) residue may be separated by distillation in a high vacuum from the methyl sphingosine and methyl lignocerate. The investigation is being pursued with the view of characterising the constitution of these derivatives, and more particularly that of the sugar residue as it exists *in situ*.

"Chemical Studies of the Vitamin A in Cod-Liver Oil," by Prof. J. C. Drummond and K. H. Coward. Most of the cholesterol may be removed from the unsaponifiable fraction of cod-liver oil by dissolving in methyl alcohol and cooling to −10° C. The remainder is removed by precipitation with digitonin. The cholesterol-free residue is a deep red, heavy oil which contains all the vitamin of the original cod-liver oil. Distillation of this material in superheated steam carries over the vitamin between the temperatures of 115–125° C., together with the bulk of the other constituents, but is useful in separating them from the non-volatile resins formed during saponification. The volatile fraction may be fractionally distilled in high vacuum (1–4 mm.) and yields four main fractions (1) b.p. 100–120° C.; (2) 210–230°; (3) 250–260°; (4) 270–300°. All these fractions contain only carbon, hydrogen and oxygen. Suffering some loss, the main part of the vitamin A comes over with fraction 3. After refractionation the constituents of all four fractions appear to consist mainly of unsaturated alcohols, probably aliphatic in nature, and generally containing two double bonds. There is some indication of the presence of aldehydes also. The vitamin fraction (3) consists mainly of an alcohol with one OH group, two double bonds, and which has a molecular weight about 350, and is optically inactive. There is evidence that this compound is not the

vitamin itself. The latter withstands acetylation, benzoylation and mild hydrogenation of the accompanying alcohol, which may be obtained in the crystalline condition by cooling the methyl alcohol solution to —20° C. These crystals sometimes show physiological activity owing to associated vitamin, and are probably identical with the substance described by Takahashi as the semi-crystalline vitamin. No reliable evidence is yet available to show that the vitamin is an aldehyde, as Takahashi claims, but this view fits in with the scanty data already obtained.

"Supposed Anærobiosis of Lumbricus," by A. D. Ritchie. Earthworms (*Lumbricus sp.*) kept in an atmosphere of hydrogen do not survive more than six or seven hours if kept in movement. At rest about half survive for six hours but none for twenty-four hours. From the bodies of worms exposed to hydrogen for some hours volatile organic acids can be extracted. As the worms' intestines have been found to contain bacteria capable of digesting cellulose, it appears most probable that the accumulation of acid is due to bacterial activity continuing during asphyxia of the worm while it is incapable of oxidising the substances so produced. These experiments dispose of Lesser's contention (*Zeit. Biol.*, 1909, **52**, 282) that earthworms are capable of anærobiosis.

"Supposed Anærobiosis of Ascaris Lumbricoides," by W. K. Slater. As the result of a quantitative investigation of the body content and metabolism products of these parasitic round-worms, Weinland (*Zeit. f. Biol.*, 1901, **43**, 55) suggested that the necessary energy for the various body functions was supplied by the breakdown of carbohydrates under the influence of an enzyme. The products of this reaction are said to be valeric acid, carbon dioxide and hydrogen. The hydrogen was, however, not identified. No oxygen whatever is required by this scheme. The author has found that the "products of metabolism" described by Weinland can be obtained on inoculating glucose solutions with a culture of the bacteria always found associated with the worms, and, further, that when the worms are continuously irritated, those kept under anærobic conditions fatigue more rapidly than those to which the air has access. Worms which have been fatigued in hydrogen recover to some extent if air is subsequently admitted. Experiments have also been tried without definite result in which the air has been replaced by hydrogen acceptors.

"The Oxidation of Stearic Acid with Hydrogen Peroxide," by P. W. Clutterbuck and H. S. Raper. Dakin has shown that oxidation of fatty acids with hydrogen peroxide yields β-keto-acids and ketones corresponding to them. This supports Knoop's theory of β oxidation of fatty acids in the animal body. The authors show that γ oxidation also takes place, γ-ketostearic acid being produced. The relative amounts of the acid undergoing β and γ oxidation are of the order of 7 to 1 respectively; but possibly more γ oxidation takes place than these figures indicate. It seems possible from these results that γ oxidation may also take place in the body. In the course of the investigation, γ hydroxystearic acid, which is supposed to exist only as the lactone (stearolactone), was isolated as a crystalline acid, stable at the ordinary temperature and melting at 88° C. It would seem difficult to account for the occurrence of both β and γ oxidation in terms of electronic structure.

"The Deaminising Action of Tyrosinase," by F. C. Happold and H. S. Raper. The action of potato tyrosinase on various amino acids has been examined, but no evidence has been obtained that ammonia or aldehydes corresponding to the amino acids, are produced. Neither could any change be detected in the amino-nitrogen content of solutions of amino acids subjected to the action of tyrosinase. The amino acids used in the experiments were glycine, alanine, phenylamino-acetic acid, phenylalanine and tyrosine. These results lead the authors to conclude that, contrary to the suggestions of Bach, Chodat and Schweigen, deamination does not play a part in the production of melanin from tyrosine by the enzyme tyrosinase.

"The Excretion of Creatinine and Uric Acid in Man," by H. Zwarenstein. This work was undertaken with the idea that creatinine might arise from some analogous ring compound—from the imidazole nucleus of histidine or the purines—and 4–5 g. of uric acid was given per os to subjects living on purine free diet. In all cases where absorption of uric acid had taken place, an appreciable increase, in one case about 0·5 g., was observed, and it was noted also that in about 90 per cent. of the urines analysed the excretion of uric acid and creatinine varied together. In two experiments ingestion of 1 g. of histidine caused increased excretion of creatinine over a period of three days. These results with uric acid may be due to some action of uric acid on the kidneys, but seem to point to formation of uric acid and to the possibility of creatinine formation from the imidazole nucleus present in some substances.

SOCIÉTÉ DE CHIMIE INDUSTRIELLE

The general meeting was held in Paris on May 13, under the presidency of Monsieur Paul Kestner. After the President had described the work of the Société during the past year, the financial statement was presented by the Treasurer, and the meeting elected officers for the forthcoming year. As Monsieur Paul Kestner was not elegible for re-election as President, Monsieur Lucien Dior, a manufacturer of fertilisers, was elected to succeed him. The other officers are as follows: Vice-Presidents, MM. Donat Agache, Boyoud, Brangier, Cuvelette, R. Duchemin, R. Etienne, Delage, H. Gall, Léon Levy, R. Masse, C. Matignon and Thesmar; General Secretary, Jean Gerard; Assistant Secretary, Jean Voisin; General Recorder, Maurice Deschiens; Treasurer, Count G. de Germiny; and Librarian, Monsieur A. Job. One-third of the members of the Council were then renewed. Monsieur Maurice Deschiens then proposed that Monsieur Paul Kestner be elected Founder-President of the Société de Chimie Industrielle, a motion adopted with such unanimity and enthusiasm as to show the esteem and affection in which Monsieur Kestner is held.

CHEMICAL SOCIETY

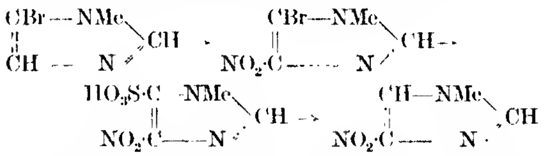
Prof. W. P. Wynne, presiding over an ordinary scientific meeting held on Thursday, May 15, announced that the American Chemical Society had kindly offered to supply copies of their *Chemical Reviews* to Fellows at the reduced price of 4 dollars, plus postage. Commencing with the last issue, no charge was now made to Fellows for binding the Annual Report; money which had been sent for this purpose in error could be reclaimed from the Assistant Secretary before October 31 next, any balance then being placed in the Publications Fund.

Prof. F. L. Pyman contributed a paper (with Mr J. E. Balaban) on:—

The bromo-derivatives of 1-methylglyoxaline and the constitution of "chloroxalmethylin."

4 : 5-*Dibromo-1-methylglyoxaline*, which results from the methylation of 4 : 5-dibromoglyoxaline, is formed in small yield by the bromination of 1-methylglyoxaline, the reduction of 2 : 4 : 5-tribromo-1-methylglyoxaline, or by the interaction of phosphorus pentabromide with dimethyloxamide.

The 4- and 5-bromo-1-methylglyoxalines are obtained simultaneously by the methylation of 4 (or 5)-bromoglyoxaline, the 5 : 1-isomeride predominating. Distillation of the common methiodide of the two bases yields the 4 : 1-isomeride as the main product. The orientation of the bases was effected by converting the 5 : 1-isomeride into the known 4-nitro-1-methylglyoxaline by the operations indicated below:—



By a similar method, Wallach's "chloroxalmethylin" was shown to be 5-chloro-1-methylglyoxaline.

Dr. O. L. Brady, recalling results he had obtained with oximes concerning the influence of the conditions of methylation on the structure of the product, invited further information on this point.

Prof. J. F. Thorpe congratulated the speaker on the advances he had made in the chemistry of glyoxaline; he thought that the present results tended to support his own views, (*a*) that benzene contains no double bond, and (*b*) that glutaconic acid contains a hydrogen atom the position of which is variable.

Prof D R Boyd, referring to the relative ease of hydrolysis of acetyl chloride, methyl chloride, and chlorobenzene, asked whether the phenyl group could be definitely regarded, on the induced polarity theory, as positive.

Prof. Pyman, after remarking that the fundamental work on the constitution of glyoxaline was due to Prof. Japp, said that alkylation was effected with methyl iodide or methyl sulphate in the absence of a solvent; under other conditions, *e.g.*, using diazomethane or alkyl salts and sodium hydroxide, the results would probably be entirely different. His own experience, however, and that of Pinner and Schwarz led him to believe that alkylation by an alkyl salt always took place by addition of the alkyl salt to the doubly linked nitrogen atom. Whilst difficulty was often encountered in determining the polarity of an atom or group, he believed Prof. Lapworth regarded the phenyl group as being positive; support for this view was afforded by comparison of the properties of the derivatives of toluene with those of nitromethane.

Prof. W. N. Haworth gave an account of the

Synthesis of amygdalin. (with R. Campbell)

A SYNTHESIS of amygdalin has been achieved by condensing bromo-hepta-acetylgentiobiose with ethyl d,l-mandelate in presence of silver oxide and conversion of this compound through several stages to the natural glucoside. The product of the above condensation was d,l-hepta-acetylamygdalinic ethyl ester, m.p. 205° and $[\alpha]_D - 62{\cdot}0°$, which was identical in all its properties with a specimen of this substance obtained from amygdalin by esterifying and acetylating amygdalinic acid. Treatment with alcoholic ammonia led to the isolation of a mixture of d- and l-amygdalinic amide, $[\alpha]_D - 77°$, and of its hepta-acetyl derivative, which was resolved, by fractional crystallisation of its additive compound with pyridine, into two stereoisomerides, m.p. 166°—167° and 152°—153°, having $[\alpha]_D - 68{\cdot}6°$ and $- 49{\cdot}7°$ respectively. The former of these gave rise on digesting its solution in xylene with phosphorus pentoxide to needles of hepta-acetylamygdalin m.p. 167° (uncorrected) having $[\alpha]_D - 36{\cdot}2°$. This was identical in all respects with a product obtained by the acetylation of amygdalin and, moreover, the final stage of the removal of the acetyl groups and its conversion into natural amygdalin has already been accomplished by E. Fischer and M. Bergmann (*Ber.*, 1917, **50**, 1066).

Prof. Haworth, who was congratulated by the President and others on the quality of the investigation, added that the *d*-amygdalin had been so called, although it gave rise to *l*-amygdalinic acid on account of its relationship to *d*-malic and *d* tartaric acids.

Mr. R. G. W. Norrish described work (with Dr E. K. Rideal) on:—

Reactivity and radiation. The photochemical union of hydrogen and sulphur.

THE critical increments of eight reactions between hydrogen, sulphur, or oxygen, on the one hand, and sulphur on the other, are all multiples of a constant quantity. This suggests that activation is a quantum phenomenon. It is apparent from the data of previous work that some of the activation of sulphur molecules occurring in these reactions must be kinetic. It is, therefore, of interest to examine them photochemically, with a view to testing how far such activation as is postulated by the "radiation theory" also occurs. The gaseous reaction between hydrogen and sulphur has therefore been investigated, and has been found to be strongly catalysed by the ultra-violet light from the mercury vapour lamp, of the calculated wave length.

The ultraviolet absorption spectrum of sulphur (S_2) vapour has also been reinvestigated and the previous work of Graham confirmed, except that the point of maximum absorption is located very slightly more towards the red end of the spectrum at $\lambda = 2750$ A.U. This wave length corresponds with a critical increment of 51,670 cal. per gram-atom of sulphur, a number in exact agreement with that calculated from the temperature coefficient of the thermal gaseous reaction between hydrogen and sulphur, as required by the radiation theory.

As a result of this work it appears that activation of sulphur molecules may be regarded as synonymous with the dissociation of one or more bonds, and may take place either by collision or by absorption of radiation. The quantity of energy absorbed per atom is independent of the mechanism, and is a function only of the number of valency bonds destroyed.

Dr. Rideal said that a definite example was now available of the stimulation of a chemical action both by thermal collision and by absorption of radiation, the amount of stimulation being in each case the same. Since the nature of the stimulation in each case appeared to be identical, and since photochemical stimulation is usually termed "excitation," it might be advantageous to drop the expression "activation" in this connexion. The similarity between sulphur, chlorine, bromine, and iodine in reaction with hydrogen was likewise evident, the lack of chain reactions in the first case being readily attributable to the difference in the reactions $H_2 + S \rightarrow H_2S$ and $H_2 + Cl \rightarrow HCl + H$. He looked to physicists for information concerning the conditions under which a molecule may be excited, converted into atoms, or ionised by collision with another uncharged molecule. Are the mechanics of collision similar to those of an electron or α-particle bombardment or must such factors as the atomic number or size of the bombarding molecule be considered as well as its *vis viva*?

Mr. W. E. Garner objected to the assumption that the head of an absorption band is the wave length corresponding with the mean energy of activation of hydrogen sulphide. The energy of activation of an individual molecule would depend on its initial vibrational and rotational states: these are quantised and hence there would be a definite number of energies of activation corresponding with the lines in a group of band spectra. Since there might be an unequal distribution of lines on either side of the head of the band, an integration process was necessary for the deduction of the mean activation energy of a gram-molecule from the absorption spectra. The molar activation energy, being the sum of the molecular energies required to raise an electron from an inner to an outer orbit, was necessarily a composite quantity and there was no evidence that it corresponded with the breaking of the chemical bond.

Prof. E. C. C. Baly, did not concur in the view expressed by Mr. W. E. Garner, that the authors' method of calculating the absorption was less trustworthy than the integration of each band. He referred to his own suggestion of the step-activation of molecules and expressed the opinion that the authors had so far discovered "but the germ of a very great truth."

Dr. J. J. Fox said that it was unjustifiable to quote the critical increment to four significant figures; he also felt that to fix on any particular band as the most persistent for any one source of light involved liability to error.

Dr. N. V. Sidgwick said it was remarkable that the energy required to break the double bond in S_2 was exactly twice that required for the single bond in S_8, the behaviour of carbon being very different.

Replying, Mr. Norrish admitted the force of the criticism concerning the critical increment; only the first two figures possessed real significance.

ACADÉMIE DES SCIENCES

On May 12, Prof. Vincent communicated a paper by MM. E. and L. Hedon describing the action of insulin on an animal deprived of its pancreas. Whereas simple ablation of the pancreas brings about death in twenty days, the authors were able to maintain an animal deprived of its pancreas for five months in perfect health, by means of subcutaneous injections of insulin combined with a protein (meat) and carbohydrate diet, to which was added pancreatic ferments.

The influence of the X-rays on the oxydases of leucocytes was described by Prof. D. Berthelot who had found that small doses of X-rays activated, whilst large doses paralysed, the indirect oxydases of the leucocytes.

At the meeting on May 5, Prof. Le Chatelier presented a note by Monsieur Ostwald showing how melted naphthalene can be used to carry out immediate analyses of coal. Gas coal, with 35 per cent. of volatile matter, contains 13 per cent. of materials soluble in naphthalene. The work was carried out in order to obtain a fuel similar to coal which could be coked without leaving an ash. The process was successful, but entailed a large consumption of naphthalene.

Monsieur Coupin observed that green substances growing in the light gave off ozone, suggesting that the greater content of ozone in country air was due to vegetation. Monsieur P. E. Janet communicated the results of work by Monsieur Granier on the conductivity of electrolytes at very high frequencies.

Dr. E. Fox Nichols, director of research in pure science in the Nela Research Laboratory of the General Electric Co., has died suddenly in Washington, D.C. Dr. Nichols was a graduate of Cornell University, and at one time a research student in physics at Cambridge University, and had held professorships of physics at Colgate, Dartmouth, Columbia, and Yale Universities.

CORRESPONDENCE

THE ENGLISH LANGUAGE

SIR,—To Mr. A. E. Johnson, who writes in the March 21 issue, it seems "somewhat of an inversion of the natural order of things that Englishmen should consult the book of an American author in order to learn how to write our common language correctly." Mr. Johnson then administers a gentle rebuke: "The Rev. E. A. Abbott long ago achieved the task attempted by the American writer, by publishing *How to Write Clearly*. From the preface of this Mr. Johnson quotes as follows: "Speeches in Parliament, newspaper narratives and articles, and, above all, resolutions at public meetings, furnish abundant instances of obscurity arising from the monotonous neglect of some dozen rules."

I hold no brief for any particular American book on the subject, but I believe that we on this side of the Atlantic may be credited with contributing to the improvement of good literature; and I feel sure that acquiescence in Mr. Johnson's attitude in regard to overseas effort of this kind is often the cause of lack of sympathy and the development of a peevish antagonism, sentiments that, among educated men, are far more common in England than in the United States.

I feel inclined to disagree with Mr. Johnson's inference that Dr. Abbott's book is sufficient for our needs. The short sentence quoted from the preface is provocative of criticism; "... obscurity arising from ... and ... some dozen ..." Does the author mean a few dozen or several dozen, or about one dozen? Of course, it is easy to assume that the reader possesses a knowledge of the traditional interpretation of localisms in common and accepted use; but scientists and technicians should surely agree (1) that, if possible, words be used in the primary sense, and (2) as to the necessity for simplicity of language, economy of phrasing and unmistakeable clarity in presentation.

The art of technical and scientific composition is not standing still, nor has it been treated adequately by authors of books that purport to tell one how to write clearly or well; we are realising the economic value of condensation and the beauty of simplicity to an extent that was not recognised when Dr. Abbott's book was first published. From the scientific classics of the nineteenth century we still gather much that is inspiring; but from them also we learn much that should be avoided. It is an easy matter for those who profess a disdain of engineering principles and scientific precision, as aids to the building of the edifice of contemporary literature, to turn to the grammar or to the dictionary for a justification of their "style." To-day, however, when competition is keen and production costs are high, additional standards must be recognised. In his *Notes on the Composition of Scientific Papers*, Sir Clifford Allbutt affirms with logic that "Many a bad sentence is grammatically correct"; to which I would add that many a word is listed in the dictionary for use in a specific sense for which it is inappropriate or entirely unsuitable.

In commenting on the preface quoted from *How to Write Clearly*, Mr. Johnson says: "Whether this strong indictment still holds good, I must leave to present-day Members of Parliament, etc., to answer for themselves." The use of etc., although common and accepted as "good English," indicates a lack of precision that mars many scientific and technical articles and books. The reader wonders whether the author was lazy or whether he used the abbreviation to hide a deficiency of information on the subject. I mention this detail to show that finality has not been reached in the art of scientific composition; and I would counter the inevitable charge of being meticulous by the contention that many examples of loose construction are repeated until their use becomes a habit, only because of custom. The plea of justification on the ground of prior and extensive usage in "good" literature is often an illogical one; an obvious disregard of scientific precision and a failure to appreciate the advantages of unmistakeable clarity are sufficient reasons for an "inversion" from what some of us may consider as the "natural order of things."

In the task of improving the technical literature of our day it is to be hoped that the English-speaking nations will act in sympathy with each other. Apart from minor and insignificant differences in spelling and punctuation, the product of the American man of science shows no difference from that of one of his British colleagues. A friendly toleration, if not a generous appreciation, of work overseas is needed to facilitate the acceptance of English as the scientific language of the world; but standards must be based primarily on simplicity, clarity and common sense, rather than on an adherence to habits of phraseology for the continued toleration of which there can be no scientific justification.—I am, Sir, etc.,

Berkeley, California, April 28, 1924. A. W. ALLEN.

ATOMIC STRUCTURE

SIR,—Bearing on my article on "Atomic Structure" (this vol., p. 323), I would like to direct attention to the conclusions inferred by Dauvillier (*Comptes rend.*, 1924, **178**, 476) from his recent determination of the widths of the X-ray spectral absorption bands corresponding to the L_3, L_2, and L_1 energy levels of the gold atom.

The L levels are identified in Bohr's theory with the eight electrons having the total quantum number 2, and are divided into two subgroups of 4 electrons each, having the azimuthal quantum numbers 1 and 2 respectively. I have indicated that the chemical properties of the elements, particularly with regard to valency and co-ordination number, do not lend support to Bohr's scheme, and point definitely to the eight L electrons being in three subgroups containing 2, 2, and 4 electrons, with the azimuthal quantum numbers 1, 1, and 2 respectively, and that in general, the number of electrons in a subgroup is equal to twice the azimuthal quantum number instead of twice the total quantum number.

Dauvillier, accepting that the widths of X-ray spectral absorption bands, are a measure of the relative numbers of the electrons in the groups to which the bands are due, shows that the L level electrons consist of three subgroups closely approximating to the ratio 1 : 1 : 2. There being eight electrons in the level, the numbers in the subgroups are, therefore, 2, 2, and 4, an arrangement identical with that inferred by me from chemical considerations.

In view of the striking agreement between the experimental evidence from both chemistry and physics, there can no longer be any doubt that the L level does not contain two subgroups of 4 electrons each, as postulated by Bohr. It is probable that Bohr inferred his scheme in which the number in a subgroup is equal to twice the total quantum number, from the very imperfect analogy with the 1 quantum group, in which twice the total quantum number gives the correct number of electrons, as in helium, a number accidentally equal to twice the azimuthal quantum number. It may be inferred from Dauvillier's results that Bohr's scheme of equal subgroups is improbable for the electron arrangement in any atom, and, in consequence, that chemical theories based on Bohr's equal subgroup scheme, e.g., the theories based on the invariable co-valent chemical bond, the di-electronic junction necessitating two equal subgroups, are based on an insecure foundation.—I am, Sir, &c.,

J. D. Main Smith

Chemistry Department,
Birmingham University
May 17, 1924

CO-OPERATION WITH GERMANY

Sir,—In your journal there have been frequent references to the state of Germany, and the possibility of co-operation. I have been in Germany for some time and have seen many universities here, and to my hand is the third report of the "Notgemeinschaft Deutsche Wissenschaft," a society which organises the relief for universities and educational research institutions. It gives some rather good information on the need of Germany, and whatever may be our opinions on the right and wrong of the war, there can be no doubt that Germany is in great need at present. Happily the Dawes report has dispelled the idea that a large bulk of German capital has been sent abroad. Also it shows how the German capitalists have given relief to their own people, for 5/6ths of the relief is supplied by Germans and 98 per cent. of all the people supported have been supported by German money, and only 2 per cent. by foreign money.

I was in the English Seminar of the Berlin University this morning, and they have a collection of books in English dealing with war matters, in order that they may get to know what the English think about the war. This shows how badly off they are for English and American publications, and scientific and industrial journals, and the number of German scientific and industrial people who see English publications I know to be very small. Travellers in Germany tell of the care with which English books are handled, because of the scarcity of such books.

As a practical method of reaching and bettering industrial matters, may I suggest that more copies of *Chemistry and Industry* be sent to Germany, either to this Society or to private members? I can send addresses of people who would be only too glad to receive them. My own copies of the journal are read with avidity by many students.—I am, Sir, etc.,

Harry Ward

Religiöse Gesellschaft der Freunde (Quäker)
Berlin, W. 3, Behrenstrasse, 26a, II
May 14, 1924

THE IMINOTRIAZOLES

Sir,—I have read Dr. Ingold's criticism of our work (Carnelley and Dutt) on Iminotriazoles (this week's *Chemistry and Industry*). I should not like to enter into any discussion in these columns as the paper referred to will soon appear in the Scientific Press. But I may point out that the experimental evidence given in that paper definitely precludes the possibility of Dr. Ingold's interpretation.—I am, Sir, etc.,

P. K. Dutt

The University, Leeds
May 16, 1924

IN PRAISE OF LIME

Sir,—I recently visited Wembley, and after a short stay in the Cyprus Pavilion, and experiencing for the first time the famous Cyprus wine, I spent some minutes at the stall of the Buxton Lime Company. The obliging people in charge handed me literature explaining its merits, and as these are not generally known I give them to the best of my recollection:

If your pastures yield Limnaea, in profusion, you may know, vainly you call on Hygeia, soon to death your sheep will go. "Quick my friends and lose no time, oh give them lime."

Regulate acidic ions, soon the pond-snails disappear, liver flukes will then like lions, be rarely found, but here and there. Free from these the sheep will rhyme, "Oh give us lime."

If your lawns are rank with daisies, plantains, yarrow and such weeds, if the clover spreads like blazes, and the grass to language leads, first restore it to its prime by adding lime.

Then the sulphates and the phosphates, nitrates and the potash salts, will act with all the speed of fates, soon the lawn will have no faults. Finest grasses in spring-time, most require lime.

Limestone, thou hast given Gordale, Malham, Haddon Hall and Brough, where from Wales, Nenthead and Yoredale, miners send lead-ore and stuff. Peerless among rocks thou standest, God's boon, Oh Pan and Puck's stone if the purest thou demandest, reputation says Buxton! There the quarries all may climb, admiring lime.

Engineers and concrete makers, iron smelters, road surveyors, tinkers, potters, dukes and bakers, distemper-men and house purveyors, sing in syncopated time, "Oh Buxton lime."—I am, Sir, etc.,

Very Qualified Chemist

Newcastle-on-Tyne
May 17, 1924

[We advise "Very Qualified Chemist" to avoid Cyprus and its products for the future.—Editor.]

PERSONAL AND OTHER ITEMS

Prof Sir Wm H Pope F.R.S., was elected a corresponding member of the Academy of Sciences of the Institut de France at the meeting held on May 12

Dr. A K Macbeth has been appointed Reader in Chemistry in the University of Durham, and Mr. H. J E. Dobson, B.Sc., has been appointed lecturer in chemistry in the same University.

In the University of Manchester, Mr A D. Ritchie, M.A., B.A. has been appointed lecturer in physiological chemistry and the Simon-Carves Industrial Research Scholarship has been awarded to Mr. H. Entwistle B.Sc.

Mr W F. Wyatt has been appointed demonstrator in chemistry in the University of Sheffield

The U.S National Academy of Sciences has awarded its Agassiz medal to O S. Petterson, of Sweden, for his studies on the chemistry and physics of the sea.

Dr. C. M Stine has succeeded Dr C. L. Reese, who has retired from the post of head of the chemical department of E. I. du Pont de Nemours and Co. Dr. Stine has been engaged in research work for the du Pont Co since 1907, and he did valuable work on explosives during the war.

Grants amounting to £175 have been awarded by the Ministry of Agriculture to Sir John Russell, Prof. R C. Punnett, Dr. N. M. Comber, Dr. B. A. Keen, and Mr. G. W. Robinson, to enable them to represent agricultural science in Great Britain at international conferences and congresses

The late Mr. A. F Wenger, the founder of Wengers, chemical manufacturers at Stoke-upon-Trent, left £96,964.

Mr. J W. Leitch, B.Sc., of J. W. Leitch and Co., Milnsbridge, and Lankshear, Wickstead and Co., Ltd., left estate of the gross value of £163,470, with net personalty. £161,383.

The death is announced of Monsieur Bethmont, president of the Société Electro Métallurgie de Dives.

At the recent meeting of the British Empire Steel Corporation the following residents of Great Britain were elected to the directorate:—Sir A. Trevor Dawson, Bart., Rt. Hon. the Viscount Furness, Rt. Hon Lord Invernairn, and Major-Gen. Sir Newton Moore

The death is announced of Mr. T Jamieson, formerly lecturer in agricultural chemistry in the University of Aberdeen, and one of the original fellows of the Institute of Chemistry.

We regret to announce the death, after a short illness, of Mr. Bernard Laporte, chairman and governing director of B. Laporte, Ltd., chemical manufacturers, Luton

Owing to the strong demand for arsenic, for the manufacture of insecticides, the tailing dumps of the Nova Scotia gold mines are being concentrated. Several thousand tons of concentrates, containing about 33 per cent. arsenic and averaging $50 per ton of gold, are ready for transportation from Halifax to Antwerp, Belgium. There are large quantities of tailings available in the vicinity of the old workings of Nova Scotian gold mines.

Sir Archibald Mitchelson, representing the British shareholders of the Porcupine Davidson Co., recently visited the mine whilst in Canada.

Chemists' Meetings in Canada

The annual meeting of the chemists of Canada will take place at Kingston, Ontario, from May 26 to 29 On May 26 the Associate Committee of Chemists of the Advisory Research Council will meet, and several papers will be presented and discussed. The combined sections, in Canada, of the Society of Chemical Industry, will assemble on May 27. Papers will be read and discussed during the day. The annual dinner will take place, in the evening, at the Cataraqui Golf and Country Club, followed by a smoking concert. May 28 will be devoted to the annual meeting of the Canadian Institute of Chemistry At 8 p.m. a public address, upon a chemical topic, will be delivered by Mr. Gilmour, in the Convocation Hall of Queen's University. The last day will consist of visits to the Canadian Locomotive Works, and the Royal Military College with reception by the Commandant, Sir Archibald Macdonell, during the forenoon. The afternoon will be devoted to a tour, by steamer, of the famous Thousand Islands, supper being served at the Isle of Beau Rivage, returning at night to Kingston.

Lawes and Gilbert

In view of the great interest of everything pertaining to the Rothamsted Agricultural Experimental Station, we are glad to reproduce, by permission of the Times Publishing Co., Ltd., the following letter from Sir John Russell, F.R.S., which appeared in *The Times* of May 17.

"It is desired to obtain at Rothamsted as complete as possible a collection of letters of Lawes and Gilbert, the great founders of the Rothamsted Agricultural Experimental Station, and of MSS. relating to Rothamsted itself in the days when they were still in charge here. The purpose is to gather material which can be used for writing a history of their work for the development of agricultural science in general and of British agriculture in particular. My object in writing is to ask if any of your readers having letters by Lawes and Gilbert, or MSS. relating to Rothamsted in its early days, would be good enough to present them to the Rothamsted library, where they will be adequately preserved so that they can be utilised for the purpose indicated above, and, when the task shall be attempted, for the tracing of the history of the development of scientific agriculture."—Sir John Russell, Director of the Rothamsted Experimental Station, Harpenden.

Erratum

In the article on "The Corrosion caused by Products of Combustion of Coal Gas," published in the issue for May 16, on line 9, col. i. of p. 507, for "rust" read "hurt."

REVIEWS

ORGANIC SYNTHESES. Vol. III., edited by H. T. CLARKE and others. Pp. v+104. New York: John Wiley and Sons: London: Chapman and Hall, 1923. Price 7s. 6d.

The third volume of organic preparations, which has now been issued by the indefatigable "editorial board," will, like its predecessors, be warmly welcomed by organic chemists. The object and scope of these volumes is already well known. It is a matter of only too common experience that a large number of preparations, which are copied from original papers into books on practical organic chemistry without being rehearsed in detail, lead to failure, owing in many cases to some small but essential omission. Then, again, the preparation of common organic materials can often be improved by some slight modification of conditions. In these volumes, the contents of which are subject to rigid revision, we have not only methods, but the best available methods for obtaining a given result, and in this way the chemist without ready access to these products may prepare them for himself without waste of time and material or a troublesome search through references.

A collection index of all the preparations so far issued with the number of the volume in which they appear is now being published with each new volume, so that it will be easy to turn to the method required.

The authors again invite co-operation. If this request were generally acceded to, especially on the part of those engaged in industry, a much larger amount of useful material would be forthcoming.

We offer our grateful acknowledgment of the disinterested work so far accomplished and our hope that it will be continued

J. B. COHEN

GRUNDZÜGE DER KOLLOIDLEHRE. By Prof. Dr. HERBERT FREUNDLICH Pp. viii+157. Leipzig Akademische Verlagsgesellschaft, 1924. Price 6 gold marks.

This volume is introduced as an abbreviated version of the author's well-known "Kapillarchemie," designed to appeal to a wider circle of readers than that standard treatise, now in its third edition. It often happens that the author of a large scale volume is so obsessed by the importance of what he has previously written that he is unable to express the essence of the subject in a smaller compass: but there is no trace of that incapacity in the present work. Mathematical deductions, references to literature, and the mass of detail which is calculated to discourage the reader who does not specialise in the subject, have been carefully eliminated, and the result is a charming and useful introduction to the chemistry and physics of colloids.

As in the larger work, the first half of the book, after a stimulating introduction, is devoted to the general properties of surfaces of various kinds, with some emphasis on adsorption and catalytic effects at surfaces. This preliminary matter might make dull reading, if it were not for the illumination of every page by copious examples which indicate the widespread applications of the conclusions summarised. The properties of sols and gels are dealt with in the second half of the book Only a few methods of preparation are given, but the general conditions of stability of sols and the distinctive behaviour of gels are discussed in more detail.

The book is up-to-date in spite of its small size Technical applications are introduced to illustrate the general theme and not relegated to an appendix as is frequently done, and the students of medicine or technology for whom the volume is specially intended will find innumerable points of contact with their own sciences brought out in its pages.

It may be remarked, in conclusion, that the language of the book is remarkably simple throughout, and that the printing and paper, like the price, are of pre-war standard.

P. C. L. THORNE

DAS ERDÖL. By DR. R. KISSLING. Monographien aus dem Gebiete der Fett-Chemie, edited by PROF. K. H. BAUER. Part V. Pp. 146 Stuttgart: Wissenschaftliche Verlagsgesellschaft m.b.H., 1923.

Unlike its classic namesake by Engler, this volume is of a handy size and deals with the technology of petroleum in four chapters. It is devoid of extraneous matter, padding and elementary treatising so frequently met with in petroleum publications (those in German not excluded). The first chapter deals with the origin and chemical composition of petroleum in 10 pages, its chemical and physical properties in 13, its historical, geographical and geological data in 5, and its winning, storing and transporting in a further five pages Chapter 2, consisting of some 50 pages, deals with all that is important in the refining of crude petroleum in general. Chapter 3, similarly concise, is devoted to the application of petroleum and its products, and Chapter 4 deals with the analysis and testing of petroleum products. In discussing the splitting up of petroleum into its various well-known products, Dr Kissling first gives an outline of the theory underlying the distillation, condensation and chemical treatment of the distillates, and then follows it up with a description of the practical application of the theories, giving details of the apparatus used on works scale. The author finds room also for a short discussion of the methods for treating the oily outflow waters from condensers etc., and spent chemicals from a crude oil refinery. The hints the author gives to refinery superintendents in connexion with refinery processes, plant and general supervision are very practical, and no less valuable are those dealing with fire prevention and fire protection measures, which prove Dr. Kissling to be something more than a writer of technical books. There is a comprehensive name and general index which adds considerably to the value of the book, and altogether this volume should be of practical use to all interested in petroleum, whether professionally or commercially.

J. H. ANFILOGOFF

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Safeguarding of Industries Act (Gas Mantles)

Answering Mr Hogge, Mr Alexander said that he had received a further application from firms in the gas-mantle trade, asking for the appointment of a committee of inquiry under Part II of the Safeguarding of Industries Act, to investigate the new conditions which have arisen as a result of the establishment of German export trade on a gold mark basis; he had now received from the applicants certain supplementary information for which he had asked. The statements made were being carefully considered, and it was hoped that it would be possible to reach a decision at an early date. (May 14.)

COMPANY NEWS

BRUNNER, MOND & CO., LTD.

The net profit for the year ended March 31 amounted to £1,552,574 (against £1,650 295 in the preceding year). With £88,911 brought forward, there is a total of £1,641 485 to be dealt with. The preference dividend takes £300,000, and the dividend for the whole year on the ordinary shares (10½ per cent., less tax, against 11 per cent.) will require £1,016,989. The amount to be placed to the general reserve is £88,015 (against £62,215), while the suspense account receives £150,000 (against £225,000), leaving £86,482 to be carried forward.

ROSARIO NITRATE CO., LTD.

A final dividend is recommended of 6 per cent., less tax, in respect of 1923, making a total distribution for the year of 11 per cent. (against 10 per cent. for the preceding accounting period of 15 months). A sum of £19,671 is to be applied to depreciation, and £29,179 carried forward (against £28,614).

NOBEL INDUSTRIES, LTD.

The directors announce that the results of the constituent and associated companies for 1923 enable them to declare a dividend on the ordinary shares as at July 1, payable on that date, on account of the year 1923 of 8 per cent., less tax. In 1922 the dividend was 7 per cent. It is proposed to increase the special investment reserve account by £160,000 (against £50,000) to £500,000, and to add £140,000 to the balance brought forward, making the total to be carried forward £650,000. The general meeting will be held in September.

CASSEL CYANIDE CO., LTD.

The directors announce that they have resolved to pay an interim dividend of 3d. per share, less income tax at 4s. 6d. in the £. The dividend will be paid on June 2 to all shareholders on the register at May 10, 1924.

LEGAL INTELLIGENCE

NITROLIM AS A FERTILISER

On May 15, in the Commercial Court, King's Bench Division, Mr. Justice Bailhache heard an action by Messrs. Pattullo Higgs and Co., Ltd., of High Street, Orpington, Kent, and Dundee, against the Anglo-Continental Guano Works, Ltd., of Dock House, Billiter Street, E.C., claiming damages for alleged breach of contract and breach of warranty upon the sale of a fertiliser known as granular nitrolim.

For the plaintiff company, it was stated that they purchased some 120 tons of the fertiliser for £1257, believing it contained valuable nitrogen in a form proper and suitable to be mixed with certain other ingredients. They alleged it was not as warranted. The defendant company denied that there was any express warranty or implied warranty and claimed that the fertiliser was in accordance with the contract. They also said they did not know the purposes for which the fertiliser was required, that none of the ingredients in the manure was mentioned, and that there was no implied condition as to its fitness for any particular purpose. Evidence was called on behalf of the plaintiff company in support of their case, and it was also stated that they lost many of their Scottish customers.

At the resumed hearing on May 16 Dr. J. A. Voelcker gave evidence on the results of his analyses of the unmixed granular nitrolim and of the plaintiff company's compound manure mixture. There was nothing, he said, in the constituents which the plaintiffs used to mix with the nitrolim, namely, muriate of potash, precipitated bone, and carbonate of lime, that would produce the chemical body which the plaintiff company said prevented the nitrogen in the nitrolim being readily available for the plants. Mr. L. E. Strong, for the defendant company, expressed the opinion that the mixture in question was unsuited for potato crops. Further evidence was called, and hearing adjourned until May 19, when it was argued for the plaintiff company that the substance contracted to be sold was a nitrogen fertiliser whose nitrogen was readily available, but the stuff supplied was not that. It was contended that the plaintiffs' evidence established that the nitrogen was not available in the material, and that the stuff did not work as a nitrogenous fertiliser should do. The evidence called for the defendants did not displace that.

Mr. Justice Bailhache, in giving judgment, said that the plaintiffs contended that whatever the mixture was the nitrogen should have shown itself in the early stage of plant development. There was no suggestion that anything in the mixture prevented the operation of the granular nitrolim. On the whole, he had come to the conclusion that in the nitrolim delivered to plaintiffs the nitrogen was not in a form which could be readily assimilated by plants. Therefore as plaintiffs did not get what they paid for, they were entitled to a return of the purchase price, less the value of the lime which the nitrolim contained. There would be judgment for plaintiffs for £1155 and costs.

In another case the Anglo-Continental Guano Works, Ltd., sued Nitrogen Fertilisers, Ltd., for damages in respect of sales to them of granular nitrolim in alleged breach of representations or warranties contained in pamphlets or leaflets. The plaintiffs claimed to be entitled to be indemnified for damages for which they had been held liable. Mr. Justice Bailhache said that the plaintiffs' principal witness said he did not rely on the pamphlets and leaflets, and another difficulty was in fact that the 120 tons of nitrolim in this case had been kept from one to two years. It deteriorated by keeping, and having regard to the fact that some thousands of tons of the nitrolim had been sold and no complaint made, he thought there must have been something specially wrong with this 120 tons. In the circumstances he could not pass on to the defendants the damages which the Anglo-Continental Guano Co., Ltd., had been ordered to pay, and judgment must be returned for defendants, with costs

REPORTS

Report on the Commercial, Industrial, and Economic Situation in Italy, December, 1923. By J. H. Henderson and H. C. A. Carpenter, Commercial Secretaries, Rome. Department of Overseas Trade. Pp. 96. H.M. Stationery Office, 1924. Price 2s. 6d. net.

Great strides have been made by the Government in 1923 in establishing a strong economic position for the country. An extended and more strictly enforced system of taxation has been put into force, and economies effected all round in administration costs. The exchange is now stable and the balance of trade (in the widest sense) is believed to be favourable.

Complete figures for 1922 show imports valued at 15,770·38 million lire, and exports at 9,297 mill. lire, the adverse balance being about 2500 mill. lire more than in 1921 (*cf. Chem. and Ind.*, 1923, 662). The figures for the first half of 1923 show imports 9073 mill. lire, and exports 4887 mill. lire; both show an increase over the corresponding figures for 1922, but a larger adverse balance.

The country with the biggest trade with Italy is the United States, Great Britain doing about half as much. In the first six months of 1923 imports from this country amounted to 1147 mill. lire, and exports to 561 mill. lire. The principal items obtained from Great Britain are coal, textiles, machinery, iron and steel, and fish, which together make up 80 per cent. of the total. Demands for coal from this country have been affected in recent years by the supplies from Germany as reparations. The textile trade in 1923 was satisfactory. There is a considerable demand for British heavy chemicals, such as caustic soda, sodium bicarbonate, copper sulphate and ammonium sulphate; other chemicals are supplies by Jugoslavia, Germany, and the United States. British paints and varnishes are in demand, but now have to meet local competition. The market for British earthenware, china and glass is restricted, only the best qualities being able to compete in this market.

Italian industries suffered in 1923 from the universal depression, an improvement being noticeable as the year advanced. The silk industry, the principal manufacturing industry in the country, had a good year, whilst other textiles also showed some improvement; artificial silk manufacture has recently become important. The chemical industry presents a normal aspect. Superphosphates have done well, owing to increased home demand, and the manufacture of dyes and soaps increased during the year.

Report on the Trade and Commerce of East Africa, to September, 1923. By Col. W. H. Franklin, C.B.E., D.S.O., H.M. Trade Commissioner, E. Africa. Department of Overseas Trade. Pp. 46. H.M. Stationery Office, 1924. Price 1s. 6d.

The statistics given in this report cover in detail the year ending December 31, 1922, though a few figures are available for the six months following. Exports are increasing and the political situation has improved since the statement of the Imperial Government's policy regarding the Indian community. Coastal exports in 1922 amounted to £9,736,862, and imports to £9,230,849. Exports of cotton from Uganda in 1922 were 61,641 bales, in the first six months of 1923, 62,700 bales. Tanganyika Territory and Kenya Colony also exported cotton to a relatively small extent. Coffee exports from Kenya and Uganda in 1922 were 129,261 cwt., and from Tanganyika, 85,428 cwt., considerably more than in 1921; there is a general increase in the acreage put under coffee. The period under review has witnessed the clearing of old stocks of skins and hides, though the market has now quietened, owing to cessation of demands from Europe and America. Small parcels of Uganda Para rubber have been disposed of, and planters have been encouraged to resume tapping; for the Ceara of Tanganyika Territory, however, there is but small demand, and production seems likely to cease. Zanzibar is an important collecting station for copra, of which about 12,500 tons are exported annually. A notable increase has occurred in the export of oilseeds; about 8000 t. of cotton seeds was exported from Uganda in the first six months of 1923, against 2440 t. in 1922, and 12,518 t. of ground nuts were exported from Tanganyika in 1922, against 8448 t. the previous year. Exports of Magadi soda practically ceased last April, and are not likely to be recommenced until the reconstruction of the company. Some prospecting for minerals, mentioned in the last report (*cf. Chem. and Ind.*, 1923, 281) is still going on, and a promising gold-bearing seam has been discovered. The exports of mica from Tanganyika are increasing.

Of the imports into the area cotton piece goods form about one-third. About 10,000 t. of cement were imported in 1922, Norwegian competition being strong, whilst in china and glassware Germany is a serious rival to Great Britain. The United Kingdom predominates as supplier of iron and steel goods, but European competition is strong here also.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech.	£24 per ton.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton
Ammonia Alkali	£6 15s. per ton, spot, delivery.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2 cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid.
Sod. Bichromate	4½d. per lb.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton according to quantity, f.o.b., 1 cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite. 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£5 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide	3s. 9d. per lb.
Carbon Bisulphide	£24—£26 per ton according to quantity.
Carbon Black	6¼d.—6¾d. per lb. Market firmer.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide, green	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	43s. 6d. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride	3d. per lb., carboys extra.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	5s. 1d. per lb. Much dearer, following rise in quicksilver.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s.—5s. 3d. per gall. 60% O.P. market stiffer.
Solvent	5s. 6d.—6s. per gall. 40% O.P. Fairly good demand but little offering.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£49 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	7d. per lb. Better inquiry at reduced price.
Crude 60's	1s. 10d.—2s. per gall. Market rather flat.
Acid Cresylic, 97/99	2s. 1d.—2s. 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—2s. per gall. Steady demand.
Dark	1s. 10d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	9½d. per gall. Very quiet
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall ex works in tank wagons.
Toluole—90%	1s. 4½d.—1s. 7d. per gall.
Pure	1s. 10d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	9½d. per gall. Few inquiries.
Middle Oil / Heavy / Standard Specification	7½d.—9d. per gall. according to grade and district. Market easier.

Naphtha—	
Crude	.. 8d.—9d. per gall. } Good demand. Prices firm.
Solvent 90/160	.. 1s. 5d.—1s. 6d.
Solvent 90/190	.. 1s. 2d.—1s. 3d.
Naphthalene Crude—	
Drained Creosote Salts	£6—£7 10s. Demand falling off.
Whizzed or hot pressed	£9 –£12 per ton. More inquiry.
Naphthalene—	
Crystals and Flaked	.. £17– £18 per ton.
Pitch, medium soft	.. 52s. 6d. –57s. 6d. per ton. Market steadier. Few inquiries for forward delivery. Very little business for prompt.
Pyridine –90/140	.. 22s.—24s. per gall. Demand well maintained.
Heavy	.. 11s.—12s. Occasional inquiries: little business.

INTERMEDIATES AND DYES

Business in dyestuffs has fallen off considerably in all branches, and the position is not so favourable as it was. Prices are without alteration.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 6d. per lb.
Acid H.	.. 4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic	.. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech.	.. 1s. 3d. per lb. Steady demand.
Acid Sulphanilic	.. 10d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	.. 1s. per lb. d/d.
Aniline Oil ..	.. 7¾d. –8¼d. per lb. naked at works.
Aniline Salts ..	.. 7¾d.– 9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base ..	.. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	.. 1s. 3d. per lb.
p-Chlorphenol ..	.. 4s. 3d. per lb. d/d.
p-Chloraniline ..	.. 3s. per lb. 100% basis.
o Cresol 19/31° C.	.. 4¾d.– –5¼d. per lb. Demand moderate.
m Cresol 98/100%	.. 2s. 1d.—2s. 3d. per lb Demand moderate.
p Cresol 32/34° C.	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline ..	. 3s. per lb.
Dichloraniline S. Acid	.. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol ..	.. £75 per ton.
Diethylaniline ..	.. 5s. per lb. d/d., packages extra, returnable.
Dimethyaniline ..	.. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene ..	.. 9d. per lb. naked at works.
Dinitrochlorbenzol	.. £84 10s. per ton d/d.
Dinitrotoluene—48/50°C.	8d.—9d. per lb. naked at works.
66/68°C.	1s. 2d. per lb. naked at works.
Diphenylamine ..	.. 3s. 1d. per lb. d/d.
Monochlorbenzol..	.. £63 per ton.
β Naphthol ..	.. 1s. 1d. per lb. d/d.
α Naphthylamine	.. 1s. 4½d. per lb. d/d.
β Naphthylamine	.. 4s. per lb. d/d.
m Nitraniline ..	.. 5s. 3d. per lb. d/d.
p Nitraniline ..	.. 2s. 4d. per lb. d/d.
Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. per lb. 100% basis d/d.
Nitronaphthalene	.. 11¾d. per lb. d/d.
p Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m Phenylene Diamine	.. 4s. 2d. per lb. d/d.
p Phenylene Diamine	.. 10s. 4d. per lb. 100% basis d/d.
R Salt	.. 2s. 6d. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 6d. per lb. 100% basis d/d.
o Toluidine ..	.. 8½d. per lb.
p-Toluidine ..	.. 3s. 6d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £49 per ton.
Acid, Acetyl Salicylic	.. 3s. 4d.– 3s. 5d. per lb. Market rather quiet. Low offers are being made from the Continent.
Acid, Benzoic B.P.	.. 3s. 9d. per lb. Larger supplies available.
Acid, Boric B.P.	.. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic ..	.. 3s. per lb. for pure crystal. Market very steady.
Acid, Pyrogallic, Cryst.	.. 7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic ..	.. Prices quoted from 2s. 2d. per lb. down to 1s. 11d. for ton lots. Market rather firmer.
Acid, Tannic B.P.	.. 3s. per lb. Market quiet.
Acid, Tartaric ..	.. 1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 2s. 3d. per lb. for quantity. Easier market.
Amidopyrin .	.. 13s. 6d per lb Neglected. Stocks low.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. per oz. for English make.
Barbitone..	15s 6d per lb. Quiet market.
Benzonaphthol .	. 5s 6d per lb. Small inquiry.
Bismuth Salts ..	.. A steady market. Prices according to quantity:
Bismuth Carbonate	.. 12s. 9d.—14s. 9d. per lb.
,, Citrate ..	.. 11s. 4d.—13s. 4d. ,,
,, Salicylate	.. 10s. 2d.—12s. 2d. ,,
,, Subnitrate	.. 10s. 9d.—12s. 9d. ,,
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides - ..	.. Market easier.
Potassium ..	.. 9½d.—10d. per lb.
Sodium ..	.. 9½d.—10d. ,,
Ammonium	.. 10½d. 11d. ,,
Calcium Lactate	.. Demand not very active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate ..	.. 3s. 9d. per lb.
Chloroform .	.. 2s. per lb. for cwt. lots. Market more active. Makers busy.
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Formaldehyde .	.. £57 per ton, ex works. English make.
Guaiacol Carbonate	.. 12s. per lb. for cwt. lots. Supplies not plentiful.
Hexamine .	.. 3s. 6d. per lb. for English make. Imports cannot be made at this figure.
Homatropine Hydrobromide	.. 30s. per oz.
Hydroquinone ..	.. 4s. 9d. per lb. Foreign make.
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	.. £36 per ton net.

Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	70s. per lb.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Market rather flat, but prices unchanged.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	2s. 3d.—2s. 9d. per lb. for carboys. A slightly better market
Methyl Sulphonal	25s. per lb. No demand
Metol	11s. per lb. British make
Paraformaldehyde	3s. 6d. per lb. Better inquiry.
Paraldehyde	1s. 4d.—1s. 6d. per lb. in free bottles and cases. Better demand
Phenacetin	6s. per lb. Somewhat cheaper.
Phenazone	7s. 9d. per lb. for cwt. lots. Quiet
Phenolphthalein	6s. 9d.—7s. 3d. per lb. In more plentiful supply.
Potass. Bitartrate—	
99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate—	
B.P. Crystal	8¾d.—9d. per lb. carriage paid.
Commercial	8d.—8¼d. per lb. carriage paid.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 6d. per lb.
Saccharin	63s. per lb., in 50-lb. lots
Salol	4s. per lb. Very quiet.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	2s. 6d. per lb. In steady demand for good qualities.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite—	
Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1 cwt. kegs.
Sod. Metabisulphite cryst	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity
Sod. Potass. Tartrate (Rochelle Salt)	77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet
Sod. Salicylate	Market easier. Powder 2s. 4d.—2s. 6d. per lb. Crystal at 2s. 6d.—2s. 8d. per lb. Flake 2s. 9d.—3s. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity. 1-cwt. kegs included. In large casks £1 per ton less
Sulphonal	17s. per lb.
Tartar Emetic	1s. 4d. per lb. for cwt. lots.
Thymol	14s.—15s. 9d. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine	14s. 6d. per lb.	
Amyl Acetate	2s. 9d. ,,	
Amyl Butyrate	7s. 3d. ,,	
Amyl Salicylate	3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. 6d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. ,,	
Benzyl Alcohol free from Chlorine	3s. 3d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate	3s. 6d. ,,	
Cinnamic Aldehyde Natural	15s. 6d. ,,	
Coumarin	20s. ,,	
Citronellol	16s. ,,	
Citral	10s. ,,	
Ethyl Cinnamate	15s. ,,	
Ethyl Phthalate	3s. 3d. ,,	Reduced.
Eugenol	11s. ,,	
Geraniol (Palmarosa)	35s. ,,	
Geraniol	11s.—18s. 6d. per lb.	
Heliotropine	6s. 6d. per lb.	Reduced.
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose	28s. 6d. ,,	Reduced
Linalyl Acetate	28s. 6d. ,,	Reduced
Methyl Anthranilate	9s. 6d. ,,	
Methyl Benzoate	6s. ,,	
Musk Ambrette	48s. 6d. ,,	Reduced.
Musk Xylol	16s. 6d. ,,	Reduced.
Nerolin	4s. ,,	
Phenyl Ethyl Acetate	12s. 6d. ,,	
Phenyl Ethyl Alcohol	16s. ,,	
Rhodinol	57s. 6d. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. 9d. ,,	
Vanillin	25s. 3d.—26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	
Anise Oil	3s. per lb.	
Bergamot Oil	18s. 6d. per lb.	
Bourbon Geranium Oil	36s. 6d. ,,	Advanced
Camphor Oil	75s. per cwt.	
Cananga Oil, Java	10s. 6d. per lb.	
Cinnamon Oil, Leaf	6½d. per oz.	
Cassia Oil, 80/85%	9s. 3d. per lb.	
Citronella Oil—		
Java 85/90%	5s. 9d. per lb.	Again dearer.
Ceylon	3s. 9d. ,,	
Clove Oil	8s. 3d. ,,	
Eucalyptus Oil 70/75%	2s. 2d. ,,	
Lavender Oil—		
French 38/40% Esters	62s. per lb.	
Lemon Oil	3s. 2d. per lb.	
Lemongrass Oil	3d. per oz.	
Orange Oil, Sweet	13s. 9d. per lb.	
Otto of Rose Oil—		
Bulgarian	27s. 6d. per oz.	
Anatolian	23s. 6d. per oz.	
Palma Rosa Oil	19s. per lb.	
Peppermint Oil—		
Wayne County	21s. 9d. per lb.	
Japanese	18s. 3d. per lb.	
Petitgrain Oil	10s. per lb.	
Sandal Wood Oil—		
Mysore	26s. 6d. per lb.	
Australian	21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents, those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than July 14th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. on May 29th.

I.—Applications

Barratt and Greaves. 11,135. See VII.

Boormann. Counter-current columns for separating or washing fluids. 11,539. May 9.

Craig, Shawfield, and Lever Bros. Distillation etc. plants. 11,530–31. May 9.

De Laval Chadburn Co., Ltd. (Aktiebolaget Separator). Separators. 11,521. May 9.

Hadlington and Washington. Reverberatory furnaces. 11,162. May 6.

Hanley. Film evaporators. 11,334. May 7.

Herrmann Ges. Filtering liquids. 11,104. May 5. (Ger., 23.5.23.)

Honigmann. Annular furnaces. 11,513. May 9.

O'Donovan. Heat treatment of materials. 11,179. May 6. (Union of S. Africa, 25.1.24.)

Procter. Apparatus for drying granular etc. materials. 11,306. May 8.

Sears. Furnaces. 11,251. May 7.

I.—Complete Specifications Accepted

2816 (1923). Hughes (Schmidt). Distillation installations, solvent recovery plants, etc. (215,073.)

3171 (1923). Iondes, Ransomes and Rapier, Ltd. Mixing machines. (215,093.)

21,851 (1923). Gettings and Bodman. Mixing-apparatus. (215,261.)

II.—Applications

Badische Anilin and Soda Fabrik. Fuel for internal combustion engines. 11,131. May 8. (Ger., 2.7.23.)

Banner. Manufacture of an emulsion of oil and water. 11,589. May 10.

Barratt and Greaves. 11,135. See VII.

Draabl. Drying peats etc. 11,572. May 10.

Koppers Coke Oven Co., Ltd. Vertical retorts for distilling fuel. 11,187. May 6. (Ger., 7.5.23.)

Lo Branchez. Internal distillation of combustibles. 10,995. May 5.

Nagel. Briquettes. 11,072. May 5.

Nagel. Binding fuel materials. 11,073. May 5.

Pase (Brégeat). Process of treating motor spirit etc. 11,471. May 9.

Potts (Algemeene Norit Maatschappij). Production of active carbons. 11,451. May 9.

Sauer. Production and revivification of activated carbon. 11,463. May 9.

Schwarz. Purifying mineral oil products etc. 11,532. May 9.

Shaw. 11,011. See IX.

II.—Complete Specifications Accepted

2411 (1923). Lamplough and Fathers. Manufacture of fuel briquettes. (215,056.)

2782 (1923). Jackson (Western Gas Construction Co.) Apparatus for the manufacture of gas. (215,069.)

3538 (1923). Koppers Co. Treatment of ammonia-charged gas. (209,379.)

3546 (1923). Koppers Co. Removal of hydrogen sulphide etc. from gases. (210,382.)

5819 (1924). Lamplough and Fathers. Manufacture of fuel briquettes. (215,292.)

IV.—Applications

Eckermann, Steinbuch, and Soc. Chem. Ind. in Basle. Condensation products of the anthraquinone series. 11,219. May 6.

British Alizarine Co., Ltd., Anderson, and Dawson. Manufacture of dyestuffs and intermediates. 11,137. May 6.

Evans. Sheet-delivery mechanism of printing machines. 11,418. May 8.

Farbenfabriken vorm. F. Bayer und Co. Manufacture of azo dyestuffs. 11,322. May 7. (Ger., 7.5.23.)

Farbwerke vorm. Meister, Lucius, und Brüning. Manufacture of dyestuffs. 11,540. May 9. (Ger., 9.5.23.)

Imray (Soc. of Chem. Ind. in Basle). Manufacture of dyestuffs etc. 11,439–40. May 8.

IV.—Complete Specifications Accepted

4287 (1923). Farbw. vorm. Meister, Lucius, u. Brüning. Manufacture of azo-dyestuffs. (193,831.)

30,838 (1923). Durand und Huguenin Akt.-Ges. Manufacture of disazo dyestuffs. (208,162.)

V.—Applications

Karplus. Treatment of artificial silk. 11,116. May 5.

Lindsay. Cellulose compositions. 11,107–8. May 5.

Newby. 11,324–5. See XIII.

V.—Complete Specifications Accepted

30,211 (1922). Dreaper. Manufacture of artificial silk etc. from viscose solutions. (215,028.)

14,154 (1923). Soc. Seta Artificiale di Padova. Treating artificial filaments. (198,673.)

VI.—Applications

British Alizarine Co., Ltd., Dawson, and Wilson. Printing fabrics and composition therefor. 11,138. May 6.

Farbenfabriken vorm. F. Bayer und Co. Process for dyeing acetate silk. 11,545. May 9. (Ger., 9.5.23.)

Hall, and Silver Springs Bleaching and Dyeing Co. Dyeing black shades on cellulose-acetate fibres, films, etc. 11,169. May 9.

Hall, and Silver Springs Bleaching and Dyeing Co. Dyeing aniline black on textile materials. 11,170. May 9.

VI.—Complete Specification Accepted

2593 (1923). Brandwood. Apparatus for dyeing, bleaching, scouring, mercerising, etc. (215,064.)

VII.—Applications

Barratt and Greaves. Apparatus for distilling ammonia liquor, washing gases, etc. 11,135. May 6.

Bernard. 11,615. See XVI.

Goldschmidt Akt.-Ges. Production of sulphur. 11,032. May 5. (Ger., 16.8.23.)

Neill. Heat process of manufacturing ferric oxide. 11,036. May 5. (Australia, 12.3.24.)

Planchon. Production of lead acetate. 11,609. May 10. (Ger., 30.10.23.)

Smith. Conversion of lead sulphate into lead carbonate. 11,409. May 5.

VIII.—Application

Soc. Anon. Quartz et Silice. Manufacture of silica glass articles. 11,039, 11,040. May 5. (Fr., 2.11.23.)

VIII.—Complete Specification Accepted

14,173 (1923). Marks (Roth A.-G.). Preparation of clay etc. for moulding. (215,207.)

IX.—Applications

Bloxam (Holzapfel). Preservation of wood. 11,220. May 6.

Dickins. Waterproofing cement. 11,067. May 5.

Girouard. Treatment of calcareous cement etc. 11,019. May 5.

Mulligan. Plaster. 11,399, 11,483. May 8 and 9.

Shaw. Production of coloured bituminous emulsions. 11,011. May 5.

X.—Applications

Durant and Rhodes. Treatment of ores, concentrates, etc. 11,421. May 8.

Kilby and Spalton. Manufacture and refining of steel. 11,209. May 6.

Minerals Separation, Ltd. Concentration of ores. 11,215. May 6. (U.S., 23.10.23.)

X.—Complete Specifications Accepted

29,272 (1922). Reis. Treatment of metals to render them harder and rustproof. (214,872.)

404 and 7870 (1923). Morgan. Manufacture of wrought iron. (215,049.)

2547 (1923). Metallbank u. Metallurgische Ges. Increasing the electric conductivity of alloys. (192,414.)

19,742 (1923). British Thomson Houston Co. (General Electric Co.). Alloys. (215,231.)

21,006 (1923). Morgan. Manufacture of wrought iron by piling. (215,212.)

XI.—Application

Soc. Anon. Le Carbone. Galvanic batteries. 11,227. May 6. (Fr., 10.1.24.)

XI.—Complete Specification Accepted

29,175 (1923). Metropolitan Vickers Electrical Co., Ltd. Electric furnaces. (207,804.)

XII. Applications

Banner. 11,589. See II.

Flockton. Extracting oil from palm fruit. 11,159. May 6.

XII. Complete Specification Accepted

3672 (1923). Marks (Nield). Apparatus for extracting oil, fats, and waxes. (215,113.)

XIII.—Applications

Caughlin. Printing ink. 11,037. May 5.

Newby. Cellulose acetate varnishes. 11,324, 11,325. May 7.

XIII. Complete Specifications Accepted

9522 (1923). Bakelite Ges., and Hessen. Manufacture of condensation products from phenols and formaldehyde. (206,169.)

17,239 (1923). Shimadzu. Paint. (215,222.)

19,175 (1923). Soc. of Chem. Ind. in Basle. Manufacture of resins. (203,340.)

XIV.—Complete Specifications Accepted

3514 (1923). Naugatuck Chemical Co. Vulcanisation of rubber. (200,789.)

19,311 (1923). Chatelain. Vulcanisation of caoutchouc etc. (201,570.)

XV. Application

Luttig and Schmid. Treatment of hides and skins. 11,064. May 5.

XVI. Applications

Bernard. Process for enrichment etc. of phosphated chalk etc. 11,615. May 10.

Hiller. Manufacture of meal for fertilising etc. 11,303. May 7. (U.S., 7.5.23.)

XVII.—Complete Specification Accepted

13,892 (1923). Smer. Purifying and decolorising sugar solutions. (198,374.)

XVIII. Complete Specification Accepted

13,860 (1923). Boby and Griffiths. Production of grist for brewing etc. (215,202.)

XIX. Applications

Hoyberg. Process for making butter. 11,328. May 7.

Mond (Chemische Fabrik Griesheim-Elektron). Utilisation of nutrient-containing shells. 11,415. May 8.

XIX.—Complete Specification Accepted

34,757 (1922). Gates. Production of milk foods. (215,039.)

20,305 (1923). Girard. Apparatus for treating sewage and like liquids. (215,237.)

XX.—Applications

Bonhôte, Montmollin, and Soc. Chem. Ind. in Basle. Manufacture of aryloxynaphthyl-ketones. 11,326. May 7.

Lockemann. Manufacture of 1-phenyl-2.3-dimethyl-4-dimethylamino-5-pyrazolone. 11,614. May 10. (Ger. 11.10.23.)

Mallinckrodt. Rendering ether air-free. 11,033. May 5.

Soc. Lefranc et Cie. Manufacture of ketones. 11,402. May 8. (Fr., 17.5.23.)

XX.—Complete Specification Accepted

25,478 (1923). Hoffmann-La Roche und Co. Akt.-Ges. Manufacture of emulsions of bismuth salts. (206,487.)

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number :—*Argentina*: Rubberred cloth (567); *Australia*: Cutlery (532), hardware (533), leather (Official Secretary, Commercial Bureau, Australia House, Strand, W.C. 2. Ref. Com. 412/7/1/1/239); *Bolivia*: Paints (884/22/F.G./C.C./2); *Brazil*: Leather, paper, iron and steel (569); *British India*: Paint (The Director General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); *Canada*: Lead pipe (13,624/E.D./E.C./2); *Cuba*: Hardware (572); *Denmark*: Industrial chemicals, anti-rust paint (541); *Guatemala*: Chinaware, cutlery, leather (574); *Hayti*: Shellac (9789/F.L./C.C./2); *Italy*: Silk (547); *Netherlands*: Cutlery (550), leather (551), silk (552); *New Zealand*: Artificial silk (538); *Poland*: Leather (554); *South Africa*: Hides (12,339/E.D./M.C. 2), copper tubes (12,225/E.D./E.C./A.); *Turkey*: Tin, ammonia, zinc, tinplate (561), petrol and crude petroleum-driven engines (563); *United States*: Steel and bronze (22,834/F.W./E.C./2); *Yugoslavia*: Tin, tinplate (555).

Trade Information

Tully Gas Plants, Ltd., have announced that consequent upon their amalgamation with Gas and Fuel Plants, Ltd., the company has gone into voluntary liquidation. The business will, in future, be carried on by Gas and Fuel Plants, Ltd., who own construction rights for plants for the production of smokeless fuel. The registered office of Gas and Fuel Plants, Ltd., is 40/3, Norfolk Street, Strand, London, W.C. 2; the telegraphic address is "Damper, Estrand, London," and the telephone numbers are City 4047 and 4048.

Italian Company News

The capital of the Società Italiana Prodotti Azotati is to be increased from 9 to 20 million lire, and that of the Società Industria Concimi ed Affini is to be raised from 600,000 to 2 million lire.

PUBLICATIONS RECEIVED

LIME AND MAGNESIA. THE CHEMISTRY, MANUFACTURE AND USES OF THE OXIDES, HYDROXIDES, AND CARBONATES OF CALCIUM AND MAGNESIUM. By N. V. S. Knibbs, B.Sc. Pp. 306. London: Ernest Benn, Ltd., 1924. Price 30s.

A COURSE OF INSTRUCTION IN INSTRUMENTAL METHODS OF CHEMICAL ANALYSIS. By W. N. Lacey. Pp. vi + [illegible]. New York: The Macmillan Co., 1924. Price 7s.

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

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EDITORIAL

THE letters from Mr. Pickard and Pedant on the English language call attention to a point of which we were ignorant, that Mr Rickard is English in his origin and education We are always glad to be corrected or supplied with additional information on topics which we have dealt with in these columns. It is at least evidence that the editorials are perused; many important and interesting facts have been given to our readers by correspondents to this *Journal* and we are glad to have the opportunity of expressing our gratitude to this numerous body. Those who make corrections to chemical articles, even to such ephemeral matter as editorials in a weekly journal, are helping to maintain a higher standard of accuracy. Editorials are usually written hurriedly and they are not intended to be of interest except for the few moments of perusal. They are hardly more than hors d'oeuvres; like these, they are a habit, a convention, and those who wish to proceed rapidly to the more solid and satisfying parts can easily spend the few minutes involved in a more profitable manner. It is accepted by all connected with journals that the correspondence columns have a quite different character; they are frequently the first to be read; they bring out new points and fresh ideas. It has surprised us that we have received so few letters from chemists about that project which is now receiving attention from a small committee but should be of interest to so many chemists, we mean of course, Chemistry House. Those we meet and talk to on the subject are enthusiastic and determined to make the project a success; we sometimes wonder whether they are representative. What do the majority think about the project? Perhaps it would be more pertinent, though less polite, to enquire whether they do think about it. When chemists have finished their arduous day's work, their tennis and their gardening, do they as the light gradually fades away, sit and think, or do they just sit?

* * *

We thought a fortnight ago that we had, for the time, finished with the War and the difference between the views of the French and Germans. Dr. Fritzsche, who writes us a further letter, has claimed to make public the views of the average German man of science; no other German has dissented from his statement, and we are entitled therefore to accept his claim. We cannot fill our columns with history and politics, and if Dr. Fritzsche had been of any other nationality we should have thought that his letter was not suitable for publication in them. But as we felt sure that to refuse to publish his letter would lay ourselves open to a suspicion of partiality we have inserted it A few days ago we read with care a great deal of the diplomatic correspondence officially published by Great Britain and by France, and also the whole of Prince Lichnowsky's Memoir. We are bound to say that many of the distinguished German statesmen who were most intimately concerned did not, so far as can be judged by the letters and memoranda written by them in June and July, 1914, hold the views which Dr Fritzsche now holds. We have no intention of mentioning in detail those statements of his which appear to us to conflict with the official statements made by the German Chancellor, Ambassadors and other important personages who might be supposed to be well acquainted with the facts. If we thought any useful purpose would be served we should be willing to discuss these matters in detail, giving chapter and verse for our arguments; but not in this

journal. *Chemistry and Industry* deals with chemistry and not history; for this reason and this reason alone we must in future refuse to publish accounts, whether they seem to us to be accurate or inaccurate, of the causes of the War. It is another matter to consider such questions as the policy of the Union Internationale; this is a question in which chemists are primarily concerned, and if our readers choose to write on this topic there is obviously no objection, subject to the qualification we have already mentioned. We are grateful to Dr. Fritzsche for his letters and interested to know what his views are; we should have been more pleased had they not been so different from those current in this country, but we cannot help this difference, nor is this the place to explain it.

* * *

How would Dr. Johnson have defined the word "photography" had this been in use at the time of his Dictionary? Seventy years ago he would have dismissed it possibly as an "occupation for light minds," but one could well imagine his absorption had he been able to read, on his way to Lichfield, not Bishop Watson, but Prof. Bancroft's reprint of his contribution to the discussion held by the Faraday Society on the physical chemistry of the photographic process, the articles on photography by Sir W. J. Pope and Mr. W. Clark in "Chemistry in the Twentieth Century," and that excellent little booklet, "Foresight in Photography" (published by Burroughs Wellcome and Co.), which is noticed elsewhere in this issue. One does not know which to admire most: Prof. Bancroft for his clear exposition of the lacunæ in photographic theory; Sir William Pope and Mr Clark for their insistence on the value of photography as a scientific instrument and the promise of its future; or the booklet "Foresight" for its able advocacy of the use of sound methods as an insurance for success. Prof. Bancroft says "the theory of the photographic emulsion is very much up in the air." Says Mr. Clark, "the 'emulsion' is in reality a 'suspension' of fine crystalline particles of silver halide in a medium of gelatin, or in certain cases, of collodion." Sir William Pope observes that "in a few years' time no one will tolerate the ordinary photographic portrait, with its false rendering in monochrome of colour values." It is to be feared we know little about gelatin or about silver halides, though the British Photographic Research Association is doing excellent work in bringing light into our darkness, and we can expect still more. But Sir William Pope has earned the gratitude of every user of photographic plates by his work on colour sensitisers and desensitisers, so we must not blame the chemist for the faulty tone renderings shown in our counterfeit presentments. And while we are waiting for the perfect plate, Burroughs Wellcome are here to show us how to make the best of what we have.

* * *

The gas industry always seems so young and vigorous that it is almost surprising to learn that the centenary of the lighting of Paris by gas is being celebrated this week. And what an outcry there was against the introduction of such a pernicious invention! It was sure to cause blindness and diseases of the lungs, people would be asphyxiated, and fires would break out everywhere. Every innovation, however useful, seems foredoomed to bitter, if futile, opposition, and the gas industry throughout its triumphant career, has never lacked its critics, even to the days of the therm. The heathen ever find cause furiously to rage, whether at spinning jennies or at steam engines. It is not so long since a steam roller had to be preceded by a varlet bearing a red flag, and there are still people who would like every industry to be neatly tagged with red flags. But it is all very good for industry, especially for British industry, which is apt to reveal unexpected qualities when there is really need, as we learnt so thoroughly during the war. The gas industry is no exception, and although the introduction of electric lighting about 1883 found the industry "trudging along in a more or less lethargic manner," very soon the pace was not lacking in vivacity. Indeed, the opponents were finally reduced to calling the gas industry "effete." It is true that the gas industry still has a very great deal to learn about its raw material, coal, but then one is told that the efficiency of electrical generation by means of coal heating is not all that could be desired. Both industries have their place, and no doubt in time they will become platonic, if not bosom friends. One does not always realise the magnitude of the gas industry, however, and it is of interest to recall that the chairman of the Gas Light and Coke Company recently stated that his company produces annually as much energy in heat, light and power as is produced by the whole of the electrical undertakings in Great Britain, and that the increased consumption (10 per cent.) of the company's gas during the first quarter of 1924 is equivalent, in electrical heat units, to 250 million kilowatt hours, or, roughly, the annual consumption of current in Birmingham and Sheffield.

* * *

The centenary of gas lighting in Paris recalls the controversy about the actual originator of the process. It is usually stated that William Murdoch first used coal gas as an illuminant about 1792, whilst Lord Dundonald used it for lighting Culross Abbey in 1782, Prof. J. P. Minckelers lighted his lecture theatre in Louvain with gas in 1785, and Philippe Lebon, to whose plans the first illumination of Paris with gas was due, took out a patent in 1799. It seems unlikely that gas manufacture arose independently any more than do other discoveries, for it is certain that the production of gas by the dry distillation of coal was known long before its commercial use was thought of. We have seen somewhere a statement that the Dean of Kildare, the Rev Dr John Clayton, wrote to Robert Boyle in 1690 describing how he filled bladders with an inflammable gas obtained by distilling coal, and Stephen Hales in 1726 published the fact that on distilling 158 grains of Newcastle coals 180 cubic inches of "inflammable air" was obtained. And did not Bishop Watson touch on the same subject? Perhaps some of our readers can inform us.

REMINISCENCES OF DR. CARO*

By Dr. E. F. EHRHARDT

"Psycho-analysis seeks to secure a healthy flow of the emotions by eliminating the impurities which by repression have contaminated the well-spring of our inner life. It is an aspect of the moral purification—the catharsis—to which Aristotle attributes the virtues of tragedy."

This is a quotation which expresses, in more beautiful language than I can dispose of on ordinary week-days, one of the reasons for the choice of my subject for a paper to you to-day. In more Victorian language the same idea would be expressed by saying, "Don't nurse a grievance but have it out."

Of all the great chemists and great lawyers that it has been my good fortune to meet, Dr. Caro is the one who seems to me to correspond most satisfactorily to the definition of a genius, and it is perhaps for this reason that he is becoming something of a fetish. It frequently happens that when certain views are to be put forward an endeavour is made to render them more palatable by connecting them in some way with Dr. Caro. Thus when the education of industrial chemists is under discussion someone will advocate what he calls the "German System" and point to Dr. Caro as a product of that system, which should, therefore, be copied. Or, again, when during the war the importance of the dyestuff industry was acutely troubling the Government and numerous dye consumers in this country, a letter was written to *The Times* giving as the solution of the difficulty, "Find a man like Dr Caro and give him a free hand." Suggestions like this that come from people who have not spent as many minutes with Dr. Caro as I have spent days cause a certain amount of irritation and lead to the desire for the catharsis that I have referred to in my opening quotation. I do not propose to give anything like a complete account of Dr Caro's life and work, and will restrict myself to a few but slightly connected reminiscences.

It is unfortunate for those who hold up Dr. Caro as a product of the "German System" for training industrial chemists that he was not trained as a chemist at all. He did attend a German polytechnicum, but he took the course provided not for chemists but for calico printers. This indeed included something of the elements of chemistry and as a consequence of his innate aptitude for chemistry and of the interest he had always taken in that subject, when Caro left the institution the certificate that he received stated that his knowledge of chemistry considerably exceeded the standard required by the institution for the certificate. He repeatedly told this with pride. Dr. Caro opened business life, therefore, as a calico printer with a knowledge of the elements of chemistry, and the production of the first coal-tar colours synchronised with this period and he learnt the chemistry of the industry as it was found out and himself contributed to this knowledge.

Even when I made his acquaintance in 1889 there were properly qualified chemists who looked upon Dr. Caro in much the same way as registered medical practitioners to-day may regard a successful bone-setter whose meritorious services have been recognised by a knighthood. At that time he already had honorary degrees conferred upon him by the Universities of Munich and of Heidelberg, but he had achieved no degree by examination and passed through no regular University course.

On the other matter—that of finding a man like Dr. Caro and giving him a free hand to recreate and develop the dye industry in this country—in the first place, I would ask, where, if you exclude the writer of the letter and present company, would you find the man of genius like Dr. Caro to whom the free hand is to be given? But apart from this difficulty it is one of the attributes of genius that they are frequently difficult to get on with, and in this respect Dr. Caro was not altogether an exception. He served only one term on the Board of Managing Directors of the Badische Co. When his five years' agreement came to be renewed he was promoted to the Supervisory Board. It was shortly before the end of this period that I went to Ludwigshafen and was engaged as a chemist under Caro. When after six months' provisional engagement the definite agreement was to be signed I asked for a salary of M. 3000 per annum as against the regular M. 2400 and gave as the reason for this £30 extra that for me the engagement meant living abroad, so that something ought to be paid by way of consolation for living in exile. Dr. Brunck, who was dealing with me in the matter, snorted at this idea and said in other words, "If you know a better 'ole, go to it," but he added, "we will give you the extra £30, not for living with us here but you have got to work under Caro, no one can get on with him, and we have noticed in the last six months that you have got on with him; we will give you the extra £30 per annum for that." When one managing director speaks like this of a colleague it is not exactly a recommendation that the latter should be given a free hand for running a factory.

Dr. Caro was a man of approximately the same age as my father; his elder children were older than me and his younger children younger. He was kind enough to take a paternal interest in me, and there was no difficulty in a young man like me getting on with him when his coevals might find it very irksome.

It was, and I suppose still is, a social custom over there for the new recruits on the staff to call on the older men, and these calls were paid between the hours of 11 and 1 on Sunday morning. I promptly paid my duty call on Dr. Caro. Instead of letting me go at the end of the regulation 10 minutes he kept me until he was fetched to dinner and insisted on taking me with him. He kept me the whole afternoon, we went for a walk and returned, he kept me for the evening meal, and for the whole of the evening until past midnight filled the time with practically a monologue on the history of the dye industry and his experiences in connexion with it.

* Paper read before the Manchester Section of the Society of Chemical Industry on February 1, 1924.

He made this most interesting to me and he thoroughly enjoyed talking in this way himself and pressed me to come again, and repeatedly my morning calls ended only at midnight. In this way, in addition to the work I did with him daily at the factory in the laboratory, I got to know him very intimately.

The Fast-Red Case

In May, 1889, I was with Caro for about a fortnight in London in connexion with a law suit with reference to Naphthol Yellow S in which Mr. Ivan Levinstein was an ally of the Badische, and Read, Holliday and Sons, Ltd., were in alliance with the defendants Messrs. Dawson. It was then that I met Mr. Ivan Levinstein and naturally the recently ended litigation between Badische and Levinsteins on the Fast Red patent, which had finally resulted in the alliance that I have referred to was frequently discussed. There are one or two points in connexion with that suit that are germane to my subject and which should be published. Everyone who is familiar with patent case law will remember that one of the defences in the suit—Badische *v.* Levinstein—was that the defendants Levinsteins made use of a secret process, not the process of the patent. The evidence on this defence was heard *in camera* with every safeguard against publication, so that to this day details of this secret process have not been given to the world. It would be useful if the text books on patent law when discussing this case would add a foot note giving the nature of the secret process and the reason why the defence based upon it fell. The patent in suit claimed the production of colouring matters by the action of diazo compounds of naphthylamine or naphthylamine sulpho acid upon the naphthols or the sulpho acids of α- and β-naphthol, that is to say, the claim is directed to making the azo dyes from the naphthylamines and from their sulpho acids, diazotised, and combined with the naphthols and their sulpho acids. It is difficult to see how there can be any secret process differing from the normal process which was patented for effecting this combination, and as a matter of fact the secret process did not refer to the patented step, it related to the manufacture of naphthionic acid. After this sulpho acid of alpha naphthylamine had been made by the secret process the treatment was just as claimed in the specification, so that it is clear why this defence failed. The secret process for making naphthionic acid was a baking process using shallow metal trays for the baking operation and breaking up the paste during the process of baking with the aid of stampers.

I learned this from Mr Ivan Levinstein's own lips in the old Gambrinus in Glasshouse Street. Dr. Caro, Mr. Levinstein and I had been at a long consultation with Professor Dewar at the Royal Institution. When we came out Dr. Caro called out that he would like a glass of German beer, which in those days was more difficult to get in London than in more recent times prior to 1914. During my visits to London University for examination purposes I had frequently passed the Gambrinus in Glasshouse Street—it was not then extended to Regent Street as it is now—and I took Caro and Levinstein into this replica of a Bavarian beer cellar as it then was with its bare wooden tables, deeply carved with initials and devices by the customers who patronised the place. Caro was delighted at the Bohemian atmosphere and here the talk drifted to the Fast Red case and I obtained the information that I have given above. Of the chemists that actually took part in the case and who would know of these details I think Professor Armstrong is the only one living.

The battle of the Fast Red case was, of course, fought again and again and from what I learnt of what passed behind the scenes and from the official reports I think it highly probable that it was putting forward the false point of the secret process and one other small false point that turned the scale and gave the final victory to the Badische.

The Method of Sulphonation

The main attack on the patent was on the ground of insufficiency and centred on the directions given for sulphonation. For this purpose fuming sulphuric acid containing 80 per cent. anhydride was recommended, this was to be applied in the sulphonation of the naphthylamines and of the finished colouring matters. Someone on behalf of Levinsteins made the false point that it was very difficult to sulphonate the naphthylamines with such strong fuming acid and *a fortiori* it would be more impossible to treat a complex body like the azo dye from naphthylamine and naphthol with this powerful acid. The underlying idea was: the more complex the body, the less likely it would be able to withstand the action of a strong fuming sulphuric acid. This is absurd, there is no connexion of that sort and in the case in point the exact opposite was the truth, the complex body, the finished dyestuff could readily be sulphonated with the strong acid whilst the naphthylamines without very special precautions could not be treated with that acid without charring taking place.

When the conflict of evidence on the action in this respect had utterly bewildered the Judge he decided to have an independent expert to repeat the reaction but chose as the crucial experiment the treatment of the dyestuff naphthylamine-azo-naphthol with this acid and not the treatment of the naphthylamines, and the sulphonation of the dyestuff was effected with perfect success by Sir Henry Roscoe, which gave the Badische Fabrik their victory.

I asked Dr. Caro how it came that the direction to sulphonate with this strong acid was included in the specification and the history is of interest. I suppose everyone is aware that on the Continent the strongest concentrated sulphuric acid is sold as "66°" acid being 66° of Baumé scale. It appears that at about the time of the Fast Red invention a firm on the Continent put on the market a fuming sulphuric acid which perhaps roughly speaking was as much stronger than 65° acid as 65° acid is stronger than 50 acid, so they called their acid 80° acid, although the degrees bear no relation to its specific gravity at all. One could imagine a chocolate manu-

facturer advertising his cocoa as 100 per cent. pure and a rival manufacturer who offered a stronger cocoa calling his 200 per cent. pure. The action of this sulphuric acid firm was similar. The strongest ordinary acid was 65-66 acid, they sold a stronger acid as 80° acid, it was this 80° that was used by Caro's assistant—a promoted laboratory boy—for the sulphonations in connexion with this work and he had not the education to distinguish between degree sign and the percentage sign, so in his note book called this acid 80 per cent. acid, putting the percentage sign instead of the degree sign. This was copied into the draft specification and so gave occupation to the leaders at the Patent Bar and all the courts up to the House of Lords in this country. Caro told me that it was his intention to go into the box as a witness and explain this to the Court and to rely on the sense of justice of the Judge not to upset the patent for the sake of a mistake like that, but he was prevented from giving evidence by illness. Another of the witnesses has boasted to me that he won that case by making Caro ill with a surfeit of champagne and so prevented his giving evidence.

Superstitions

Dr Caro was superstitious in many ways or, at any rate, pretended to be. Thus, on the occasion of this Naphthol Yellow law suit he wore a peculiar diamond pin, in the centre of which there was a pear-shaped diamond mounted as a pendant. The swinging of this diamond every time he moved attracted my attention, and when he noticed that I was looking at it, he explained to me that it was a talisman and that he always wore it when he had important business on hand but never on ordinary occasions. For many years afterwards I repeatedly noticed that this talisman pin was put on when it might be regarded as desirable to propitiate the fates. The photograph that is published in the *Berichte* with Caro's biography written by Prof. Bernthsen shows this pin, which he wore when that photograph was taken. Another instance of this trait is afforded by his account of his invention of the reduction of nitro "propriolic" acid, which was the first technical production of artificial indigo. All efforts to find a suitable reducing agent for "propriolic" had failed, then Dr. Caro one night in a dream saw in letters of flame before him the words "xanthate of soda," and tried the next day xanthate of soda. It worked perfectly, and the "propriolic" acid was put upon the market for indigo printing. I suggested to him that the supernatural powers who had favoured him in this way might have given him a hint how to prepare indigo in bulk, for after all the manufacture and sale of the "propriolic" acid was more a matter of prestige than of dividends, but he did not take the criticism of his spooks kindly.

Similarly Dr. Caro liked to emphasise the effect of chance on his inventions. One of the most important was his invention, independently of Perkin, of the commercial process for making alizarine. Graebe and Liebermann had brought to the Badische their process for making alizarine by brominating anthraquinone and fusing the dibrom-derivative with caustic alkalis. The first question that was put to them was whether instead of the highly expensive bromine, sulphuric acid could not be used to prepare a sulpho acid of anthraquinone which could be fused with caustic; they reported that they had tried it, but had failed. Every effort was made to make Graebe and Liebermann's process technically possible but without success, and the experiments were flagging or almost abandoned. For the purpose of the experiments a considerable quantity of anthraquinone—a rare product in those days and not readily obtainable—had been got together. Caro wanted to find some use for this anthraquinone, which had been acquired at considerable expense, and just as he had prepared Rosolic acid from phenol he thought he could prepare something similar from anthraquinone by heating it with sulphuric acid and oxalic acid, and this experiment was set going in a porcelain dish. He let the temperature rise gradually, the oxalic acid began to decompose and passed away as CO_2, and he had given up hope that the experiment would prove a success when he was called away from the laboratory and forgot to remove the Bunsen burner from under the porcelain dish in which the sulphuric acid, anthraquinone and oxalic acid mixture was being boiled. Upon his return to the laboratory the place was full of fumes of sulphuric acid, and the contents of the dish had been evaporated to dryness, and round the edge of the crust, which was partly charred, Caro noticed a pink line. He interpreted this as proving that energetic boiling of the anthraquinone with sulphuric acid had led to some sulphonation, and the subsequent dry distillation had got rid of the sulpho group, giving the oxy groups which, with a trace of alumina derived from the porcelain, gave this pink line, showing the presence of alizarine. He at once experimented again, taking the strongest fuming sulphuric acid available and heating energetically, and succeeded in getting sulpho acids of anthraquinone, which on melting with caustic gave alizarine and its isomers as desired. The provisional specification was at once despatched to England, and had the luck of being registered at the Patent Office one day before Perkin's similar application. That was a momentous day for the German dye industry, Caro's patent was No. 1936 of June 25, 1869, and Perkin's patent No. 1948 of June 26, 1869.

Chance and the "Benzene Ring"

Another instance of a chance visit leading to important effects was the experiment which enabled Caro to put the dyestuff factories in a position to break up the "Benzene Ring," that is to say, the commercial ring of producers and dealers in benzene, who were raising the price to the dyestuff manufacturers. This story has a prologue which played in this country. During Caro's partnership in the firm of Roberts, Dale and Company an inventor came to that company with a process for the manufacture of oxalic acid. He prepared oxalic acid by running coal gas from the ordinary gas supply mains into nitric acid, when after a short time crystals of

oxalic acid appeared in the nitric acid solution. Roberts, Dale and Company were manufacturers of oxalic acid, and had recently put down new plant for the purpose. He brought the invention to them to see if it was of any interest, and Caro undertook the work of testing the process. He tried the experiment running the gas through the nitric acid and obtained oxalic acid. If that had been all it would have only been necessary to make a costing to show that the process had no advantage over the old process of making the oxalic acid from sawdust, but to the dismay of Roberts, Dale and Company not merely was oxalic acid obtained, but a noticeable quantity of nitro-benzene was also produced as a by-product. That put the matter in a different light. If nitro-benzene, which was then very expensive, were obtained in this way it was the oxalic acid that might be the by-product and the new oxalic plant of Roberts, Dale and Company would have at once been worthless. The process was condemned, nothing was said about the production of nitro-benzene, and the matter was left like that. Many years later when the " Benzene Ring," to which I have referred, had come into existence, and was seriously worrying dye manufacturers, Caro remembered this old process, and in his writing-room he started an experiment letting coal gas bubble through a beaker containing nitric acid on his window-sill. He had hardly got the experiment started when Prof. Witt called upon him, and he drew the curtain so that Witt should not see what was going on and attended to the business with Witt, during which the experiment was completely forgotten and the gas went bubbling through that nitric acid all night. When Caro saw the beaker next morning he saw a little oxalic acid but, on the surface of the nitric acid, there was quite a considerable layer of oily liquid which turned out to be almost entirely benzene; a little nitro-benzene had been formed, and this had washed the benzene out of the coal gas. This led to experiments on coal gas with other solvents, and it was soon proved that the coal gas, as delivered in those days, contained a quantity of benzene that had not been suspected at all, and that this could readily be extracted from the gas. The dye factories got into touch with the gas manufacturers behind the backs of the tar distillers, and with the aid of this process obtained from the gas factories a supply of benzene at the crucial moment, which forced the members of the ring to come to terms.

Jacketted Pans

Before concluding, I would like to register one claim that Dr. Caro made which I have never heard discussed or seen published in any way. He claimed to have introduced into the chemical industry the use of jacketted pans; these are nowadays so much a matter of course that it is difficult to realise that someone had at some time invented and introduced them. Dr. Caro told me that it came about in this way. In his early laboratory work he used an ordinary English glue pot as a convenient water bath for making small experiments, and found glue pots so useful for this purpose that he took some to Germany when he went over there and used them there for laboratory work. When larger scale plant was required, larger glue pots were made, and in this way the jacketted pan as we know it to-day arose.

Now the rest of the acts of Dr. Caro and the inventions he made, and the honours and decorations that were bestowed upon him by Princes and by Universities and by Scientific Societies, are they not written in the official biography of Dr. Caro by Prof. Bernthsen in the *Berichte* of the Berlin Chemical Society, Vol. 45?

* * *

In the subsequent discussion Prof. Green said he did not know whether the story was apocryphal, but he remembered being told about the way in which it was sought to convince the judge in the Fast Red case that the method of sulphonating α-naphthylamines, as described in the patent, was not practicable. The judge was invited into a small back room, and a pound of α-naphthylamine was placed in a big pot and 4 or 5 lbs. of 80 per cent. fuming sulphuric acid was poured on to it. There was a frightful commotion at once. In one moment, the room was full of SO_3 fumes, and the Judge and everybody else got away as quick as they could. The Judge declined to see any more experiments. Dr. Caro was certainly one of the greatest men the dyestuff industry produced. He had a wonderful genius for discovery, and a marvellous enthusiasm for chemistry which was a science he loved from the bottom of his heart. In many respects, he was a poet. He did not necessarily write in verses, but anyone who had read the Lecture delivered before the Berlin Chemical Society on the Development of the Dyestuff Industry would realise that it was an absolute epic and one of the most beautiful pieces of writing imaginable. He could not say that he had the pleasure of knowing Dr. Caro well. But he did call upon him occasionally at his flat in Mannheim. One of the reasons Dr. Caro left Manchester was ill health. He went straight to Heidelberg, and lived there for two or three years, practising as a general consultant. Very soon all his time was given up to the Badische Co., and eventually he joined their undertaking. After leaving the Badische Co., he still resided in Mannheim. Dr. Caro's daughter was very intimate with his (the speaker's) wife and they occasionally corresponded. In fact, his wife received a letter from Miss Caro only a few weeks ago in which was enclosed an interesting bit of correspondence which was not entirely without some reference to the present conditions in the dyestuff industry. It was a curious thing how history had repeated itself over and over again. In 1904, just after Dr. Caro's jubilee, Prof. Meldola wrote on February 17: " My Dear Caro, . . . I write now to offer you my sincere congratulations, and to express the hope you may be spared for many long years yet to enjoy your well-earned period of leisure and to pursue your scientific work. *The worst thing that ever happened to the coal-tar colour industry of this country was the loss of Heinrich Caro!* Now we have nearly lost the industry altogether,

and serve us right!—Yours very sincerely, R. Meldola." Caro replied to this letter on March 2, 1904:—

"My Dear Professor Meldola,

Allow me heartily and sincerely to thank you for your very kind congratulations on the past jubilee of my 70th birthday. Your good wishes have not come too late. The bright sunlight of friendship and fellow feeling which threw its radiant beams upon that wonderful and never-to-be-forgotten day, has not yet passed away, and as long as it lasts the days may roll on in their ordinary course, but the 13th of February will still remain in existence. I feel very happy that my dear old friend and colleague, Professor Meldola, has on that memorable day shaken hands with me wishing me good luck on my onward way.

In your kindly worded letter I have noted an expression, which, coming from an authority like yours, has assumed the character of a verdict. You are alluding to my former participation in the rise of the English coal-tar industry, and then you go on to say its truly deplorable decline may be partly traced back to my leaving your country in 1866. Now, my dear Professor, with all due respect I beg to be allowed to differ from you in my views on that question. I think that *many* fatal circumstances had been working together to shift the leadership in the development of the Colour Industry from England into Germany. At about the same time, the great and successful manufacturers, Perkin and Nicholson retired from business; Hofmann, then the real head of the scientific "General Staff," left his glorious laboratory in the Royal Institution and recreated a new era of scientific progress in Germany; his English school was scattered to the winds; Adolf Baeyer commenced his splendid career in Berlin; Kekulé's benzol theory remained, comparatively speaking, disregarded and fruitless in England whilst in Germany the laboratories became too narrow."—(*i.e.*, too small for the students)—"The worst thing was that the English manufacturing chemist, in consequence of his innate self-reliance, trusted rather to his own energy and practical experience than to the skill and knowledge of scientifically thoroughly trained assistants: Wishing to save wages he himself spoiled his own trade, and when he bethought himself of his folly, the reins had already slipped from his hands. If I had remained in England I could not have stopped the fatal change. I see now no reason why the lessons of the past should not be rendered fruitful by the present generation of English chemists, who, as your own noble example shows, are in respect of the high qualities of heart and mind certainly not inferior to their German colleagues.—Ever yours, H. Caro."

Although Dr. Caro was an intense patriot, and had an intense belief in the great potentialities of German science, enterprise, and industry, he yet had a very tender spot in his heart for England. It would have been a terrible thing for him if he had lived to see the war, but fortunately he did not. He always used to speak with the greatest pleasure about the period of his life that he lived in Manchester. He always seemed to look back upon it as one of the happiest parts of his life.

Prof. Knecht said he knew Dr. Caro in 1883. At that time he, the speaker, was making the homologue of resorcin, and from it a fluorescein, and from that an eosin. Victor Meyer, whom he was assisting at the time, strongly urged him to see Caro, and an interview was arranged shortly afterwards in Switzerland. He showed Dr. Caro some fluorescein and eosin dyed on silk. Dr. Caro took a considerable interest in the method and said he would try it in the works. There was considerable difficulty in making the homologues, and the experiment proved a failure. Subsequently, he met Dr. Caro frequently in this country, and could bear out Dr. Ehrhardt's statement that if he took a fancy to anyone he invariably gave them rather long lectures. Personally, he remembered being at Dr. Caro's house in Mannheim on a Sunday, and he gave him the lecture he had delivered to the Berlin Chemical Society in great detail. It took six hours to do it. It was very interesting, but he was very tired when it was finished. Dr. Caro gave as one of the reasons why he was so successful that whenever he made a discovery he went on with it until he had got something out of it of a definite character, and then only did he look in the literature to see if anybody else had done anything of the same kind. He also attributed much of his success to his early training in calico printing, which always stood him in good stead in the works; and what Caro said in this respect was borne out also by Bohn's experience and the experience of various other technologists.

THE ALCOHOL INDUSTRY IN CANADA

The alcohol industry has been revivified, but whether this be due to the repeal of prohibitory legislation in the provinces of Alberta and Manitoba, and the possibilities of a similar result of a referendum in Saskatchewan and Ontario, it is difficult to say. The Canadian Industrial Alcohol Co., of Montreal, has been improving its various plants and bringing them up to a higher degree of efficiency. At its Corbyville, Ont., distillery, among the improvements have been the installation of a plant for the recovery of the carbon dioxide from the fermentation tuns and production of compressed gas, and a new method for the manufacture of high grade ethyl acetate and several other ethyl and amyl compounds. A subsidiary known as the Canadian Industrial Alcohol, of Manitoba, has been incorporated with a capital of $2,000,000. The distillery is now being erected at St. Boniface, Man., and the company is also considering the erection of a plant in British Columbia.

The Commercial Alcohols, Ltd., Montreal, has been incorporated and is proceeding with the erection of a distillery to have a daily production of 1500 gals. alcohol. The raw material will be Cuban molasses which will be transported by tank steamers.

THE OUTLOOK IN CHEMISTRY*

By PROF. SIR WM. J. POPE, K.B.E., F.R.S., D.Sc., LL.D.

One of the many useful functions of an ancient Society such as this is undoubtedly that of taking stock, from time to time, of the actual position which has been so laboriously achieved in one or other of the large divisions of pure or applied science. This, I feel sure, is a function which would appeal particularly to the gentleman whose services to science are to be perpetually recalled to fresh generations of students of science by the Trueman Wood lectures. And so, when the Council of the Royal Society of Arts did me the honour of adding my name to the distinguished list of Trueman Wood lecturers, the opportunity seemed appropriate for directing attention more particularly to one specific branch of science in which developments of fundamental importance have quite recently taken place.

I believe, and I think my belief is well founded, that the historian of the future will mark the last twenty-five years as one of the really memorable stages in scientific progress. This brief period has witnessed such a broadening in the scientific outlook on the physical sciences as was never contemplated towards the end of last century: a broadening of the scientific horizon which has forced previously dissonant sections of the scientific community to regard their individual subjects and their main objectives of research from precisely the same standpoint of knowledge and of purpose.

Some obscurity may attach to this problem and a little explanation is desirable. During the nineteenth century the physicist was largely concerned with the determination of essential physical constants and the establishment of the primary relationship between the various forms in which energy manifests itself; it would be difficult to overestimate or overstate the intellectual beauty of the work of Thomas Young on the undulatory theory of light, of Clerk Maxwell on the properties of gases, or of Kelvin on thermodynamics and the theory of electricity. During roughly the same period the chemist dealt in the main with the material changes brought about in ponderable matter by chemical reaction; Lavoisier's recognition of the elements and his law of the conservation of mass, Dalton's establishment of the atomic theory, Frankland's doctrine of valency and his work on organic synthesis, and the development of organic synthesis by Perkin, Baeyer and Emil Fischer, are among the many expressions of genius directed towards purely chemical ends in this particular epoch. But whilst both Physics and Chemistry developed rapidly during the nineteenth century, they developed on what appeared to be quite divergent lines; they had but little community of method, of purpose or of outlook, and the chemist was fairly sharply distinguished from the physicist in his mode of attacking a problem and his conception of the meaning of natural phenomena. To the chemist, and especially the organic chemist, the internal constitution of the molecule was the main object of enquiry, whilst the physicist, in his dealings with matter and energy, concerned himself chiefly with extra-molecular happenings; this statement is, of course, not entirely true, and it became less true as time passed on, but it is sufficiently accurate as indicative of the diversity of outlook.

During the last twenty-five years this state of affairs has entirely changed; the physicist has developed methods for penetrating into the atoms of which molecules are made up and of elucidating the manner in which the primitive atoms themselves are built up; he has provided simple explanations of many remarkable chapters in chemistry which had been worked out in an almost entirely empirical manner with but little theoretical basis. To-day, Physics and Chemistry are but arbitrary subdivisions of the great subject of Natural Philosophy; each of their students is a specialist cultivating some minute field of the whole domain, but all have the same fundamental conception of the nature of the non-living part of our universe.

It is very interesting to attempt a comparison of the outlook of the chemist of thirty years ago with that of to-day; to make such a comparison involves a brief review of the appearance of the chemical universe then and now, indicating the milestones in the path of progress, and remarking on their significance.

Undoubtedly the atomic theory enunciated by Dalton in 1803 remained for a century the corner stone of the chemical edifice; in essence, the atomic theory postulates that any chemical element is composed of inconceivably minute and similar particles called atoms and that the atom of different elements combine in simple numerical proportions to form the ultimate characteristic units, the molecules, of chemically compound substances. It has always seemed to me that Dalton's atomic theory had, at the date of its enunciation, no sure foundation as a logical interpretation of observed facts, though it is naturally impossible to recover precisely the outlook of the chemist of a century ago; but whether the atomic theory represented a logical interpretation of experimental observations, or whether it expressed an inspiration of a great generalising intellect, it is clear that until a few years ago the atomic theory remained a theory and nothing more. Ostwald, indeed, made an earnest attempt to present modern chemistry without the aid of the atomic theory and, notwithstanding the recognised utility of the theory as a piece of chemical scaffolding, few held the opinion until quite recently that the atomic theory depicted an actual state of affairs or supposed it proved that atoms and molecules actually exist. After Dalton came Avogadro, who in 1811 stated the hypothesis that under similar conditions of temperature and pressure equal volumes of different gases contain the same number of molecules; again, no complete logical proof could be given that what was often erroneously described as Avogadro's Law represented an actual state of affairs; nevertheless, Avogadro's hypothesis still

* The Trueman Wood Lecture, delivered before the Society of Arts, on May 21, 1924.

stands as the mechanism for rendering intelligible our methods for determining molecular weights.

Other great chemical monuments were raised from time to time: Prout's hypothesis stated in 1816 that the atomic weights are integral multiples of that of hydrogen and become whole numbers if the atomic weight of hydrogen is taken as unity, and Mendeleef's periodic relationship between the atomic weights and physical and chemical properties of the elements, dating from 1869, had a profound influence on chemical thought. Prout's Law was temporarily discarded, to be resuscitated a century later in a slightly modified form as perhaps the most striking exemplification of the truth of modern views of the nature of matter and energy: Mendeleef's periodic classification of the elements remained for half a century as a purely empirical justification of a rapidly increasing belief that the elementary atoms are complex structures and that all have a common origin.

With the rapid development of organic chemistry came the enunciation by Frankland of the doctrine of valency, with its immediate clarification of our knowledge of the molecular constitution of organic compounds; the introduction of constitutional formulæ by Kekulé gave a directional lead to the work of the organic chemist, and this mode of expressing the position relationships between the atoms composing a molecule, based upon the doctrine of valency, has furnished the theoretical network upon which the whole of the vast expansion of organic chemistry has been spread. Again, however, the doctrine of valency represented an empirical conception in the sense that it seemed impossible to give it any theoretical interpretation; at the same time, constitutional formulæ, although continually acquiring a more concrete character from stereochemical work based upon Van't Hoff and Le Bel's conception of the asymmetric carbon atom, were commonly regarded as not necessarily of greater significance than expressing a geometrical relationship which was to some extent parallel with the actual state of affairs. Possibly, however, it is not sufficiently grasped by chemists that the introduction of constitutional formulæ, with all their modern consequences such as the recognition of the existence of definite groups or radicles as component parts of the molecule, constituted an entire revolution in chemical thought. I have myself discussed modern organic chemistry with veterans of before Frankland's day and have been struck by their distrust of the idea that individual atoms of the component elements and specific groupings of those atoms exist as such in the complex molecule; the early conception seems clearly to have been that when two dissimilar atoms enter into combination each loses its identity and becomes, as it were, fused into the other. To our predecessors with such an understanding of chemical combination, the attribution of concrete signification to constitutional formulæ must have been peculiarly difficult.

A multitude of other steps in the development of the chemist's conception of his universe, many of them of importance, might be noted, but all are of the same category as the foregoing. The gradually extending chemical outlook of the last century resulted from the exercise of great experimental skill in the collection of observational facts and in the logical generalisation from those facts which yielded the theoretical groundwork of modern chemistry; a wonderfully supple theoretical network was thus built up but it was a network which, in the end, was regarded merely as theory and not as necessarily presenting any real picture of what really exists as causative of the experimental results. This mode of conception has become obsolete during the present century; the atom and the molecule are now known to be realities and much has indeed been disclosed concerning the way in which the elementary atoms themselves are built up. It is interesting to review the manner in which the new outlook has been gained before considering how it affects modern chemistry.

The first step towards a proof of the existence of Daltonian atoms and molecules as concrete entities obviously consists in devising methods for determining some constant relating to their absolute sizes, to the number present in a definite weight of a material or to the mass of an individual atom or molecule; such quantities as these are intimately related and it is convenient, in tracing the development of the subject, to confine attention to but one of them. We may choose for this purpose the Avogadro constant, N, which represents the number of molecules contained in the molecular weight in grams of any species of matter. The mathematical development of the kinetic theory of gases by Clerk Maxwell, Clausius and van der Waals led to a method, based in part on measurements of the viscosity coefficients of gases, by which the Avogadro constant could be calculated; from measurements made on argon, the value $N = 6{\cdot}2 \times 10^{23}$ was deduced. Naturally the calculation of this quantity provides no proof of the existence of atoms or molecules because it is based upon the assumption that they do exist; the point which is of importance, however, is that many quite dissimilar methods for arriving at a value for the Avogadro constant are now available and that all lead to values which are identical within the limits of experimental error.

Thus, the botanist Robert Brown noted in 1827 that very finely divided particles suspended in a liquid appear on microscopic examination to be in a state of perpetual agitation, and some sixty years later it became admitted that this incessant movement is due to the bombardment of the tiny solid particles by the swiftly moving molecules of the liquid medium itself. If this is the case, the solid particles suspended in a liquid should distribute themselves vertically according to the same law as governs the pressure of the atmosphere at various altitudes; very careful series of observations were made by Perrin of the concentration of uniform particles of gamboge at different altitudes in a thin layer of liquid and it was shown that, interpreting these data as representing an equilibrium condition between the dispersive tendency of the bombardment and the sedimenting effect of gravity upon the particles, a method for calculating the Avogadro

constant was obtained. Perrin thus calculated the value $N = 6 \cdot 83 \times 10^{23}$, which, considering the difficulties of the experimental work, may be regarded as identical with the value calculated from the viscosity of argon The remarkable nature of this correspondence will be realised when it is noted that a parallel is being drawn between the weight of a gram-molecule of such a gas as hydrogen, namely, two grams, and that of the gram-molecule equivalent of the relatively enormous gamboge particles, which is of the order of 100,000 tons; also that an atmosphere of hydrogen round the earth would have its density diminished to one-half by the action of gravity at an altitude of about 80 kilometres, whilst a similar diminution to one-half density occurs at a height of 0·02 to 0·03 mm. in the suspension of gamboge.

Again, the late Lord Rayleigh pointed out that the diffusion of light by a gas is due to the gaseous molecules acting as diffracting particles; by an argument which need not now be discussed he traced the blue colour of the sky to this effect and gave a method for calculating the Avogadro constant. This method, applied with modern refinements, has yielded the value $N = 6 \cdot 54 \times 10^{23}$, again sensibly identical with those furnished by the previously entirely distinct methods.

By far the widest expansion in modern knowledge of the constitution of matter, and indeed also of energy, is that which has resulted from the study of radioactivity Apart from the pioneer work on radiant matter by Crookes, the discovery of radioactivity in 1896 by Becquerel and its association shortly afterwards with radium by Madame Curie mark the opening of a fresh chapter in the development of science; so striking has been the broadening of the chemical outlook under the influence of the rapid advance in the study of radioactivity that it may be useful to note a few points of special importance. The most fundamental of these is perhaps the identification by Sir J. J. Thomson of the β-particle as the particle or unit of negative electricity and the demonstration that the α-particle, thrown out during the first stage of the atomic degradation of the radium atom, is the atom of helium carrying one unit charge of positive electricity. Following this as clearing up our ideas on fundamental chemical theory is possibly Rutherford's conception of the structure of the chemical atom; in this it is conceived that the atom consists of a nucleus, minute in comparison with the total volume occupied by the atom, which contains all the particles of positive electricity and, in the case of all the elements but hydrogen, a definite number of particles of negative electricity; the nucleus carries a positive charge equal to the difference between the number of positive particles and the smaller number of negative electrons composing the nucleus. The positively charged nucleus is in electrical equilibrium with the much larger external atomic domain by reason of the presence in the latter of negative particles or electrons equal in number to the nuclear charge. Since the property of mass is chiefly associated with the positive particle of electricity, the electron having a mass only about 1/1800 as great, the atomic weight of an element becomes very nearly the number of positive particles contained in the nucleus; the atomic weights should thus be practically whole numbers, multiples of the unit atomic weight of the lightest element, hydrogen, in accordance with Prout's hypothesis of 1816. Further, one of the most important characteristics of an element should be the positive charge on the atomic nucleus, or the number of electrons in the external atomic domain; this is the atomic number which was first defined by Moseley, who showed the simple relation which exists between this constant and the spectrum of the light evolved by an element when bombarded by β-particles. As connecting this strange new development of science with earlier knowledge it may be noted that the most accurate method for determining the Avogadro constant depends upon the measurement of the charge carried by the electron or β-particle; Millikan thus determined the value for N as $6 \cdot 062 \times 10^{23}$, a number approximately identical with those previously quoted.

It would be impossible in the limited time now available to submit any adequate picture of the far-reaching deductions from recent work on radioactivity; one or two points may, however, be emphasised. The Moseley atomic number shows that 92 elements should exist and 87 of these are now known, five being left to be discovered; it indicates that the atomic weights of all the elements should be whole numbers. Rutherford showed that the atomic nucleus, which gives the atomic weight as the number of units of positive electricity included within it, is composed of ponderable positive particles and practically non-ponderable negative particles of electricity, the difference being the atomic number of Moseley; it appears, however, that the atomic nucleus of any particular element can preserve its identity, from the purely chemical point of view, if containing one or more positive and the same number of negative units of electricity less

The positive charge, the Moseley atomic number, would be thus left unaltered and consequently the identity of the element for purposes of chemical change should remain unchanged. In accordance with this Aston has proved in a large number of cases that the chemical elements are mixtures of atoms of different nuclear composition, although identical as regards the number of negative electrons which compose the outer or chemically active atomic domain. Elements which differ to the extent just indicated in nuclear composition, but which are identical in the number of electrons present in the external domain, have been termed isotopes; it is now known that the atomic weights of each variety of any element appear as whole numbers when referred to a particular unit. For a reason which is not yet elucidated, but which is certainly of significance in connexion with our knowledge of the relation between matter and energy, the unit value for the atomic weight of hydrogen has to be selected as 1·008; this unit chosen, the atomic weights of the isotopes of all the elements appear as whole numbers. The empirical deduction of Prout of a century earlier has thus been completely justified. Again, the purely empirical deduction by

Mendeleef of the so-called periodic classification of the elements, which has exercised enormous influence on the development of inorganic chemistry, has found complete theoretical justification in the arrangement of the elements in sets of eight in accordance with the system of atomic numbers introduced by Moseley. The deductions drawn by Lavoisier about 1775 which indicated the existence of chemical elements and stated the law of conservation of matter both find theoretical justification in modern conclusions; each chemical element is characterised by the Moseley atomic number and the law of conservation of matter stands subject to the slight adjustment involved in the attribution of an atomic weight of 1·008 to hydrogen. Lastly, the atomic theory of Dalton has passed from the stage of being merely a useful hypothesis to that of stating an actual condition of affairs; it is safe to assert that never again in the history of science will the existence of atoms of the elements be seriously challenged.

So far we are on undebatable ground, but much more still disputed territory is in sight which will undoubtedly be secured in the very near future. The nature of chemical combination has been long in dispute: the Frankland doctrine of valency has been very fertile as leading to a classification of types of reaction and to a very perfect system of indexing the composition and constitution of chemical compounds. It seems likely that the Rutherford conception of atomic structure, interpreted quantitatively by Bohr and his co-workers, and adapted to chemical mechanisms by men of the Langmuir and Millikan school, will ultimately provide a satisfactory solution of many of the baffling problems now presented by the question of atomic valency.

Yet another remarkable chapter has been recently opened in connexion with the confirmation by contemporary physicists of the singular accuracy of the manner in which chemists long before had interpreted the observed facts relating to molecular constitution. Frankland's doctrine of valency enabled Kekulé about 1858 to develop the theory of the molecular constitution of chemical compounds, and later generations of chemists have brought to a great state of perfection the methods for ascertaining the manner in which the component atoms of an organic molecule are joined together. The precision of the synthetic methods of organic chemistry and the striking facts of stereochemistry made it certain that the so-called structural formulæ run closely parallel to the actual arrangement of atoms in the chemical molecule; at the same time, no independent or more direct confirmation of the substantial correctness of constitutional formulæ was until quite recently forthcoming.

The purely geometrical investigations of Bravais, extended and completed by Sohncke, Schönflies and Barlow, have long since shown that all properties of crystals are consonant with the supposition that crystal structures consist of a regular repetition in space of the molecular units, and consequently also of the atoms which compose the molecule; any particular plane section of a crystal is thus to be regarded as having a definite reticulated pattern formed by the geometrically regular repetition of component atoms in the plane. It has also been long known that light is diffracted in accordance with well-understood laws from gratings ruled with a large number, say 100,000 to the inch, of fine lines. The reticulated pattern of a crystal surface is, of course, far more minute than corresponds to the dimensions just stated and X-rays are of wavelengths of the order of 1/10,000 of those of visible light. It thus occurred to Laue in 1912 that X-rays should be diffracted from a reticulated crystal surface in the same way that visible light is diffracted by a grating; he showed this to be the case and shortly afterwards Bragg founded upon this observation a method for determining the atomic spacings in a crystal by observation of the manner in which X-rays are diffracted from the crystal. Debye and Scherrer showed a little later that massive crystals are unnecessary for the application of the Bragg method, but that finely powdered crystalline material can also be used, and, in fact, the study of X-ray diffraction from particles of colloidal gold in aqueous suspension has proved that the colloidal particles of this element are crystalline.

The Bragg method has been intensively applied during the last few years and has demonstrated that the constitutional formulæ deduced in an entirely different fashion by the chemist are substantially correct representations of the actual manner in which the atoms are arranged in the chemical molecule.

This necessarily very abbreviated summary of the most important directions of recent progress in physics in so far as they influence chemistry will suffice to prove a quite simple thesis. Whilst the chemist at the end of last century had laid certain theoretical foundations to his science, more particularly those connected with the atomic theory, the doctrine of valency, the Mendeleef classification of the elements, and the vast network of organic chemistry which culminates in the determination of molecular constitution, all these achievements remained as theories or even in part as mere hypotheses until the sudden development of physics during the last twenty years or so transformed them into actual statements of fact. The history of science has never before had to record so dramatic and far-reaching a broadening of the horizon as that which has so recently unified chemistry and physics.

It is doubtful whether the importance of the unifying process which has been carried out so rapidly has been sufficiently realised by the majority of those interested in physico-chemical science, and attention may be directed to one aspect of the question which appears to be relevant.

Whilst the present generation of students is acquiring an outlook very different from that prevalent a few decades ago, our general organisation of teaching methods remains unchanged. The student commences his training in natural philosophy by attending separate courses in inorganic and organic chemistry and in general physics, including heat, electricity and magnetism. But the reason for this early differentiation has now entirely vanished, if indeed it ever really existed; all these

subjects have the same basis, namely, the electronic constitution of matter and energy, and it would seem more rational for the student of natural philosophy to commence his training by a general course for the purpose of elucidating the manner in which all these specialised sections of the one large subject fit into the one great scheme. Students have frequently asked me how to reconcile the tenacity with which a complex molecule of an organic compound retains the perfectly definite arrangement of its component atoms with the view that an atom itself is but a minute nucleus surrounded by a large planetary system of particles of negative electricity in rapid gyration: there is indeed a striking contrast between the rigidity of molecular structure evinced by organic compounds and the apparently flimsy nature of the rotating sub-atomic units from which the whole wonderful edifice is built up. Our teaching methods require considerable adjustment to make them fit the exigencies of the modern scientific outlook.

Probably I have said sufficient to make it clear that the outlook in chemistry is far broader than it was twenty-five years ago; we understand now the meaning of much that had been painfully deduced by generations of careful observers of experimental facts. We may now proceed to enquire what we see in front of us as the result of the wider outlook.

All enquiring minds in science are accustomed to peer into the future in an attempt to discern the directions in which progress is possible; hundreds of imaginative writers have tried to foretell the effects upon human life which will accrue from coming advances in science. In this connexion I desire to submit one ruling principle, a principle which is admirably exemplified by the directions of progress during the present century and which appears to be as yet but ill recognised. The principle is that all scientific prophecy which goes outside what will obviously and logically result from the normal and unsensational development of the existing scientific position is necessarily false. No one in 1900 ever conceived anything so sublime and yet so fantastic as the achievements of the past quarter of a century.

Fears are often expressed that humanity is being impoverished, and that posterity will be embarrassed by the rapidity with which our coal and petroleum resources are being consumed; but it is reasonable to presume that long before these potential supplies of energy have disappeared, their applications will have become obsolete. Whilst every motive exists for employing our present sources of energy with the maximum efficiency, we may safely leave posterity to look after itself with the aid of the scientific heritage with which it will be endowed. The desire to leave coal and petroleum for our successors to consume shows benevolence, but appears no more rational than the action of our ancestors in planting England with oaks after the Napoleonic wars, so that we might not lack material for the building of battleships.

But whilst we cannot see far into the scientific future, we can safely foretell certain immediate consequences of the position which chemical and physical science has so lately attained: we are confident that the period, 1925-1950, will be as prolific of discoveries previously unimagined as was the period 1900-1924, and it is futile even to speculate concerning the entirely novel conceptions and discoveries which the next quarter of a century will bring in natural philosophy.

It may be taken for granted that the Bragg method for determining crystal structure, which is still in its infancy and not so far capable of dealing directly with the lighter elements, will provide a means for locating accurately all the atoms present in any molecular complex, either inorganic or organic. This must lead to a great development in our knowledge of chemical structure, and should enable the relations between chemical constitution and physical properties, many of which have merely been studied empirically up to the present, to be discerned and stated with precision. Thus, it may be expected that the exact relation between the molecular configuration of an optically active substance, and its molecular rotatory power will be ascertained.

Our present knowledge of atomic constitution, with its inevitable developments and its applications to the elucidation of valency, and the elaboration of purely physical methods for determining molecular constitution, may be expected to throw light on an almost infinite number of points of detail in organic chemistry which are still obscure. We may expect to learn the cause of the great stability of the benzene ring, the basic principle underlying the tautomerism exhibited by ethyl acetoacetate and its analogues, the origin of colour in the quinones, and why copper of atomic number 29 refuses to form organo-metallic compounds whilst its followers in the series of the elements, namely, zinc, gallium, germanium, arsenic, selenium and bromine, of atomic numbers 30 to 35, all combine with methyl radicles. A quantitative explanation of the energy changes which accompany chemical reactions is to be anticipated. An exposure of the mechanism attending chemical changes in general and of catalytic reactions in particular should be forthcoming; the importance of this latter in connexion with the chemical operations performed by living matter, as bearing upon the utilisation of energy at low potentials for synthetic purposes, can hardly be exaggerated.

A myriad of other obscure questions, which the chemist has already carried nearly as far as his classical experimental methods will permit, but which are obviously open to further elucidation in the light of modern methods, will suggest themselves to the intelligent student of chemistry. A danger, indeed, exists that we may encroach on the domain of the imaginative writer of fiction by speculating on the new chemistry which is foreshadowed by Rutherford's transmutation of the elements by the α-particle bombardment of the atomic nuclei, and on the complications which will ensue when the several isotopes of many of the elements are available in quantity; although it is often stated that the isotopic varieties of an element will never be isolated in such quantities

is are necessary for chemical work, yet it is difficult to believe that this state of affairs will long persist. It may be taken for granted that in due course the isotopic chlorines of atomic weights, 35 and 37, will be available in quantity.

Up to the present, I have only discussed the change in the chemical outlook which has resulted from the superb achievements of modern physics, but another and very dissimilar factor has been simultaneously operative. Although the theoretical basis of modern chemistry is of a comparatively simple character, the mass of exact and detailed experimental material laboriously collected and recorded during the last century has made every chemist a specialist; each has ultimately been forced to settle down as a cultivator of one minute patch of the vast chemical domain. A tendency towards individualism has thus been fostered. If we look around, however, we see that a tendency in a contrary direction has become operative, namely, towards combined action for the purpose of producing a definite mass effect. The coal-tar colour industry furnishes an illuminating example of this effect; for many years past a large community of most competent chemical investigators has devoted its attention to the exploitation of the subject of dye-stuffs in conjunction with similar bodies of industrial and commercial experts. It cannot be denied that this co-operative effort has produced remarkable results; not only has it, in a comparatively brief span of years, succeeded in dominating one of the oldest and most conservative industries in the world, but it has extended its influence in many other directions. The coal-tar colour industry has, in fact, made itself essential in the production of materials necessary to many other industries, such as those of pharmacy and photography; whilst avowedly commercial in its aims, it has contributed much to the purely scientific development of organic chemistry.

Something very similar has taken place in the electrical industries. Certain of the great research laboratories which form part of a number of electrical firms have made most valuable contributions to the science of pure physics; they can afford a huge expenditure of money for scientific equipment, and can attract the assistance of real leaders in contemporary science.

In chemistry itself the advantages of collective effort towards the extension of industrial efficiency is not confined to the coal-tar colour industry; it is seen in the gas industry and in the novel institution, fostered by experience gained during the war, of research establishments each devoted to the development of some specific large branch of manufacturing industry. But if chemical science is to carry its full responsibility in connexion with the amelioration of the conditions of life, far more must be done to ensure sufficient team work in developing the applications of chemistry to human interests.

A few examples will illustrate this. The spirochaete of syphilis is susceptible to treatment by certain organic arsenic compounds; knowing this, Ehrlich conceived the idea of studying the therapeutic action of a long series of such compounds for the purpose of selecting the most suitable for the treatment of this disease. He ultimately decided that one particular substance, the so-called 606, was the most satisfactory curative agent from amongst the many which passed through his hands. Since Ehrlich's day other organic arsenic compounds have been introduced for the treatment of this particular disease, but all present certain disadvantages and possess certain limitations in efficiency. No thinking person can doubt that if 10,000 compounds, all variously toxic to the spirachaete, had been studied, one immeasurably superior to all the others as a curative agent would have been found; this could have been easily done by team work, and such a discovery would have repaid thousands of fold the original outlay on experimental work. A similar tale has to be told concerning sleeping sickness: Bayer 205 seems to be useful, but something much better would certainly have resulted from the examination of some scores of thousands of chemical substances. No such success can be claimed in connexion with the foot-and-mouth disease, which has cost the country many millions of pounds during the last year, because team action has not been enlisted, and consequently absolutely nothing is available for the treatment of this particular malady. A pressing need exists in this country for an organisation with the duty of drawing up schemes for the preparation of long series of related compounds of possible therapeutic value, making the substances and subjecting them to pharmacological investigation

Let us take another instance. The common and the noble metals have been for centuries the materials of staple industries in many parts of the world; no one metal finds industrial applications in a state of purity, but all are used as alloys with other metals. This being the case, and since none of the alloys in general use approaches perfection, it would have been anticipated that by this time we should have been in possession of an elaborate scheme of experimental data which would provide exact information concerning the properties of every possible admixture of one particular metal with one or several other elements: the scheme would, of course, be a very complicated one, but not nearly so complicated nor as difficult and costly to work out as our present system of organic chemistry.

In spite of much pioneer work by Sorby, Heycock and Neville and many others, no such scheme has been evolved; the National Physical Laboratory is now just initiating an experimental investigation for the purpose of studying the alloys of pure iron and chromium, and this, if successful, will be the first occasion on which the systematic study of alloys of pure iron with another pure metal has been undertaken.

Much more might be said on the need for a broader outlook on the applications of chemistry to other sciences, and to the arts, and on the necessity for the detailed working-out of large and comprehensive plans, involving much experimental work of a rather routine or repetitive nature, so as to provide the vast amount of precise data always essential to any

application of chemistry to technical ends. Many cases in which valuable results would be thus achieved will occur to anyone familiar with chemical science and acquainted with its bearings upon other branches of knowledge.

FORTHCOMING EVENTS

June 2. SOCIETY OF CHEMICAL INDUSTRY, *London Section.* There will be no meeting of the Section on this date.

June 3. ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, 35, Russell Square, W.C. 1, at 7 p.m. "The Analysis of Motion by Kinematography."

June 3 to 6. EMPIRE MINING AND METALLURGICAL CONGRESS, to be held at the British Empire Exhibition. Among other items, papers will be read on the following subjects:—Mining, Petroleum, Metallurgy of Iron and Steel, as well as Non-Ferrous Metallurgy.

June 4. INSTITUTE OF METALS, Annual General Meeting, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 1, at 8 p.m. "Atoms and Isotopes," by Dr. F. W. Aston, F.R.S.

June 4. BRITISH EMPIRE EXHIBITION, WEMBLEY. Conferences on "Heredity as the Basis of National and Industrial Efficiency." Also June 11, 18, 25.

June 5. THE CHEMICAL SOCIETY, Burlington House, Piccadilly, W. 1., at 8 p.m. Ordinary Scientific Meeting. (1) "The Absorption Spectra of Camphor and of Camphorquinone," by T. M. Lowry and H. S. French. (2) "Studies in Dynamic Isomerism. Part. XVI. Mutarotation of Beryllium Benzoylcamphor. Formation of an Addition-compound with Chloroform. The Optical Activity of Beryllium," by H. Burgess and T. M. Lowry.

June 6. BRITISH EMPIRE EXHIBITION. Conferences of Engineering Societies to be held in Conference Hall No. 1 at Wembley, at 10.30 a.m. Short Papers on various Engineering Subjects will be read and discussed. Further information as to tickets may be obtained from The Secretary, Society of Engineers, 17, Victoria Street, Westminster, S.W. 1.

June 6. ROYAL INSTITUTION OF GREAT BRITAIN, 21, Albemarle Street, W. 1, at 9 p.m. "The Glow of Phosphorus," by Lord Rayleigh.

June 11 to 13. SOCIETY OF DYERS AND COLOURISTS. Annual dinner on June 11 at the Hotel Victoria, Northumberland Avenue, London, S.W. 1. Conference on June 11 and 12 at the British Empire Exhibition, Wembley; on June 11 (3 p.m.) J. R. Hannay will give "An Historical Survey of Dyeing and Calico Printing," and on June 12 (11 a.m.) Prof. A. G. Green, F.R.S., will speak on "Modern Methods of Dyeing." River outing (cost 15s. per person) to Windsor on June 13. Application for tickets should be made to the Society of Dyers and Colourists, 30, Pearl Assurance Buildings, Bradford.

June 12. CHEMICAL SOCIETY. Meeting to be held in the Theatre of the Royal Institution, 21, Albemarle Street, W. 1, at 5.30 p.m., when the Faraday Lecture, entitled "Atomism in Modern Physics," will be delivered by Prof. R. A. Millikan.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 10.30 a.m.

A detailed programme has been sent to every member of the Society.

A ballot list for the election of Members of Council has also been despatched to each member entitled to vote.

J. P. LONGSTAFF,
General Secretary

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The eighth volume of these Reports is now ready. The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members, post free in each case.

A Member of the Society may purchase a set of Vols. II to VIII inclusive at the reduced price of £2 2s. 6d., and a Non-Member can procure a set at the reduced price of £3 15s., post free in each case.

DEATH

Bailey, Harold J. (elected 1903), of Ingleside, Heath Park Avenue, Cardiff, Alkali Inspector. On April 16, 1924.

MONTREAL SECTION

The annual meeting was held on April 14, preceded by the usual dinner, Mr. F. W. Horner being in the chair. After dinner entertainment was given by "our trio," Messrs. Hovey, Toole and Grigg, followed by a very humorous address by Prof. LeCointe on the Radio and the "Radio Bug." The reports of the Treasurer and of the Chairmen of the various Committees were adopted.

Dr. Wall, of London, England, was called upon by the chairman to address the meeting. During his remarks Dr. Wall told the members of the experience of the London Section relative to attendance, and suggested that more frequent meetings might bring fuller attendance of the members; this was the experience of the London Section.

As no other names were suggested for the offices of Chairman and Secretary-treasurer, Mr. J. B. Bell was declared Chairman, and Mr. C. C. McFee Secretary-treasurer for the year 1924-25. The following were elected members of the Executive Committee: Dr. A. R. M. MacLean, Prof. P. LeCointe, and Messrs. J. R. Donald, F. Cornell, C. G. Kertland, and W. B. Woodland.

Mr. W. H. Barnes then gave a summary of his bursary prize essay on "The Acid Plant—Its Function and Operation in the Sulphite Mill," illustrating his remarks with a number of lantern slides and exhibits of sulphite liquors, and the products obtained by their aid.

OTTAWA SECTION

A meeting was held in the University Club on May 8, 1924. Dr. Macintyre in the chair. The Secretary's report for the 1923-24 session showed the average attendance at the six meetings held to be 32. Prior to three of the meetings dinner was served, an average of 13 members being present. The opportunity thus afforded for closer personal contact appeared to be much enjoyed by those attending. The register contains the names of 18 members and 28 associates being an increase of 2 members over last year. The expenditure for the year was $110·06, leaving a balance on hand of $102·71.

The report was carried and the following officers were elected for the forthcoming session :—Chairman, Dr. A. E. Macintyre ; Secretary, A. E. MacRae ; Committee, Dr. L. F. Goodwin, P. V. Rosewarne, J. E. Goodie, F. C. Collier and F. A. Herman, in addition to Mr. Hambly, past chairman.

The programme for the meeting of Canadian Chemists at Kingston on May 27-29 inclusive, was read by the chairman who urged that as many of the members as possible should be present.

Mr. G. D. Mallory, of the British American Nickel Co., then gave a very interesting address on "The Electrolytic Production of Nickel," first outlining the various uses of nickel and describing the processes used by the International Nickel and the Mond Nickel Companies. He then clearly and fully described the process used at the smelter and at the refinery of the British American Nickel Co.

After an interesting discussion the thanks of the meeting was expressed to the speaker and light refreshments served.

SOCIÉTÉ DE CHIMIE INDUSTRIELLE

At the close of the six years during which Monsieur Paul Kestner has presided over the destinies of the Société de Chimie Industrielle, that body has conferred upon him the title of "President Fondateur" to show appreciation of his eminent services. The Bureau and Council of the Société, however, wishing to offer still more complete testimony to the first President entertained Monsieur and Madame Kestner to dinner at the Cercle Interallié. Professor C. Matignon outlined the part played by President Kestner and his influence on the amicable relations with foreign societies, particularly the Society of Chemical Industry. Monsieur R. Duchemin presented to Monsieur Kestner a work of art in the name of the Council, and in well-chosen words, outlined the work he had done. In the name of the National Federation of Chemical Societies in France Prof. Béhal added further testimony, and insisted on the need for the Maison de la Chimie, an idea due to Monsieur Kestner. In reply Monsieur Kestner modestly attributed all the merit to his collaborators, and showed how much work still remained to be done. The new president of the Société de Chimie Industrielle, Monsieur Dior, then paid a warm tribute to his predecessor. The whole evening was remarkable for the spontaneity of the expressions of appreciation and esteem offered to Monsieur Kestner.

The Organic Industries Group met on May 13, to hear a description by Monsieur E. Fourneau of the synthesis of "309" and the changes brought about in the therapeutic action of its derivatives by chemical modifications. The speaker described how he was lead by the study of "Beyer 205" to develop his "309" of which the chemotherapeutic index and properties were comparable with those of the German product. By means of a kinematograph film the synthesis of "309" was explained, and it was shown that by displacing certain groups in the molecule or replacing them by other groups, the therapeutic action could be greatly modified.

Monsieur C. H. Cofignier discussed the thickening of paint, and suggested that for paint containing resin and lead pigments, the thickening could not be sufficiently explained by the formation of insoluble lead resinates. He suggested that the action would first consist in the formation of a grain swelling by adsorption then resolving into finer granules, thus leading to further swelling and to thickening owing to the influence of abietic acid, the presence of a small quantity of which could cause thickening. Completely etherified resins did not give rise to this phenomena. In copal varnish mixed with zinc white or litharge, thickening was caused in a similar way by the free acids of the copals. If gum kauri was etherified with glycerin a neutral resin was obtained which would yield a varnish free from thickening. The free acids were also an important factor. Despite adverse criticisms the speaker still held that the simple formation of lead resinate was insufficient to explain the thickening.

THE DYESTUFFS INDUSTRY IN FRANCE

This industry has continued to develop, the total production having risen from 7056 metric tons in 1920 to 5869 t. in 1921, 8067 t. in 1922, and 10,000 t. in 1923, compared with imports of 5888 t. in 1920, 1148 t. in 1921, 1797 t. in 1922, and 1371 t. in 1923. It thus appears that imports, which represented over 83 per cent. of the production in 1920, corresponded in 1923 to no more than 12 per cent. of the production. The Swiss factory at St. Fols produces roughly 2500 t. annually, an amount not included in the statistics of production. In 1923 France actually imported only 9 per cent. of its effective consumption. On examining the production of dyestuffs it is seen that azo dyes represent 40 per cent. of the total output, with 5124 t. produced, against 444 t. imported. Indigo and its derivatives constitute 24 per cent. of the total, 2132 t. being produced in 1923 and 4 t. imported, whilst sulphur dyes (16 per cent. of the total) represent the production in 1923 of 2279 t., against an import of 58 t. Similar progress has been made in the alizarin, oxyquinone, indophenol, oxazine and thyazine colours. Much progress, however, remains to be made in the commercial production of the vat dyes, which are still imported to a large extent from abroad.

CORRESPONDENCE

THE SCIENCE OF BAKING

Sir,—I trust you will allow me space in your journal for a few remarks anent the recent contribution of the Rev B. V White The reference to one Captain Wimperis, formerly a baker in Boulogne, set me wondering and enquiring Briefly, the result of my enquiries has been to bring to light one Wimperis, who acknowledges to being a dauber, and another who is a word manipulator by profession, but no one of that name, though the Directory mentions several, will admit to having been a dough-thumper Seeing therefore that there was some doubt in the Rev. White's mind whether the Captain's name *was* Wimperis, I have ventured to think that I might be the gentleman to whom he wished to allude. In any case, I am anxious that you should tolerate this incursion on your space to enable me to congratulate the Rev White on his careful and accurate observations of the chemical actions involved in the art and science of bread-making. I shall be grateful to anyone who can put me into communication with this student, nay professor, of what he himself terms "natural knowledge" To come to the case for the scientific study of the processes of bread-making, I have frequently met with the objection that such investigation would result finally in a chemical concoction that would be passed off as bread upon a less suspecting public than that which consumes chemist-controlled beer. So far as beer is concerned I have little knowledge, but I have noticed, as the Rev. White would say, that experts on beer and milk invariably choose the former beverage and do not seem to fear the danger of poisoning. There is, however, no necessity for a chemical-laden loaf to be produced from scientific management of the bakery, which is all that need arise from the results of the investigation.

Though bread-making is one of the most ancient of industries, it has but very recently become one capable of being carried out on the factory scale, and is even now without a scientific foundation Mass production, especially of such an article as bread, demanding close attention to temperature and fermentation conditions and time factors as well as a recognised standard of public taste, necessitates first an intimate knowledge of "what happens," and secondly, a sound knowledge of the various component parts, all of which in the case of bread are necessarily variable in composition

Nor is analytical knowledge by itself sufficient for the manager if regular good bread of standard excellence is to be produced on the factory scale. It would appear that the physical state of the ingredients and doughs in each process of manufacture (and there are many) is of far more importance. Hence it is that a plea is here made for a study of bread-making from the colloid point of view I have had to sit by and watch several Colleges and Industrial Laboratories in the United States and Germany making considerable headway in this study without being able to interest more than half a dozen persons on the subject on this side. Manchester has certainly made a start, and there is one student at the Borough Polytechnic London, who is looking into the matter. And there as far as I know, the study ends. The engineering side of a continuous and automatic plant for the manufacture of bread is even more important than the scientific study of doughs, and it is interesting to note that America, where such plants are common buys 90 per cent., if not all, of its continuous and automatic bread bakeries from a British engineering firm that has specialised in this form of machinery The only completely continuous and automatic bread bakery that I know in this country can be seen at Wembley Exhibition, whilst there must be hundreds in the United States of America.

The baking of bread is not one iota less worthy of scientific study than the manufacture of dyes—there is more in bread than meets the eye.

With apologies for taking so much of your valuable space, I remain, yours, etc.,

R. WHYMPER

THE BRITISH ASSOCIATION OF CHEMISTS

Sir,—In your issue of the 9th inst. is an account of a deputation from the Federal Council to the Board of Trade, in which Sir William Pope is reported as saying that "the Federal Council consisted of representatives of the Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, and all the other organisations connected with English chemistry."

My Council desires to point out that the British Association of Chemists, though having no part at present in the Federal Council, represents an important section of the chemists of the country, more particularly technical chemists interested in the manufacture and use of dyestuffs, and took the earliest possible opportunity of placing its views on the proposed Dyestuffs Agreement before the President of the Board of Trade. A report of the Deputation is to be found in your issue of March 7. and a comparison of the two reports shows a considerable similarity between the views of the two deputations.—I am, Sir, etc.,

I. BOODSON,
General Secretary, British
Association of Chemists

Bedford House,
108, Baker Street, W. 1
May 20, 1924

THE ENGLISH LANGUAGE

Sir,—In reference to recent correspondence in the *Journal* on the above subject, Mr. T. A. Rickard, author of "Technical Writing," was, to the best of my knowledge, born of English parents and received his technical education at the Royal School of Mines London, He has, I believe, only recently become an American citizen.

I do not wish to take up your space, but I think you may be glad of the information.—I am, Sir, etc.,

HUGH F. K. PICARD

44, London Wall. E.C. 2
May 23, 1924

THE ENGLISH LANGUAGE

Sir,—May a humble, pedantic but otherwise harmless, reader of *Chemistry and Industry* offer a little criticism of your editorial and Mr. Allen's letter? First, you would have us believe that you do not know whether it is difficult to write well, because you have never attempted it. Are we then to assume that it is possible to achieve what one has never attempted, or that the rapture of—I forget what character of Molière's, who had written prose all his life without knowing it—is still in store for you?

Mr. Allen is a brother and his letter warmed one's heart. But if there is any splitting of hairs to be done, let me, too, be among the splitters. Consider this quotation from his soul's outpouring:—

"The use of etc., although common and accepted as 'good English,' . . ."

To a purist this sentence is meaningless. What Mr. Allen wished us to read may have been:—

"The use of 'etc.,' although common . . ."

but without the inverted commas his criticism lacks precision. It is also inaccurate. A corrupt Latin abbreviation may be allowable in writing English, but, not itself being English, cannot be accepted as 'good English."—I am, Sir,

[here follows the customary method of concluding letters to the Press, usually abbreviated in a manner hateful to the Precise]

London, S.W. 1 PEDANT

May 26, 1924

THE GERMAN STANDPOINT

Sir,—The various communications in Nos. 16, 17, 18 of your esteemed *Journal* which are concerned with the re-establishment of peace compel me to write you once again.

Prof. Noyes' letter forms a welcome starting-point. One can recognise in it with satisfaction the honest intention to judge the matter from a non-party point of view, and must agree that he succeeds to a certain extent. True, he has not remained immune from the poisonous activity of the anti-German Press, which remains silent over essential facts or turns them into the contrary. In this manner, the foundation on which he builds (*i.e.*, the question of responsibility for starting the war) is shifted to a place to which it does not belong. Prof. Noyes is apparently of opinion that the World War started with the German invasion of Belgium. Such is not the case. The War started with the devastation of East Prussia by the Russians, and the German nation took to arms and anticipated its western enemies only when it saw it would have to make an effort to stave off the fate to which it was destined by St. Petersburg and Paris. Long before the murders at Serajevo Russian troops had stood in close formation on the German frontier; they were prevented only with difficulty from committing too early an invasion of Germany (small detachments had already committed acts of war as early as June) because the army had been worked up to a fanatical hatred of Germany by the agitation connected with the visit of the French President to Kronstadt. Whether Germany sided with Austria in her quarrel with Serbia or remained neutral was immaterial as regards the attitude of Russia and France; the attack on Germany had been decided on, as shown by telegrams between Iswolski and Clemenceau, and was going to be carried out in any case. The march of the Germans into Belgium cannot therefore be put on the same basis as the Russian invasion of East Prussia; the former was a necessary act of war which finds its justification in Belgium's taking part in the Franco-Russian plot, the latter was a deliberate breaking of the peace for which Germany had given no cause. Nine-tenths of the German people would never have consented to war had it been possible to avoid it without sacrifice of national honour. This was no longer the case after Russia had already begun the war against Germany.

Only if the chronological sequence of events, which is beyond doubt, is made clear can a non-party judgment on the guilt of one side or the other be pronounced.

From the above facts it is at once evident that the political platform which Prof. Noyes puts forward is not acceptable to us Germans either. In that platform it is mentioned how Austria was guilty and how Germany was alleged to be guilty, but not a word is said about the guilt of the Allies. Their guilt in relation to Russia was, however, gigantic. Why have the Allies the right to interfere in a quarrel between Austria and Serbia, and to attack Germany before she had even decided whether or not she would fight on the Austrian side?

Apart from the fact that Germany would have to concede a wrong in accepting Prof. Noyes' platform, she has in addition to submit to the decision of a World Court in the matter of the occupation of the Ruhr and other German territory! What is this World Court? It is France for the time being, for she has the power to which the other countries bow. What sort of decision this World Court would arrive at can be anticipated from its attitude in Upper Silesia and Memel. We have already been deceived twice by this World Court, and are again asked confidently to put our trust in its hands. One cannot expect a person who has been attacked, plundered and several times deceived to have any more faith in the world.

I more than doubt whether Prof Noyes is right in the assumption that the French oppose the admission of Germany to the League of Nations because they are suspicious of an attack on the part of Germany. That would not be a sufficient reason, even if the idea were not so absurd as it is at the present time. Even the most timorous Frenchman cannot suppose that the Germans would attack the French at the meetings of the League! It seems to me much more likely that it is their bad conscience which urges the French to obtain a confession of guilt on the part of Germany. It is quite clear that the World War was the fruit of forty years' agitation, kept up by the leading French politicians from the time of the last Franco-German War.

The question may be raised as to whether Germany was altogether innocent of causing the War. She was not, but her guilt was passive, not active. The

German Government, since the resignation of Bismarck, had convinced its enemies by its vacillating policy that now was the time to get even with Germany—the *parvenu* amongst European nations. That William II., in spite of occasional sabre-rattling, never contemplated an offensive war is clear to all our enemies. One may think as one likes about the man himself, but it must be conceded, in full justice, that he was always ready for peace; this he has proved more than once and even at the price of the dignity of the Empire. The guilt of the German Government is, therefore, the guilt of a man able to secure his house against burglars but unwilling to do so, thereby giving malefactors their opportunity. Hence the German people have the right to bring their late rulers to account but their enemies have not.—I am, Sir, etc., DR. P. FRITZSCHE

Leipzig.

May 25, 1924

PERSONAL AND OTHER ITEMS

Prof. H. B. Dixon has been elected president of the Manchester Literary and Philosophical Society.

The honorary degree of LL.D. will be conferred on Prof. F. Gowland Hopkins, F.R.S., and Emeritus Prof. Frankland, at the Degree Congregation of the University of Birmingham, on July 5.

The Franklin Institute of Philadelphia has presented, through the British Embassy in Washington, the Franklin medal and certificate to Prof. Sir Ernest Rutherford, F.R.S., in recognition of his researches in radio-activity.

It is announced that Mr. J. B. Coleman will retire shortly from his post as head of the chemical department of the Chelsea Polytechnic.

Mr. J. B. Speakman, M.Sc., has been appointed lecturer in textile chemistry in the University of Leeds, in place of Mr. E. A. Fisher, M.A.

Sir Charles Parsons has been re-elected president of the Institute of Physics for the forthcoming year.

Prof. J. C. McLennan, of Toronto University, has been elected president of the Royal Society of Canada.

Mr. B. Mead, a graduate of the Imperial College of Science and Technology, London, has joined the staff of the Research Laboratory for Applied Chemistry in the Massachusetts Institute of Technology.

The degree of D.Sc. in chemistry of London University, has been conferred on Mr. S. Sugden, of Birkbeck College.

We regret to announce the death of Sir Milton Sharp, chairman of the Bradford Dyers' Association. Sir Milton Sharp possessed a wide knowledge of the dyeing industry, both in this country and abroad, and during the war he rendered valuable service as a member of the committee on the manufacture of high explosives.

The death of Mr. John Sterry in Australia marks the passing of a well-known photographic experimenter. Mr. Sterry was the author of much work on the properties of the latent image, work for which he received the Progress Medal of the Royal Photographic Society in 1908.

Chemical Workers' Wages

The claim of the chemical trade workers for another penny an hour for day workers and three-halfpence for shift workers, and for week-end work to be paid at double instead of time and a half, has been heard in the Industrial Court. The Chemical Trades Joint Industrial Council, for the workers, claimed that the present wage was inadequate, discussed reductions in wages during the last two or three years, and suggested that the industry was financially able to meet the claim. For the employers, Mr. Lloyd Roberts, of Messrs. Brunner, Mond and Co., opposed the claim on the ground that concession of the claim would endanger the stability of the chemical industry and would react unfavourably on other industries. In addition, he said that foreign competition was severe, the employers were responsible to the shareholders and consumers as well as to the workpeople, and the existing rates of pay were reasonable. He also stated that if existing plant were employed to capacity 34,000 workpeople could be employed as against the 22,000 at present employed and covered by the claim. The award will be announced shortly.

Denatured Spirit

The Commissioners of Customs and Excise have given notice that all mineralised spirits made on and after May 1 must consist of:—90 per cent. plain British spirits, or unsweetened foreign spirits or rum; 9·5 per cent. methyl alcohol; and 0·5 per cent. crude pyridine; and must contain, in addition, 0·375 per cent. by volume of approved mineral naphtha or petroleum oil, and not less than 0·025 of an ounce of aniline dye (methyl violet) for each 100 gallons of spirits. Further regulations lay down specifications for the crude pyridine to be used, and require the provision of a tank of a minimum capacity of 10 gallons for storing the pyridine. In all other respects, the law and regulations governing the making of methylated spirits remain unchanged.

Chemical Warfare in Russia

According to the *Times* of May 22, a "Chemical Defence League" has been formed in Russia to organise the "fourth fighting service," to be known as the "Dobrokhim" (a word derived from the name "chemical volunteers)." The Soviet press states that the other fighting services will merely be mediums to bring the "Dobrokhim" in touch with the enemy.

New Italian Technical Journal

Under the title of "Revista Technica delle fermentazioni," Prof. G. Mezzadroli, of Bologna, has founded a review devoted to the scientific study of the fermentation industry, including the wine-making, distillation, beer, acetic acid, casein and cheese, retting and related industries. The yearly subscription is 30 lire, and the editorial secretary is Dr. G. Marenduzzo, Bologna (18), Via Toscana 301

The Kent Coalfield

The formal initiation of the sinking of a shaft at the Betteshanger colliery on May 20 marked an important step in the development of the Kent coalfield. According to *The Times*, this pit is the first of a series projected by Messrs. S. Pearson and Dorman Long, Ltd., who have acquired the mineral rights under, roughly, 60 of the 80 square miles in Kent, in which borings and sinkings indicate the existence of 1500 million tons of coal in seams 3 to 9 ft. thick at depths from 400 to 1000 yards.

REVIEWS

Oils, Fats, Waxes and Resins. By E. R. Bolton and R. G. Pelly. With a foreword by H.R.H. The Prince of Wales, K.G., and General Introductions by the Rt. Hon. Sir E. Geddes, G.C.B., and J. H. Batty. Pp. 275. London: E. Benn, Ltd., 1924. Price 21s.

Of the twelve volumes which are to constitute the Resources of the Empire series it is probable that none will be more useful to its own particular public than that now issued under the above title. Few only of those engaged in the various industries concerned with the preparation, refining and utilising of oils have more than a vague idea of their magnitude in the aggregate, and certainly the user of the finished products has little knowledge of their enormous importance as items of imperial commerce. The civilised and accessible parts of the Empire furnish oil-bearing seeds and prepared fats in quantities amounting to millions of tons, whilst the arctic circles are penetrated for supplies of whale and similar oils, and the virgin forests of our tropical colonies are made to yield their supplies of palm and many other oils. It is obviously impossible for the authors to have compressed into the space of a book of less than 300 pages all that is known about the various oils, fats, waxes and resins, but recognising the purpose of the series they have wisely restricted themselves to a statement of the outstanding characteristics, both technical and commercial, of the important articles of commerce which can be included under the very comprehensive title chosen for their volume.

The earlier pages are taken up by a brief, but nevertheless lucid, statement of the manufacture and refining of the various oils and fats, their physical and chemical characteristics being so summarised that the basis of the commercial valuation of the raw or finished products is readily understood.

From the succeeding pages, in which individual materials are dealt with, much is to be learnt of their origin and preliminary treatment. Indications are also given as to how supplies may be increased, but these are not given without a full and reasoned statement of the pitfalls that lie in the way of the unwary, especially those who have little realisation of the need for marketing to best advantage by-products as well as prime materials.

An important part of the volume is the summarised statement of the trade of the Empire, which is remarkably comprehensive and of the greater value in that mere statistics are relieved by comments, *e.g.*, on local conditions, which cannot fail to be of value to commercial men.

This is essentially a business man's encyclopædia, and must be of the greatest value to everyone connected with the industries with which it deals.

J. Allan

Clouds and Smokes: The Properties of Disperse Systems in Gases and their Practical Applications. By W. E. Gibbs, D.Sc. Pp. xiii + 240. London: J. and A. Churchill, 1924. Price 10s. 6d.

All chemists and technologists, and many other individuals, will find much of utility and interest in the volume on "Clouds and Smokes" by Dr. Gibbs. The author has produced within a comparatively small compass a very complete treatise upon disperse systems in which a solid or liquid substance is dispersed in gas-systems and termed by the author "Aerosols."

The book is divided into two parts, the first of which is mainly theoretical, whilst the second deals with the various practical aspects of the subject. The extent of the topics dealt with by the author is very wide, and includes industrial treatment of fumes and dusty gases, dust explosions, meteorological phenomena, the preparation of metallic powders, the production of metallic coatings, spray evaporation, and also the use of smoke in warfare.

The utility of the book is enhanced by a very complete bibliography which is included at the end of every chapter; in addition to this, the book is provided with a subject and name index.

There are a few misprints, as, for example, on page 1, in which the velocity of gaseous molecules is stated to be 10·4 cm. per second. This error is repeated again on page 41. On page 24 the statement is made that: "The presence of an electrical charge on the surface of a liquid opposes the surface tension and, therefore, diminishes the vapour pressure to an extent that is proportional to the fourth power of the drop." This is a loose statement which should be corrected in subsequent editions.

It is, of course, impossible for any author to be fully conversant with the large variety of topics which are dealt with and discussed in the volume, and the reviewer is not in agreement with all the statements made in the chapter upon the use of smoke in warfare. The major part of this chapter appears to be derived from the publication by Fries and West on Chemical Warfare. This gives the American viewpoint, which was not always in accord with the British. For example, the reviewer is very much inclined to doubt the formation of a true smoke from a mixture of chlorpicrin and phosgene as stated on page 230. Any liquid particles produced from this mixture are at best present for a very short period only, and this mixture behaves as a toxic gas and not as a smoke in the commonly accepted sense of the term.

L. Levy

COMPANY NEWS

CANADIAN CONSOLIDATED RUBBER CO., LTD.

The financial statement of the Canadian Consolidated Rubber Co., Ltd., shows that the net sales for the past year amounted to $14,590,433 as compared with $13,221,575 the previous year. Net income was $906,044 as compared with $132,262 in 1922 and $90,336 in 1921. Current assets on December 31, 1923, totalled nearly $7,000,000, while current liabilities were slightly over $550,000 as compared with $1,082,114 in the previous year. Bills payable were reduced from $459,000 to $7,000, while loans payable of $105,000 were entirely eliminated. After payment of preferred dividends the surplus for the year amounted to $696,044, equal to 24·81 per cent. on the $2,805,000 of common stock which is comparable with a deficit of $781,876 in 1922, and a deficit of $1,935,495 in 1921.

ROSARIO NITRATE CO., LTD.

The directors propose to pay a final dividend of 6 per cent., less tax, making 11 per cent., less tax, for the year, and to carry forward £29,179. This profit is arrived at after setting aside for depreciation £19,672 to cover the estimated value of raw material extracted from the grounds, and also for depreciation of plant and machinery. Oficina "Rosario de Huara" worked throughout the year; "Argentina" is being entirely reconstructed; and "Pintilla" is being dismantled. The previous accounting period was for 15 months to December 31, 1922, when the net profit was £25,966 and the dividend was 10 per cent., free of tax.

In 1923 the profit was £51,303, and £28,614 was brought forward.

FORTH GLASS WORKS

An extraordinary meeting has been called to discuss a resolution for the voluntary winding-up of this company, which was formed in 1920 in Glasgow with a capital of £60,000, of which £45,000 was issued in £1 shares. For last year the working showed an adverse balance of £12,630.

AGUAS BLANCAS NITRATE CO., LTD.

The net profit for 1923 was £21,330, to which is added £27,141, making £48,471 available. It was decided to distribute a final dividend of 50 per cent., less income tax, making 75 per cent for the year, and to carry forward £8,753. The company's oficina is working nearly at full capacity.

ANGELA NITRATE CO., LTD.

The accounts for 1923 show a net profit of £24,498 (£1071 in 1922), and a further dividend of 15 per cent. is proposed, making a total of 25 per cent. for the year (against 10 per cent.). £3350 is placed to amortisation of grounds reserve, leaving a balance (including £1005 brought in) of £4652 to be carried forward, subject to corporation tax. Profit has been taken on 123,698 metric quintals (22,452 metric quintals in 1922).

BRUNNER, MOND & CO., LTD.

At the annual general meeting on May 23, Mr. Roscoe Brunner, who presided, first referred to the death of Mr. A. Travers Hawes, an old director of the Castner Kellner Alkali Co., who joined the board in 1916. In discussing the balance-sheet (*cf. Chem. and Ind.*, May 23, p. 496), Mr. Roscoe Brunner said that sums advanced to subsidiary companies—Synthetic Ammonia and Nitrates, Ltd., and the Buxton Lime Firms, Ltd.—now appeared, not as debts owing, but as investments, an item which thus was increased by £1,140,000; debts owing were reduced by £1,639,000, and cash at bank was up by £537,000. The sum of £186,000 had been written off suspense account, which was used to keep the plant up to date, and £200,000 had been added to depreciation account. Judging from all indications, the outlook could be considered with confidence. The loss of £25,000 in the Japanese earthquake was suffered by the Japanese company, but increased trade promised to cancel the loss. It was not yet possible to say when the new Wallerscote works would begin to produce, but the works would be the "best in the world." Synthetic Ammonia and Nitrates, Ltd., began to produce in December, and the process was working so well that work was in hand for extending the plant and for the production of ammonia salts other than the sulphate, a salt which had met with great favour. The company's proposals for the reconstruction of the Magadi Soda Co. were still under consideration. Taxation was still too heavy, and the workers were asking for increased wages. Given relief from taxation, freedom from strikes, and more stiffness towards demands for higher wages, there would be an improvement in trade that would allow industry to pay those higher wages that would increase both consumption and trade.

Sir Alfred Mond, commenting on the reduced dividend, said the directors were conserving out of profits a large amount so that their great business might be maintained on sound lines. He then paid a high tribute to the staff of the Synthetic Ammonia works for overcoming the technical difficulties of the process in so short a time, an achievement which was also praised by Sir John Brunner.

The report and accounts were adopted, and the six retiring directors—Sir J. Brunner, and Messrs. A. Colegate, H. Glendinning, J. H. Gold, C. F. Poole and L. Solvay—were re-elected.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Geological Museum

Replying to Sir John Brunner, Mr. Trevelyan said that he was aware of the fact that the Geological Museum was overcrowded. Steps were being taken to put the Museum into constructional and decorative repair, but the Board of Education and the Committee of the Privy Council for Scientific and Industrial Research intended in due course to reconsider the Bell Committee's Report, which proposed to house the Geological Museum on a site near to the collections

of the Natural History and Science Museums.—(May 15.)

British Dyestuffs Corporation, Ltd.

In a written answer to Mr. Black, Mr. Webb stated that no reparation dyestuffs had been sold to the British Dyestuffs Corporation for re-working or disposal, with the exception of a certain quantity of indigo requisitioned under a special arrangement which was in operation for a short time between the Board of Trade, the principal consumers of indigo in the textile trades, and the Corporation. The prices charged for reparation dyestuffs were fixed by the Board of Trade from time to time with the help of an informal committee consisting of two representatives of the Colour Users' Association, and two representatives of the British Dyestuffs Corporation as the Board's agents. The supplies of dyestuffs were requisitioned by the Board after consultation with representatives of the British makers and of the consumers, and had been confined, so far as practicable, to products not competitive with British products. The amount paid to the British Dyestuffs Corporation in the year ended March 31, 1924, for commission and all other charges was £40,070, representing commission on sales during the year amounting to £343,600, and not on the value of dyestuffs received, together with certain expenses chargeable to the Board of Trade.—(May 20.)

Safeguarding of Industries Act

Replying to Mr. D. G. Somerville, Mr. Webb said that the operation of the depreciated currency provisions of Part II of the Safeguarding of Industries Act was specially limited to three years, and could not be continued after August 19 next without fresh legislation. The decision not to introduce such legislation was taken by the Government after full consideration of all the circumstances, and he did not feel that an inquiry into the anticipated effect of the cessation of these provisions, on the expiry of the period for which they were enacted, would serve any useful purpose.

In answer to Mr. Kean Mr. Alexander replied that he could not give details of an individual works, but he was informed that the number of persons employed in making arc-lamp carbons in April of this year was approximately double that of April, 1921. The output of the factory included various types of carbons which were not covered by the Safeguarding of Industries Act.—(May 20.)

The 1851 Exhibition (Surplus Income)

Replying to Sir F. Hall, Mr Graham said that the Commissioners of the Exhibition of 1851 possess, as a result of judicious investment of the original surplus funds of that exhibition, an estate now valued at approximately £500,000, with a net income of over £20,000. This income was entirely devoted to scholarships and grants to research students, nearly half of which are allocated to research students from overseas and to industrial bursaries. The Commissioners had no objection to their accounts for the year ending December 31, 1923, being laid before Parliament with a memorandum explanatory of the activities of the Royal Commission past and present. This would accordingly be done.—(May 26.)

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40%, tech. ..	£23 10s. per ton.
Acid Hydrochloric ..	3s. 6d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£19 10s.—£27 per ton makers' works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	£6 15s. per ton, spot, delivery.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¾d. per lb.
Potass. Chlorate	3d.—4d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£3 10s. per ton d/d.
Soda Caustic ..	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton carr. paid.
Sod. Bichromate.. ..	4½d. per lb.
Sod. Bisulphite Powder 60/62%..	£18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £14 10s. per ton. d/d
Sod. Sulphide cryst. ..	£9 per ton d/d.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide—	
Golden	5¾d.—1s. 4d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Barytes	£3 10s. to £6 15s. per ton, according to quality.
Cadmium Sulphide ..	3s. 9d. per lb.
Carbon Bisulphide ..	£24—£26 per ton according to quantity.
Carbon Black	6¼d.—6¾d. per lb. Market firmer.
Carbon Tetrachloride ..	£56 per ton, drums free.

Chromium Oxide, green ..	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4¾d.—6½d. per lb. Demand very brisk. Prices likely to remain steady owing to firmness of rapeseed oils.
Lamp Black	43s. 6d. per cwt., barrels free.
Lead Hyposulphite ..	7¼d. per lb.
Lithopone, 30%	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Sulphur Chloride ..	3d. per lb., carboys extra.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep ..	5s. 1d. per lb. Much dearer, following rise in quicksilver.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19—£20 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s.—5s. 3d. per gall. 60% O.P. market stiffer.
Solvent	5s. 6d.—6s. per gall. 40% O.P. Fairly good demand but little offering.
Wood Tar	£5 per ton.
Brown Sugar of Lead ..	£49 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	6½d.—7d. per lb. Better inquiry at reduced price.
Crude 60's	1s. 9d.—1s. 10d per gall. Market rather flat.
Acid Cresylic, 97/99 ..	2s. 1d.—2s 2d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—1s. 11d. per gall. Steady demand.
Dark	1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40% ..	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	9½d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor ..	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole 90%	1s 5½d. per gall.
Pure .. .	1s 10d.—2s. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s 3d. per gall.
Creosote—	
Cresylic 20/24% ..	9d.—9½d. per gall. Few inquiries.
Middle Oil .. / Heavy .. .. / Standard Specification	7½d.—9d. per gall. according to grade and district. Fair demand.
Naphtha—	
Crude	8d.—9d. per gall. Market not quite so firm.
Solvent 90/160 ..	1s. 4d.—1s. 5d. Market not quite so firm.
Solvent 90/190 ..	1s. 2d.—1s. 3d. Market not quite so firm.
Naphthalene Crude—	
Drained Creosote Salts	£6—£6 10s. Demand falling off.
Whizzed or hot pressed	£9—£12 per ton More inquiry.
Naphthalene—	
Crystals and Flaked ..	£17—£18 per ton.
Pitch, medium soft ..	52s. 6d.—57s. 6d. per ton. Market steadier. Few inquiries for forward delivery. Very little business for prompt.
Pyridine—90/160 ..	21s. 6d.—22s. per gall. Demand well maintained.
Heavy ..	12s.—12s. 6d. More business passing.

INTERMEDIATES AND DYES

Business in dyestuffs has improved slightly during the week.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% ..	1s. 6d. per lb.
Acid H.	4s. 4d. per lb. 100% basis d/d.
Acid Naphthionic ..	2s. 4d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 8d. per lb. 100% basis d/d.
Acid Salicylic, tech. ..	1s. 2d.—1s. 3d. per lb. Steady demand.
Acid Sulphanilic ..	10d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% ..	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C. ..	4¾d.—5½d. per lb. Demand moderate.
m-Cresol 98/100% ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. ..	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid ..	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	5s. per lb. d/d., packages extra, returnable.
Dimethyaniline	2s. 4d per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol ..	£84 10s. per ton d/d.
Dinitrotoluene—48/50°C.	8d.—9d. per lb. naked at works.
66/68°C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. per lb. d/d.
Monochlorbenzol	£63 per ton.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine ..	1s. 4½d. per lb. d/d.
β-Naphthylamine ..	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5½d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol ..	2s. per lb. 100% basis d/d.
Nitronaphthalene ..	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine ..	4s. 2d. per lb. d/d.
p-Phenylene Diamine ..	10s. 4d. per lb. 100% basis d/d.
R. Salt	2s. 5d. per lb. 100% basis d/d.
Sodium Naphthionate ..	2s. 6d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.

p-Toluidine ..	.. 3s. 6d. per lb. naked at works.
m-Toluylene Diamine	.. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £49 per ton.
Acid, Acetyl Salicylic	.. 3s. 3d.—3s. 5d. per lb. In good demand.
Acid, Benzoic B.P.	.. 3s. 9d. per lb. Larger supplies available.
Acid, Boric B.P.	.. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric ..	.. 19s.—21s. per lb.
Acid, Citric ..	.. 1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic ..	.. 3s. per lb. for pure crystal. Market very steady.
Acid, Pyrogallic, Cryst.	.. 7s. per lb. for 1 cwt. lots. Market firm; increasing demand.
Acid, Salicylic ..	.. Prices quoted from 2s. 2d. per lb. down to 1s. 11d. for ton lots.
Acid, Tannic B.P.	.. 3s. per lb. Market quiet.
Acid, Tartaric ..	.. 1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 2s. 3d. per lb. for quantity. Stocks are small.
Amidopyrin ..	.. 13s. 6d per lb. Neglected. Stocks low.
Ammon. Benzoate	.. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	.. 12s. per oz. for English make.
Barbitone	.. 15s. 6d. per lb. Quiet market.
Benzonaphthol ..	.. 5s. 6d. per lb. Small inquiry.
Bismuth Salts ..	.. A steady market. Prices according to quantity:
Bismuth Carbonate	.. 12s. 9d.—14s. 9d. per lb.
„ Citrate ..	.. 11s. 4d.—13s. 4d. „
„ Salicylate	.. 10s. 2d.—12s. 2d. „
„ Subnitrate	.. 10s. 9d.—12s. 9d. „
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides	.. Prices advanced. Raw material much dearer. Higher prices expected when present stocks of foreign material are cleared.
Potassium ..	.. 11d. per lb.
Sodium ..	.. 1s. „
Ammonium ..	.. 1s. 1d. per lb.
Calcium Lactate	.. Demand not very active. Good English make can be had from 1s. 7d. to 2s. 6d. per lb.
Chloral Hydrate ..	.. 3s. 7d. per lb., duty paid.
Chloroform ..	.. 2s. per lb. for cwt. lots. Market more active. Makers busy.
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Formaldehyde ..	.. £57 per ton, ex works. English make.
Glycerophosphates —	Fair business passing
Calcium, soluble and citrate free ..	.. 7s. per lb.
Iron	.. 8s. 9d. per lb.
Magnesium ..	.. 9s „
Potassium, 50%	.. 3s. 6d. „
Sodium, 50% ..	.. 2s. 6d. „
Guaiacol Carbonate	.. 12s. per lb. for cwt. lots. Supplies not plentiful.
Hexamine ..	.. 3s. 6d. per lb. for English make. Imports cannot be made at this figure.
Homatropine Hydrobromide	.. 30s. per oz.
Hydroquinone ..	.. 4s. 3d. per lb. in cwt. lots. Foreign make.
Hypophosphites—	
Calcium ..	.. 3s. 6d. per lb., for 28-lb lots.
Potassium ..	.. 4s. 1d. per lb
Sodium	.. 4s. „
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £26 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	.. 62s. 6d. per lb.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials ..	.. Market rather flat, but prices unchanged.
Red oxide ..	.. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	.. 3s. 6d.—3s. 7d. „
White precip. ..	.. 4s. 7d.—4s. 8d. „
Calomel ..	.. 3s. 11d.—4s. „
Methyl Salicylate	.. 2s. 3d.—2s. 9d. per lb. for carboys. A slightly better market.
Metol	.. 11s. per lb. British make.
Paraformaldehyde	.. 3s. 6d. per lb., Better inquiry.
Paraldehyde ..	.. 1s. 4d.—1s. 6d. per lb. in free bottles and cases. Better demand.
Phenacetin ..	.. 6s. per lb. Somewhat cheaper.
Phenazone ..	.. 7s. 3d. per lb. for cwt. lots. Quiet.
Phenolphthalein ..	.. 6s. 9d.—7s. 3d. per lb. In more plentiful supply.
Potass. Bitartrate— 99/100% (Cream of Tartar) ..	.. 88s. per cwt, less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate ..	.. 1s. 8d.—2s. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	.. 7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate—	
B.P. Crystal ..	.. 8¾d.—9d. per lb. carriage paid.
Commercial ..	.. 8d.—8¼d. per lb. carriage paid.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 5s. 6d. per lb.
Saccharin	.. 63s. per lb., in 50-lb. lots.
Salol	.. 4s. per lb. Very quiet.
Silver proteinate	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	.. 2s. 6d. per lb. In steady demand for good qualities.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite— Photographic ..	.. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	.. 77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet

Sod. Salicylate ..	.. Market easier. Powder 2s. 4d.— 2s. 6d. per lb. Crystal at 2s. 6d.—2s. 8d. per lb. Flake 2s. 9d.—3s. per lb.
Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Thymol	.. 15s per lb. for good white crystal from ajowan seed. Very firm and scarce.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.		
Aubepine	.. 14s. 6d. per lb.		
Amyl Acetate ..	.. 2s. 9d.	,,	
Amyl Butyrate ..	.. 7s. 3d.	,,	
Amyl Salicylate ..	.. 3s. 3d.	,,	
Anethol (M.P. 21/22° C.)	4s. 6d.	,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d.	,,	
Benzyl Alcohol free from Chlorine ..	.. 3s. 3d.	,,	
Benzaldehyde free from Chlorine ..	.. 3s. 6d.	,,	
Benzyl Benzoate	.. 3s. 6d.	,,	
Cinnamic Aldehyde Natural.. ..	.. 15s. 6d.	,,	
Coumarin ..	.. 20s.	,,	
Citronellol ..	.. 16s.	,,	
Citral	.. 10s.	,,	
Ethyl Cinnamate	.. 15s.	,,	
Ethyl Phthalate ..	.. 3s. 3d.	,,	Reduced.
Eugenol	.. 11s.	,,	
Geraniol (Palmarosa)	.. 35s.	,,	
Geraniol	.. 11s.—18s. 6d. per lb.		
Heliotropine ..	.. 6s. 6d. per lb.		Reduced.
Iso Eugenol ..	.. 15s. 9d.	,,	
Linalol ex Bois de Rose	.. 28s. 6d.	,,	Reduced.
Linalyl Acetate ..	.. 28s. 6d.	,,	Reduced.
Methyl Anthranilate	.. 9s. 6d.	,,	
Methyl Benzoate	.. 6s.	,,	
Musk Ambrette ..	.. 48s. 6d.	,,	Reduced.
Musk Xylol ..	.. 16s. 6d.	,,	Reduced.
Nerolin	.. 4s.	,,	
Phenyl Ethyl Acetate	.. 12s. 6d.	,,	
Phenyl Ethyl Alcohol	.. 16s.	,,	
Rhodinol	.. 57s. 6d.	,,	
Safrol	.. 1s 10d.	,,	
Terpineol	.. 2s. 9d.	,,	
Vanillin	.. 25s. 3d.—26s. 6d. per lb.		

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 15s. 6d. per lb.		
Anise Oil	.. 3s. per lb.		
Bergamot Oil ..	.. 18s. 6d. per lb.		
Bourbon Geranium Oil	.. 36s. 6d	,,	Advanced.
Camphor Oil ..	.. 75s. per cwt.		
Cananga Oil, Java	.. 10s. 6d. per lb.		
Cinnamon Oil, Leaf	.. 6½d. per oz.		
Cassia Oil, 80/85%	.. 9s. 3d. per lb.		
Citronella Oil—			
Java 85/90% ..	.. 6s. per lb.		Again dearer.
Ceylon	.. 3s. 9d. per lb.		
Clove Oil	.. 7s. 6d.	,,	
Eucalyptus Oil 70/75%	.. 2s. 2d.	,,	
Lavender Oil—			
French 38/40% Esters	.. 57s. 6d. per lb.		
Lemon Oil ..	.. 3s. 2d. per lb.		
Lemongrass Oil ..	.. 3d. per oz.		
Orange Oil, Sweet	.. 13s. 9d. per lb.		
Otto of Rose Oil—			
Bulgarian ..	.. 27s. 6d. per oz.		
Anatolian ..	.. 23s. 6d. per oz.		
Palma Rosa Oil ..	.. 19s. per lb.		
Peppermint Oil—			
Wayne County	.. 21s. 6d. per lb.		
Japanese ..	.. 16s. 3d. per lb.		
Petitgrain Oil ..	.. 10s. per lb.		
Sandal Wood Oil—			
Mysore	.. 26s. 6d. per lb.		
Australian ..	.. 21s. per lb.		

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition not later than July 10th; they are on sale at 1s. each at the Patent Office Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, on June 5th.

I.—Applications

Atkinson, and Powdered Fuel Plant Co. 11,684. *See* II.

Griscom-Russell Co. Evaporator. 11,692. May 12. (U.S., 12.6.23.)

Hille, Procter, and Young. Pulverisation of substances. 12,160. May 17.

Pollak. Removing liquid medium from emulsion colloids. 12,033. May 15. (Austria, 22.6.23.)

Stern. Treating liquids with gases. 12,096. May 16.

Wilson and Young. Drying, dyeing, vulcanising, etc. 11,763. May 12.

I.—Complete Specifications Accepted

14,383 (1923). Allen and Co., Ltd., and Coles. Grinding or crushing mills. (215,595.)

2355 (1924). Koppers Coke Oven Co., Ltd. Apparatus for washing liquids with liquids. (210,774.)

II.—Applications

Atkinson, and Powdered Fuel Plant Co. Drying and pulverising coal. 11,684. May 12.

Chambrier, de. Process for recovery of crude oil. 12,132. May 16.

Donald. Drying peats etc. 11,884, 11,980. May 14 and 15.

Gelsenkirchener Bergwerks-Akt.-Ges. Abteilung Schalke. Process for obtaining light oils and gaseous constituents from distillation products. 11,950. May 14. (Ger., 16.5.23.)

Ges. fur Chemische Produktion, and Clemm. Manufacture of decolorising charcoal. 11,847. May 13. (Ger., 14.5.23.)

Humphreys and Glasgow, Ltd. (Fulweiler). 11,751. *See* XXIII.

Koppers. Coke ovens. 12,209. May 17. (Ger., 13.6.23.)

Misch. Gas-producer. 11,720. May 12.

Naamlooze Vennootschap Philips' Gloeilampenfabrieken. 11,753. *See* X.

Rider, and Woodall-Duckham, Ltd. Manufacture of water gas. 12,208. May 17.

Seigle. Liquid fuels. 12,021. May 15. (Fr., 19.5.23.)

Sulfrian. Production of combustible gases. 11,939. May 14

Tinker. Production of petrol. 12,207. May 17.

II.—Complete Specifications Accepted

444 (1923). Koppers Co. Regenerative retort oven batteries. (191,393.)

15,812 (1923). Withers (Vere n. Kolenmaatschappijen). Apparatus for refining or concentrating coal slimes and ores in accordance with the froth flotation process. (215,615.)

3,250 (1923). Ketterer. Recovery of carbon dioxide from waste gases and the like. (204,063.)

III.—Application

Moore. Purification of creosote oils etc. 12,179. May 17

IV.—Application

Farbwerke vorm. Meister, Lucius, u. Brüning. Manufacture of vat dyestuffs. 11,859. May 13. (Ger., 25.6.23.)

.—Applications

Bergen, van. Manufacture of viscose threads, films, etc. 11,775. May 13. (Holland, 15.5.23.)

Carpmael (Farbenfabriken vorm. F. Bayer und Co.). Process for protecting wool, fur, etc. from moth. 11,749. May 12.

Cross, and Viscose Development Co. Application of cellulose hydrates. 11,723. May 12.

Hands. Non-inflammable sheets etc. of cellulose. 12,173. May 17.

Silbermann. Production of pure cellulose fibres etc. 12,118. May 16.

.—Complete Specification Accepted

2112 (1923). British Celanese, Ltd. Manufacture or treatment of threads of artificial filaments. (215,417.)

I.—Application

Wilson and Young. 11,763. *See* I.

I.—Complete Specification Accepted

29,913 (1923). Callebaut and Blicquy. Hank-dyeing machine. (215,672.)

II.—Applications

Brunner, Mond and Co., Ltd. Process of making ammonium by catalysis. 11,655. May 12. (U.S., 12.5.23.)

Ges. fur Chemische Produktion, and Schmidt. Obtaining hydrochloric acid free from arsenic. 11,846. May 13. (Ger., 14.5.23.)

Humphreys and Glasgow, Ltd. (Fulweiler). 11,751. *See* XXIII.

Metal Traders Technical, Ltd. Process of concentrating sulphuric acid. 11,676. May 12. (Ger., 11.5.23.)

II.—Complete Specifications Accepted

1619 (1923). West and Jaques. Manufacture of ammonia compounds. (215,170.)

9405 (1923). Cassale. Synthetic production of ammonia. (19.,655.)

III.—Complete Specification Accepted

19,182 (1923). General Electric Co., Ltd. Production of transparent bodies from opaque substances, especially oxides. (211,824.)

X. Application

Bureau d'Organisation Economique, and Soc. Anon. de Ciments Français. Manufacture of cement. 12,058. May 16. (Fr., 9.4.24.)

X.—Complete Specification Accepted

3722 (1923). Naaml. Ve. noot. Glasfabriek "Leerdam." Process for preparing stone-like material. (201,880.)

X. Applications

Cothay. Gravity concentration of ores. 11,965. May 14.

Marks (Electro-Metallurgical Co.). Metal treating compositions. 11,737. May 12.

Naamlooze Vennootschap Philips' Gloeilampenfabrieken. Manufacture of tungsten filaments. 11,753. May 12. (Holland, 17.5.23.)

X. Complete Specifications Accepted

30,772 (1922). Coley. Reduction of ores, oxides, and the like. (215,400.)

5727 (1923). Jackson (Ossa). Treatment of copper ores. (215,139.)

6313 (1923). Benjamin. Furnaces for melting and casting. (21.,495.)

11,669 (1923). Parkes, Ltd., Sharpe, and Hartland. Grinding mills. (215,555.)

15,812 (1923). Withers (Vereen. Kolenmaatschappijen). *See* II.

16,057 (1923). Electro-Metallurgical Co. Heat treated chromium steel, and processes of making same. (210,388.)

18,009 (1923). General Electric Co., Ltd. Preparation of ductile wire of tungsten or the like. (209,025.)

XI.—Application

Banyay. Electric accumulators. 12,057. May 16.

XI.—Complete Specifications Accepted

5872 (1923). Heis and Jezler. Treating substances in an electric field. (194,293.)

31,979 (1923). Heis and Jezler. Treating substances in an electric field. (215,701.)

XII.—Application

Lever Bros., Ltd., and Tyrell. Manufacture of dry soap. 11,757. May 12.

XII.—Complete Specification Accepted

29,534 (1923). Soc. Anon. Acetoleum. Extracting oil from grains etc. by solvents. (207,542.)

XIII.—Complete Specification Accepted

25,274 (1923). Deutsche, Thorn, and "Amalith" Chemische Industrie Ges. Hardening products of condensation from phenols and aldehydes. (207,790.)

XIV.—Application

Wilson and Young. 11,763. *See* I.

XIV.—Complete Specification Accepted

3865 (1924). Naugatuck Chemical Co. Compounding of rubber and similar materials. (211,494.)

XVI.—Complete Specification Accepted

4270 (1923). Christensen. Production of fertilising-material. (215,463.)

XIX.—Applications

Braeutigam, and Weber A.-G. Disinfectant. 11,942. May 14. (Ger., 14.5.23.)

Ges. fur Chemische Produktion, and Deutsch. Elimination of iron from water. 11,845. May 13. (Ger., 14.5.23.)

XIX.—Complete Specifications Accepted

345 (1923). Fry. Disposal of industrial wastes. (215,410.)

3545 (1923). Agopian. Process for obtaining vitamines. (193,831.)

XX.—Application

Portratz. Production of isotonic solutions for treatment of infectious diseases. 11,728. May 12.

XXI.—Application

Christensen. Manufacture of multicolour screens. 11,963. May 14. (Ger., 1.6.23.)

XXIII. Applications

Cirio Co., Ltd. (Signorini). Apparatus for determining specific gravity etc. 11,857. May 13.

Humphreys and Glasgow, Ltd. (Fulweiler). Determination of hydrogen sulphide in gas. 11,751. May 12.

GENERAL NOTES

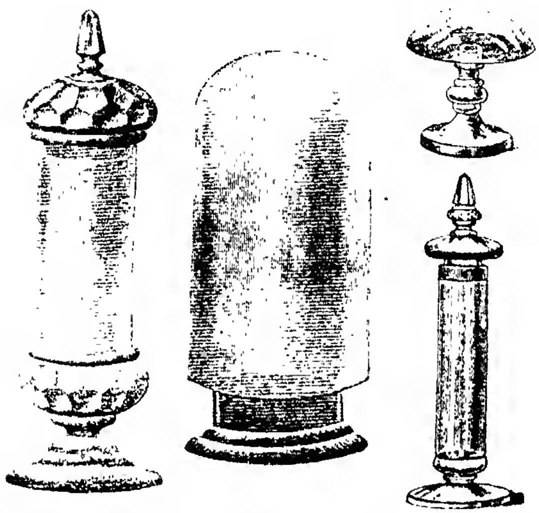
Official Trade Intelligence.

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department, and quoting the specific reference number:—*Canada*: Cutlery, crockery (581); *Finland*: Chemicals (589); Oils (590); *France*: Copra, groundnuts (593); Tinplate, sulphate of copper (594); *Germany*: Silk, electroplate (597); *Netherlands*: Copper sheets, enamelware and cutlery (604); *New Zealand*: Crockery (585); Microscopes (918/8/F.G./C.C./2); *Palestine*: Hardware (586); *Rumania*: Galvanised iron wire (13,120/F.E./E.C./2); *South Africa*: Iron (587); *Sweden*: Silk (607); *Turkey*: Skins (611); Leather, hides (612).

Trade Information

Photography has become so usual a feature of modern life that few pause to think of the scientific work that lies behind so much technical excellence. Of this excellence no little share is due to the efforts in deed and word of Burroughs Wellcome and Co., who have now added an excellent and artistic booklet entitled "Foresight in Photography" to their publications. On the cover is a reproduction of Commander Wild in the crow's nest of the "Quest," and this is ingeniously used throughout the booklet as a text to encourage the photographer to "look out" and exercise prevision in his work. A nautical flavour is pleasantly perceptible in the directions for the exposure, development and after-treatment of negatives by means of "Rytol" developer and other "Tabloid" photographic chemicals. An interesting feature is the inclusion of an illustration showing the effects of chromium intensification and of the possibilities of subsequent modification by treatment with reducers in various ways. A remarkably up-to-date table—it even includes the new Wellington "Spectrum" plate—is given showing plates and films grouped according to speed of development. One cannot but commend this advocate of sound methods to all photographers. Copies can be obtained free of charge from Burroughs Wellcome and Co., Snow Hill Buildings, London, E.C. 1.

Show Jars are products which are often rather neglected. It is occasionally forgotten that, whilst such a jar is primarily a container, it should also provide a suitable setting for its contents, and thus should be designed with thought for its esthetic effect. No such reproach can be levelled at the



show jars made by the Edinburgh and Leith Flint Glass Company, whose products, some of which are illustrated below, are brilliant in appearance and tasteful in design, as can be seen by those who visit the British Empire Exhibition.

Space is available to illustrate but a few of the products of the Edinburgh factory, whose output includes a wide variety of round and oval jars stoppered or with ground plate covers, inverted round, and conical bottles, cylindrical bottles with cut-glass stoppers, and other types to suit all purposes. The firm also supplies all types of chemical apparatus, such as resistance glass beakers and flasks, graduated measures, as well as microscope slides and cover glasses.

PUBLICATIONS RECEIVED

The Manufacture of Paint. By J. Cruickshank Smith, B.Sc. Third and enlarged edition. Pp. xvi+306. London: Scott, Greenwood and Son, 1924. Price 12s. 6d.

Chemistry for Dental Students. By H. Carlton Smith, Ph.G., and R. M. Smith, A.B. Vol. I, Qualitative Analysis and Dental Metallurgy, pp. vi+186, and Vol. II, Organic and Physiological Dental Chemistry, pp. iv+320. Fourth edition, revised and enlarged. London: Chapman and Hall, Ltd., 1923. Price Vol. I, 12s. 6d.; Vol. II, 17s. 6d.

Forty-eighth Annual Report of H.M. Inspectors of Explosives, being their Annual Report for the Year 1923. Explosives Acts, 1875 (38 Vict. c. 17) and 1923 (13 and 14 Geo. 5). Pp. 50. H.M. Stationery Office, 1924. Price 1s. net.

Report on the Commercial and Industrial Situation in Hungary, dated February, 1924. By R. J. E. Humphreys. Department of Overseas Trade. Pp. 18. H.M. Stationery Office, 1924. Price 1s. 6d.

Monthly Circular of Recent Selected Publications. No. 64. Pp. 20. H.M. Stationery Office, May, 1924.

Bulletin of the Cleveland Scientific and Technical Institution. Compiled by the Director and Secretary, E. L. Johnson. Vol. III. No. 7. Pp. 387–415. Middlesbrough. 1924.

Nitrogen Fixation. The Honorary Advisory Council for Scientific and Industrial Research. Bulletin No. 11. Pp. 28. Ottawa: F. A. Acland, 1924.

Publications of the Imperial Mineral Resources Bureau. The Mineral Industry of the British Empire and Foreign Countries. Statistics 1919–21. H.M. Stationery Office, 1924.—

Molybdenum. Pp. iv+8. Price 6d.

Potash Minerals. Pp. 48. Price 2s. 6d.

Vanadium. Pp. iv+5. Price 6d.

Publications of the United States Geological Survey, Department of the Interior. Washington: Government Printing Office, 1924:—

Natural Gas. By G. B. Richardson. No. II:31. Mineral Resources of the United States, 1922. Part II. Pp. 353–358.

Natural-Gas Gasoline in 1922. By G. B. Richardson. No. II:30. Mineral Resources of the United States, 1922. Part II. Pp. 317–351.

Sulphur and Pyrites in 1923. By H. M. Meyer. No. II:1. Mineral Resources of the United States, 1923. Part II. Pp. 1–6.

Summary of Technical Methods for the Utilization of Molasses, Collated from Patent Literature. Circular of the Bureau of Standards, No. 145. Department of Commerce. Pp. 72. Washington: Government Printing Office, 1924. Price 15 cents.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

Vol. 43 NEW SERIES LONDON, APRIL 4, 1924 No. 14

EDITORIAL

THE discussions on chemical co-operation which recently took place at various local sections of the Institute of Chemistry provide a number of useful ideas and suggestions. A good many of these depend on the acquisition of a Chemistry House and many formal and informal meetings are now being held to investigate the merits of particular schemes and particular sites. Some of the possibilities of co-operation are independent of the existence of a London mansion containing the headquarters of the various societies. Throughout Great Britain there are local sections of two or three distinct societies, each local section having a large committee, some honorary officials and meetings where interesting chemical communications are read. He would be an acute man, with a nice sense of discrimination, who could tell from reading a report of a local section paper whether it had been read before the Institute, the Society of Chemical Industry, the Institute of Metals or some other body. It would be a highly irregular proceeding for some ambitious local section to appoint one joint committee of two or three of these societies, with one joint honorary secretary, eight or ten joint meetings a year and some scheme of joint reporting, joint publication and sharing of expenses. We cannot conceive any well-drawn rules which would permit such a proceeding, and it would not only be irregular but undignified. But we are of opinion that, but for an unqualified respect for rules—the result of a training which some chemists consider almost criminal—we should, if actively engaged in the work of the Herefordshire local section, make the experiment, treating the consequences in the manner advocated by Lord Milner. Is there a local section of the Great and Little Cumbraes and the adjacent islands of Great Britain and Ireland?

* * *

The Referee's Award on the inclusion of "Rongalite," a formaldehyde sulphoxylate, in the Safeguarding of Industries Act, 1921, has now been published. The Award refers to an article which appeared in this Journal on pages 5, 117 and 169 last year, and the learned Referee has incidentally pointed out that the statement in the article that he decided that calcium carbide was not synthetic is wholly inaccurate. We know ourselves from bitter experience how easy it is to make such inaccurate statements and how fallacious is the memory as to quotations unless the wording be verified almost immediately beforehand. Wondering whether Sir William Pope or ourselves had made this slip and fearing the latter, we have refreshed our memory by reading again the article, and with humility and diffidence we suggest that the learned Referee himself is under some slight misapprehension. The whole tenor of the Calcium Carbide articles is an argument that calcium carbide is a synthetic organic chemical and that the Referee's decision that it was not so was inaccurate. It is true that Sir William Pope first showed that it was organic and went on to argue that calcium carbide is not only an organic chemical but is also a synthetic organic chemical. This we suppose was to satisfy our readers that it would not have been possible for the Referee had he considered calcium carbide to be organic to have excluded it on the ground that in any case it was not synthetic. A careful search through the article has failed to disclose a statement that the Referee decided that calcium carbide was not synthetic. It is interesting to notice that chemical terms are now for some purposes being defined by legal minds. All definitions of any value are rigid; it is frequently of no consequence that they are logical. If chemists do not frame their own definitions or adopt some unanimous views of the meaning of the words they employ, they lay themselves open to having definitions thrust upon them by lawyers. The Federal Council, which has hardly anything to do except trying to raise funds for Chemistry House, to select a suitable site, to foster co-operation between some bodies who have as yet only elementary ideas of it, to propound a satisfactory scheme for the dyestuffs industry here and to assist in preparing for the Copenhagen meeting, might profitably spend a week-end at Chequers or some other country house and frame

half-a-dozen definitions to start with. No definition of an "organic" chemical will satisfy everybody. A definition could be framed which would now satisfy 60 per cent. of the chemists of this country, and if this were adopted each year the percentage would slightly grow until the non-conformists would on analysis reveal merely "trace."

* * *

The letter from Mr. N. K. Smith, in a recent number of this *Journal*, on the subject of the review of a recently published book, raises some interesting and difficult points. If a book is in the opinion of the reviewer good, it is worth while devoting a certain amount of space to a discussion of it, and to the explanation of errors and doubtful passages. If the book is in the opinion of the reviewer bad, the space available for the review is necessarily restricted. If a number of errors be mentioned as instances, unless ample space is taken up, the result is unsatisfactory both to the author and the readers. In the particular case Mr. Smith refers to, the reviewer originally wrote a much longer and detailed review, and it was at the request of the editor that his review was curtailed and left in very general terms. If we had sufficient space, nothing would afford us and our readers greater satisfaction that the exposure of a number of errors, the true explanation of the facts and the proper deductions to be made therefrom. No one has read Macaulay's review of Croker's Boswell without enjoyment and profit, and most of our readers are no doubt familiar with this instance. But how much time and space is involved! The practice of this journal is to be careful in the choice of reviewers, to afford as much space as possible—too often inadequate—for a good book and less space for a book which does not attain that standard. Only in the case of good books is it worth while to point out errors, and even then not errors which are obvious to everyone who reads the book. We are expressing no opinion as to the particular book in question; we have not read it. From the opinion of the reviewer, it seemed to fall into the class of books for which we cannot afford a column for a review, and we accordingly invited the reviewer to curtail his observations, and we must ourselves be saddled with the blame, if any, for this proceeding.

* * *

Cynics may shake gloomy heads over the fact that the announcement of the "isolation of vitamins," by Dr. W. Eddy, of Columbia University, was made in the issue of the *Times* dated April 1. The statement runs that the "new material is proved to be definite, chemical and individual, . . . is crystalline, possesses a definite melting point of 233° C., and . . . behaves like [illegible] Further, it contains "43 per cent. [illegible] per cent. hydrogen, about 25 per cent. nit[illegible] 24 per cent. oxygen," and "is present [illegible] growing yeast in the proportion of one part in 40,000." Prof. Drummond will doubtless be pleased with the spelling of "vitamin," but we wonder what he thinks of this "definite, chemical and individual" body, with its approximate content of nitrogen and oxygen.

EVAPORATING AND DRYING PLANT

PART II

By S. G. URE, M.A., B.Sc., M.I.Chem.E.

The term drying is used, with few exceptions, in industrial work, to denote the removal of small quantities of liquid, usually water, from a substance or structure. The method by which this liquid is removed will naturally vary with the substance being treated. Drying may be effected either by chemical action, by adsorption, by mechanical means, or by the addition or removal of heat.

Chemical Action

When water is to be removed from a substance by chemical means, this may be done by effecting its decomposition by bringing it into contact with such

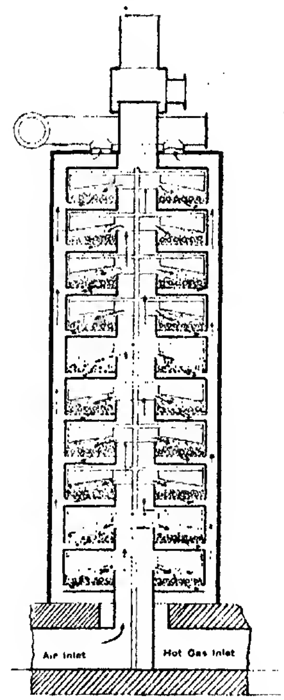


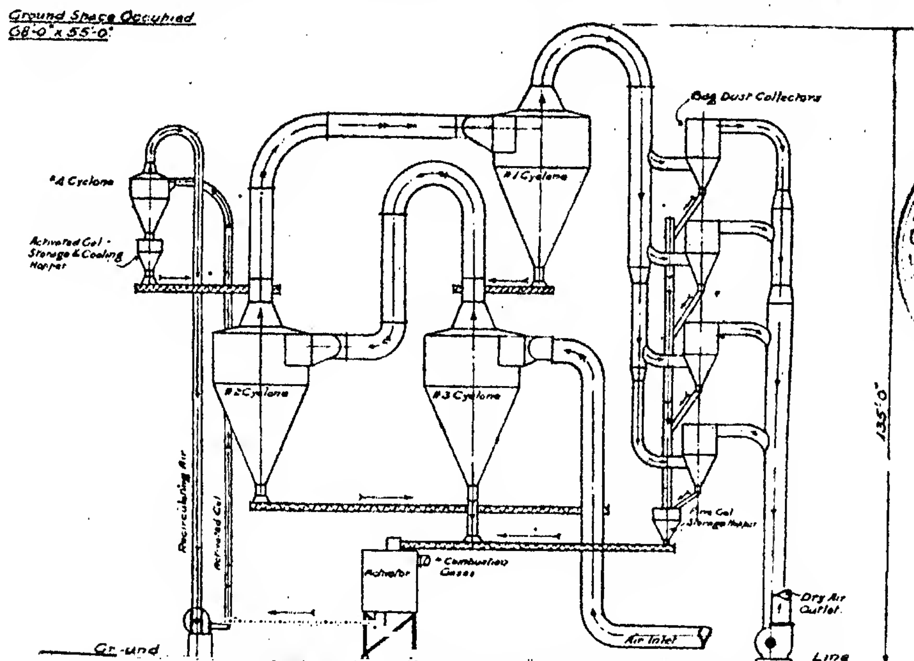
Fig. 1

substances as metallic sodium, the carbides, and the nitrides, or by drying agents such as calcium chloride, lime, sulphuric acid, etc. For drying gases on a large scale, calcium chloride is employed, and, since 1880, various large-scale plants using calcium chloride have been designed. Daubine and Roy have designed such a plant which is capable of treating 30,000 cubic metres of air per hour. It consists (Fig. 1) of a cylindrical shell, inside which are ten trays, each containing a layer of calcium chloride, 24 cm. thick. Each tray is also fitted with a cooling coil. The air to be treated enters at the bottom of the cylinder, and is then admitted either to a central distribution tube, or to the annulus formed by the outer wall of the unit and the outer walls of the closed

trays containing the calcium chloride. In the first type of unit the air passes from the central shaft, through ports, into the closed trays, and then downwards through the mass of calcium chloride. After its passage through the mass, the dried air flows into the annulus, which is connected with the delivery pipe of the unit. In the second type, the air, entering through the annulus, passes upwards through the bed of calcium chloride, and is collected in the central tube, which in this case is attached to the outlet pipe. Provision is made whereby hot gases can be passed through the layers, to regenerate the calcium chloride. For continuous working, therefore, the plant consists of three such units, one being used to dry the air, whilst the calcium chloride is being regenerated by hot gases in the second, and cooled by the coils in the third.

Adsorption

In this type of drying the moisture is removed by being adsorbed and condensed within a structure containing ultra-microscopic pores, although these adsorbed vapours may be at temperatures and pressures considerably above their liquefaction point. Such natural substances as bauxite, clay, charcoal, etc. after activation, possess this property in varying degrees. An artificially prepared adsorbent is silica gel, which is the substance used for drying air in the plant illustrated diagrammatically in Fig. 2. In this plant the silica gel is fed into the current of air leaving cyclone 2, and is carried by this air into cyclone 1. Here the gel, having adsorbed the moisture, falls into the bottom of the cyclone, and is then transferred by a worm conveyor, and discharged into the outlet pipe from cyclone 3, where it meets with a partially dried current of air, which carries it into cyclone 2, where separation again takes place. The gel which collects at the bottom of this vessel, is carried by a conveyor, and discharged into the inlet pipe to the plant. The incoming untreated air carries this gel into cyclone 3, in the bottom of which the gel ultimately collects. From this vessel the gel is carried to the activator for heat treatment, after which it is again admitted to the plant. The air, after passing in turn through the cyclones 3, 2, 1, is discharged into a battery of bag dust collectors, which remove any gel which has been brought over by the dried air. Plants of the type illustrated are capable of handling large quantities of air such as would be required in blast-furnace work. Where small quantities of air have to be dried, the static type of plant is used. In this the air passes through a bed of silica gel, which surrounds a number of parallel tubes, fixed at their ends to two tube plates attached to the ends of the containing vessel. When drying is in progress, water is circulated through the tubes, which are also used to carry the hot gases employed during the reactivation period. This plant consists of two vessels, which, working alternately, produce a continuous supply of dried air. From tests made on a plant capable of handling 100 cb. ft. of air per minute, it was found that from 91 to 98 per cent. of the moisture was removed from the air, and that the temperature of the entering air could be varied from 53° to 107° F, without



Silica-gel Air-Drying Plant by the Kestner Evaporator and Engineering Co., Ltd.

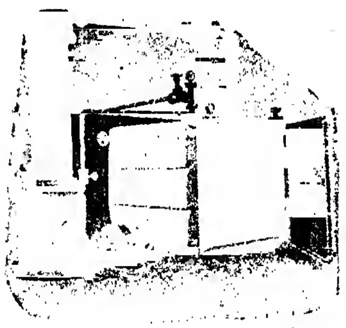
Fig. 2

causing the percentage of moisture removed to fall below that stated above.

Under the heading of mechanical separation can be included the removal of moisture from spongy materials, by compression in hydraulic or other presses, as well as the use of centrifugal machinery.

Addition or Removal of Heat

Drying by the removal of heat is practically confined to the treatment of gases, the temperature being reduced until the water vapour is converted into ice, which can be easily removed. Sometimes, however, this method, in conjunction with centrifugal separation, is employed in the treatment of delicate liquids, such as fruit juices. When a solid is heated, the outer layers of water which it contains are evaporated, and, owing to the difference in concentration between the outer layers and the centre, diffusion of the water takes place from the interior to the surface of the body. For drying to be continuous, therefore, it is essential that the rate of diffusion of the water through the material shall equal the rate of evaporation of the water from the surface of the substance. Sometimes the rate of diffusion is the controlling factor in drying, and, if this is the case, if the rate of evaporation from the surface exceeds the rate of diffusion through the material, cracks are liable to be produced on the surface of the material. With fibrous materials on the other hand, the moisture on the surface layers is usually replaced as quickly as it is removed, and then the rate of drying is directly dependent upon the rate of surface evaporation obtainable.



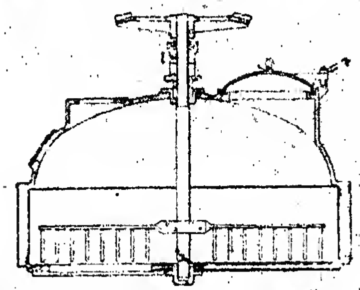
Vacuum Shelf Drier by F. Shaw and Co.

Fig. 3

The surface evaporation itself is a diffusion of water vapour through a relatively stationary film of air in contact with the surface, and then dispersion of the vapour by convection into the surrounding atmosphere. Naturally the thickness of this air film will affect the rate of evaporation, which will also be directly affected by the exposed area of the material, and the difference in pressure between water at the temperature of the surface of the film in contact with the material and the partial pressure of the water vapour in the surrounding air. Since the vapour pressure at any temperature over two non-miscible substances equals the sum of their partial vapour pressures, whilst, if the substances are miscible the vapour pressure in the liquid will be lowered, it follows that, other factors remaining constant, the rate of drying in the second case will be less than the rate of drying in the first.

Discontinuous Driers

One of the earliest forms of drying plant consists of a well-ventilated chamber, upon the floor of which the goods to be dried were laid. Sometimes the floor was made of iron plates, and was heated from underneath either by a number of small fires placed at different points or by metal pipes which carried the flue gases produced by a single furnace, and so distributed the heat more uniformly over the floor space.



Johnston Drier by Manlove, Alliott and Co., Ltd.

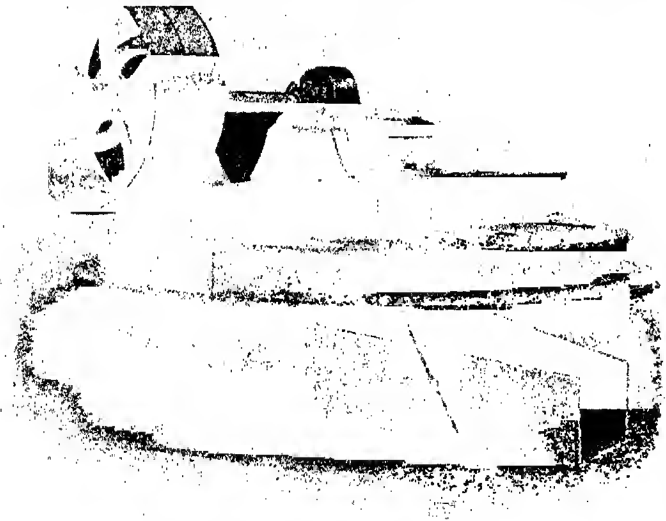
Fig. 4

When air inlets are provided in the floor, these are usually so arranged, that the air, before entering the chamber, is heated by passing round the pipes carrying the flue gases. The heated air laden with water vapour is removed through suitable ventilators in the walls or roof of the chamber. Sometimes the heating element consists of a series of pipes placed round the walls, through which either hot water or steam is circulated. The air inlets are then placed in that portion of the wall behind the heating pipes and the outlets in the walls or roof, in such a position that the heated air must traverse the chamber.

To increase the accommodation in the chamber, the goods are often placed on trays which are supported on racks. These chambers usually work at atmospheric pressure, but where recovery of the vapour evolved is desirable, the outlet is connected with a suction fan. A development of the ordinary chamber drier is the vacuum shelf drier, manufactured by various firms such as F. Shaw, J. P. Devine Co. and G. Scott and Sons. This plant, illustrated in Fig. 3, consists of a heavily ribbed cast-iron box fitted with a number of shelves. These shelves are made of rolled steel plates flush-riveted together at the edges through a welded ring. Steam is admitted to the space between the plates through bent pipes which allow of the expansion or contraction of the shelf with variations of temperature. An inlet pipe is attached to one corner of each shelf, the other end of the pipe being connected to a steam header, which forms an integral part of the outer casing. The shelves are so arranged that the condensed steam will drain to another corner of the plate, from which it is removed by a second pipe, which

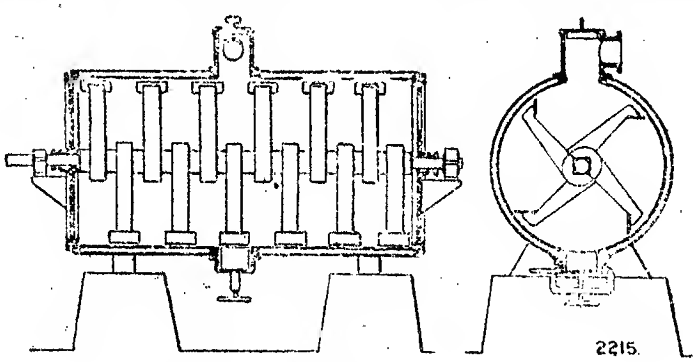
s connected to a second header, also forming part of the outer casing.

In the smaller sizes, only one door is provided, but for larger driers a door is fitted at each end if required. The doors may be of the hinged or sliding pattern, and when closed form an airtight joint by the pressure of their machined faces against



Drier by the Lennox Foundry Co., Ltd.
Fig. 5

a rubber ring contained in a groove cut on the inside skirting. Windows are fitted in the doors to permit of inspection of the material in the dryer during the drying operation. A cast-iron vapour pipe connects the top of the casing with a condenser. Each stove should be provided with its own con-

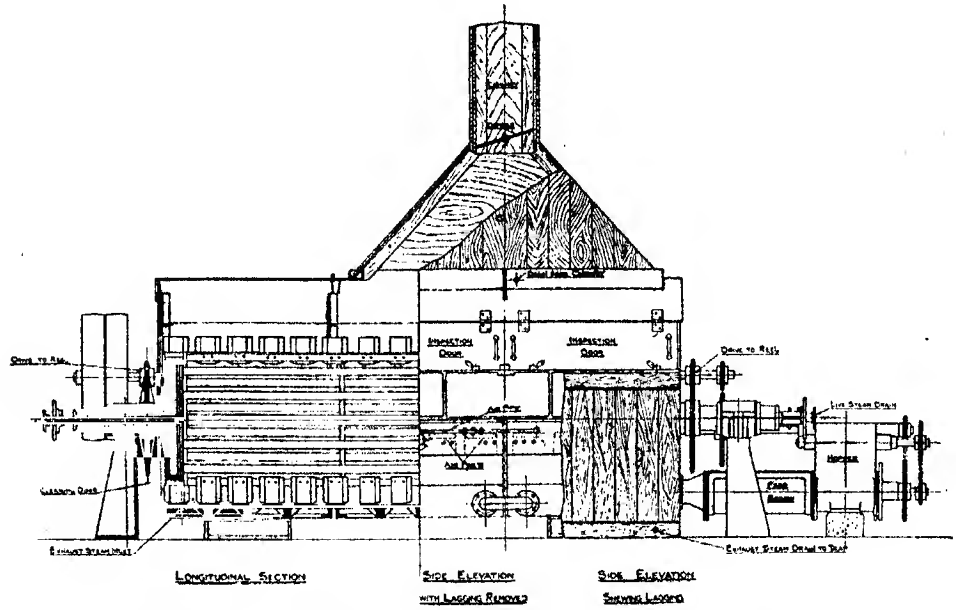


Firman Drier by Manlove, Alliott and Co., Ltd.
Fig. 6

denser, for, if a number of these stoves are coupled to a common condenser, it will be found that for efficient working all the stoves must be charged at one time. If an attempt is made to introduce a newly charged stove into the system, after drying has been in progress in the other stoves, it will be found that drying in these stoves is stopped, and remains so, until the contents of the newly charged stove become as dry as the others. Dryers of this type, whether of the cylindrical or box pattern, are designed to withstand vacuum, and are suitable for drying such substances as dyes, explosives, fine chemicals, foodstuffs, extracts, etc. This type of dryer is sometimes electrically heated. Another type of dryer, illustrated in Fig. 4, consists of a flat bottom cylindrical pan, provided with a steam jacket. The pan is provided with a cover, to which is attached the mechanism for operating the stirring and the stool for the vapour pipe. The charging hole is situated in the cover, whilst the machine is discharged through a rectangular opening in the bottom of the pan, which can be closed by a hinged and balanced door. This dryer is designed to obviate

the labour required in charging and discharging the shelf type of drier. Here the material is fed into the drier in bulk, and during drying is continually broken up and turned over by the stirring gear, which also automatically discharges it through the opening in the bottom of the pan. Sometimes the outlet for the pan is provided at the side (Fig 5). In the Firman drier, made by Manlove, Alliott and Co. (Fig 6.), a steam jacketed cylinder made of mild steel plates is mounted with its axis horizontal. Inside this cylinder and rotated by a suitably driven central shaft are a number of scrapers. The material is fed into the drier through an opening in one of the end plates of the machine, and discharged through a second opening at the lowest point of the cylindrical wall. The only difference between this machine and the Shetland drier is that the upper portion of the latter machine is rectangular instead of semi-circular in cross-section. These machines are largely used in the handling of waste products during their conversion into manures. All the above machines are of the discontinuous type, and, in addition to the labour often involved in charging and discharging, there is frequently a considerable heat loss due to the cooling down of the plant before discharging operations can begin.

(To be continued)



Imperial Grain Drying Machine by Blair, Campbell and McLean, Ltd.

Fig. 7

It is announced that Mr. H. Hollings, M.Sc., senior gas chemist to the South Metropolitan Gas Co., has been appointed chief gas chemist to the Gas Light and Coke Co.

THE USE OF GRAPHS IN CHEMISTRY

By J. R. JERROLD, M.A.

The use of graphs to show solubilities at varying temperatures is well-known, and other graphs showing the composition of binary and ternary alloys are of frequent occurrence but some other curves receive inadequate attention in our chemical publications.

The change in radioactive substances and all other changes where the rate is a uniform percentage of the value at a given moment are indicated by the curve $y=e^x$ shown below (Fig. 1), in which the horizontal distance x denotes the time, and O A represents the state at the time which is taken as the origin.

The curve $y=e^{-x^2}$ deserves far greater attention from chemists than it receives. It is shown in Fig. 2, and the theory of probabilities proves that it represents the curve of normal error. The line O A

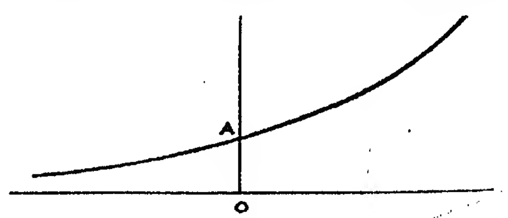


Fig. 1

which divides the curve symmetrically separates the departures due to chance errors into two classes, those which are too little, and those which are too great. The vertical distances show the number of

such errors; small errors are those close to the median line, they are frequent in number. The large errors which are shown by greater distances from the median line occur less frequently and the curve will, at a suitable distance, become practically coincident with the horizontal axis. This implies that errors exceeding a certain figure will practically not occur.

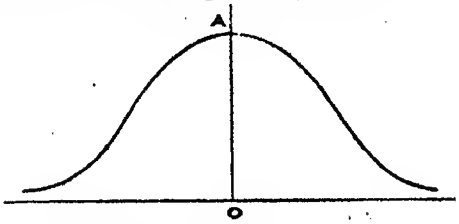


FIG. 2.

The importance of this curve in chemistry is obvious. If a score or so of determinations of an atomic weight be made and suitably plotted on the basis of this curve, the median line can be drawn and this denotes the probable true atomic weight. So, too, a number of inaccurate analyses of a compound will—if sufficiently numerous—enable us to determine correctly the true proportions. It is the only curve that enables the truth to be rigidly deduced from inaccurate premisses. In fact, what we mean by truth is simply the median line drawn through the curve which results from plotting human opinions, whether true or false. This is, of course, merely a mathematical statement in few words of Lord Balfour's "Foundations of Belief." If only we can get some definite statements of the beliefs of many individuals as to the theory of solution, the existence of bivalent hydrogen atoms, or any other problems where opinions are not unanimous, the truth can be elucidated by plotting.

But this curve shows not only the truth and the probability of error, but the normal and the probability of the abnormal. We may take the median line to show the average height of men, the very tall and the very short will be denoted by positions close to the horizontal line. Or we may arrange humanity in the order of their intelligence; the great mass of normal people occupying the central positions in the curve, Fellows of the Royal Society on the extreme left, lunatics on the extreme right. If the members of the Society of Chemical Industry be classified in this manner, one can judge how long it will take for them to secure their Chemical House. It depends on the average member.

The curve may be considered politically, the extreme right will be occupied by such men as Lord Curzon and Lord Birkenhead, the extreme left by some vigorous men from the Clyde school of politics. The most elementary integration will enable one to see what types of opinion must be included to enable a Prime Minister to command a majority. If a Prime Minister includes the extreme men, he will have to include a great length of horizontal space to obtain a majority; on the other hand, the central party requires only a short horizontal length in order to include a majority. This principle is capable of frequent application, and the mathematical analysis is not so difficult as might be expected.

FORTHCOMING EVENTS

Apr. 4. SOCIETY OF CHEMICAL INDUSTRY, *Liverpool Section*, The Clubrooms of the Overseas League, 14, Elliot Street, Liverpool, at 6 p.m. "Agriculture and Chemical Industry: Some Suggestions for Closer Co-operation Between the Chemical Manufacturer and the Farmer," by E. H. Rideout, B.Sc. An informal dinner will be held after the meeting at the University Club, Mount Pleasant.

Apr. 4. SOCIETY OF CHEMICAL INDUSTRY, *Birmingham Section*. Joint meeting with the Chemical Engineering Group, at the White Horse Hotel, Congrieve Street, Birmingham, at 6.30 p.m. "The Premier and Other Disintegrating Mills and their Applications in Industry," by Captain F. J. C. China. Informal supper at 8.30 p.m.

Apr. 4. SOCIETY OF CHEMICAL INDUSTRY, *Manchester Section*. Annual general meeting, the Textile Institute, 16, St. Mary's Parsonage, Manchester, at 7 p.m. "The Tautomerism of Amidines," by Prof. F. L. Pyman, D.Sc., F.R.S.

Apr. 7. CERAMIC SOCIETY, Central School of Science and Technology, Stoke-on-Trent, at 7.30 p.m. (1) "Note on the Use of Wood-Wool as a Packing Material," by B. Olsen. (2) "Electrical Porcelain; the Effect of Varying the Composition upon some of its Properties," by E. Watkin. Short communications will also be given by F. S. Worthington and Dr. J. W. Mellor.

Apr. 7. SOCIETY OF ENGINEERS, the Apartments of the Geological Society, Burlington House, Piccadilly, W. 1, at 5.30 p.m. "Gas-firing (Flame Control)," by A. C. Ionides.

Apr. 7. INSTITUTION OF THE RUBBER INDUSTRY, The Engineers' Club, Coventry Street, Piccadilly, W., at 8 p.m. (1) "Improvements in Education in the Rubber Industry," by Dr. T. J. Drakeley, and (2) "The Buyer Criticises the Manufacturer," by H. F. Trevillion.

Apr. 7. SOCIETY OF CHEMICAL INDUSTRY, *London Section*, at the Royal Institution, 21, Albemarle Street, W. 1. Prof. H. E. Armstrong, F.R.S., will give an address on "Sir James Dewar as an experimental inquirer," with demonstrations.

Apr. 8. INSTITUTION OF PETROLEUM TECHNOLOGISTS, The Royal Society of Arts, John Street, Adelphi, W.C. 2, at 5.30 p.m. "The Crude Oils of Burmah and Assam," by W. J. Wilson, F.I.C.

Apr. 8. INSTITUTION OF CIVIL ENGINEERS. Joint meeting with the Institute of Chemistry and many other Engineering Societies, Great George Street, Westminster, S.W. 1, at 6 p.m. Discussion on "Standards of Comparison in Connection with the Thermal Efficiency of Internal Combustion Engines.

Apr. 8. INSTITUTE OF METALS, *North-East Coast Section*, Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. Annual general meeting. *Birmingham Section*, the Chamber of Commerce, New Street, Birmingham, at 7 p.m. Annual general meeting.

Apr. 10. INSTITUTE OF METALS, *London Section*, the Institute of Marine Engineers, at 8. "Failures in Metals and Alloys," by G. H. Gulliver, D.Sc.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

July 9—12

PATRON: H.M. THE KING

Preliminary information regarding this meeting was given on p. 309 of *Chemistry and Industry* for March 21.

A programme will be issued shortly.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

OFFICIAL NOTICES

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The eighth volume of these Reports is now ready, and copies are in course of being despatched to purchasers.

The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members, post free in each case.

For full particulars see page xiii. of the Advertisement Section of the issue of March 28.

BIRMINGHAM AND MIDLAND SECTION

During the meeting held on March 18, Mr. A. W. Knapp read a paper on "The Fermentation of Cacao," of which the abstract reached us too late for inclusion with the account of his paper on the theobromine content of cacao.

Mr. Knapp said the cacao bean, as it came from the pod, was covered with a fruity pulp. It was necessary to dry the bean in order to obtain a stable product, and the drying could be more rapidly accomplished if the beans were first allowed to ferment, either in boxes or heaps. *Saccharomyces cerevisiæ*, *S. ellipsoideus* and *S. theobromæ*, had all been found in satisfactory cacao fermentations. With "forastero" cacao, which was fermented for six or more days, after the third day the temperature is usually 48–50° C. This was a very high temperature for yeast fermentation and was not satisfactorily accounted for by the presence of acetic bacteria. The cider-like liquid which ran away during fermentation was known as "sweatings," and about 10 million gallons of this liquid, which contains about 10 per cent. of sugars, ran to waste every year.

A detailed account was given of the changes occurring in the interior of the bean during fermentation. These included the distribution of the isolated masses of violet pigment throughout the bean, and the oxidation of the tannins to brown bodies in the presence of an oxidase. It was this oxidised tannin which produces the chocolate colour of roasted cacao beans. It was, however, odourless and tasteless. Oxidation thus was responsible for a reduction in the astringency but did not account for the characteristic cocoa aroma. The oxidation was continued during drying.

Fickendey had suggested that the fermentation of cacao might be replaced by killing the bean by freezing, and removing the pulp by washing. Perrot had suggested that the bean should be steamed, and the pulp removed by dilute alkali. Neither of these methods gave a bean which had the chocolate aroma on roasting. Experiments were described to show how far the normal changes could be brought about in the absence of the pulp. In the presence of 2 per cent. acetic acid at 40–43° C. the skinned beans assumed the appearance of fermented cacao, but, on roasting, the aroma was lacking. Research was needed to show what substances were produced in the bean during fermentation, which, on being heated, gave the cocoa aroma.

GLASGOW SECTION

The seventh meeting was held in the Institute of Shipbuilders and Engineers, on March 28, and was presided over by Mr. W. E. Moodie, F.I.C., Chairman of the Section.

Prof. T. S. Patterson gave an addendum to a paper on "Modifications of Laboratory Apparatus," communicated by him to the Section at its last meeting, and he was able to show an improvement on the second of the series then exhibited which had since occurred to him: *namely*, by the suitable change and simple redesign of the receiver for distillation under reduced pressure applicable to small quantities of distillate. He showed how this applied to larger quantities and also demonstrated another piece of apparatus designed for this purpose a long time previously, but suffering from the disadvantage of too large a number of joints which had to be kept air-tight. A description of a test-tube rack of simple construction, which rapidly drained the tubes concluded Prof. Patterson's remarks.

Dr. J. A. Cranston then read a paper on "The Influence on Chemistry of the Recent Knowledge gained of Atomic Structure," beginning with a review of the genetic relationship of the elements, in which he pointed out the undue prominence given to the number 8 by the classification suggested by Newlands and incorporated by Mendeleeff in his table, which, notwithstanding its failings, had been to chemists a map of the world. One thing, however, remained clear, and that was that some relationship obviously existed between the elements, as shown in the diverse forms in which they had been tabulated, but that the rare earths had generally been a difficulty. A table constructed on the Rydberg series and atomic numbers was shown and made the basis of further remarks. A consideration of Sir J. J. Thomson's work showed that some relationship existed between matter and electricity, and this relation had been resolved into that between the electrical content and the chemical properties and structure of the atom by the discovery of radio-activity, for the expulsion of α- and β-particles was followed by the well-known change in position in the classification—or change in the atomic number—to that of the resultant element. That the relationship between matter and electricity was not confined to the radi-

active elements was soon shown by Sir Ernest Rutherford, who, by bombarding matter with α-particles, made the application general throughout the table. That only 1 in 10,000 α-particles were deflected in their passage through matter was an object of wonder, and led to the conception of the condensed positively charged nucleus. This was greatly added to by Moseley's famous set of experiments, from which the idea of atomic number arose. The discovery of isotopes by Aston was a matter of great significance, for inasmuch as the atomic number for any element was constant and indicated the net charge on the nucleus, it must be possible for the element, though the net change indicated it was homogeneous in chemical properties, to be composed of atoms differing in mass, and hence in the arrangements of their nuclei. To the simplest type of nucleus having one positive charge, such as was found in hydrogen, the name "proton" had been given, and all elements might be considered to be composed of various groupings of protons and electrons.

Dr. Cranston then dealt with various suggestions as to structure based on the chemical properties, and elaborated in further detail that of Lewis and Langmuir, whose postulates were three in number: (1) The electrons round any nucleus tend to arrange themselves in a stable form, namely, that of the octet in the lighter elements. This stable form is seen in the rare gases, the zones or shells of which successively contain 2, 8, 8, 18, 18, 32, electrons. (2) The electrovalency of an element is governed by the number of electrons which it either lacks or has in excess of this stable number, and which it will collect or part with to attain it. Sodium, of atomic number 11, will part with one electron to fluorine, of atomic number 9. Each will then have 2+8, and be held together by electric attraction. Mg and O, atomic numbers 12 and 8, will interchange 2 electrons. Identically arranged molecules are given, differing only in electric attraction, shown to a great extent in the different physical properties of MgO to NaF. This is equivalent to the "inorganic bond." Crystallographically these two would be expected to be isomorphous, which was what Bragg's X-ray examination had shown. (3) Covalency may also be shown by an element, governed by its power of sharing electrons, as in the gases O_2, N_2, F_2, etc., and compounds of two or more elements as in the charged ion SO_3'', SO_4'', etc. This was a much stronger bond than that of electrovalency and was equivalent to the common "bond" of organic chemistry. Any dissociation leads to a breakdown of the compound, whereas in electrovalently-joined compounds dissociation readily leads to ionisation—a reversible change. Ions, however, are never found to have large charges, and hence a limit to the exchange of electrons is patent, controlled by Coulomb's law. A sort of compromise therefore exists in such a case as iron, which sometimes is found as $Fe^{\cdot\cdot}$, sometimes a $Fe^{\cdot\cdot\cdot}$. No explanation of the complexity of intermetallic compounds had so far been given, but the results of Prof. Edwards were of great interest. Mg_2Pb, Cu_2Sb, Cu_3Sb had been obtained by him, the first and last being of salt-like character and zero electroconductivity, whilst Cu_2Sb showed the ordinary conducting properties of alloys. All were of Langmuir's "complete compound" type, in which each component formed a complete stable octet. Dr. Cranston touched also on subsidiary points of valency, other than the rare gases, in the table and the cases of complex salts, but time prevented elaboration.

After the discussion, during which a number of interesting points were dealt with, Dr. Cranston was most cordially thanked for his paper.

NOTTINGHAM SECTION

At the meeting on March 26 a paper entitled, "Some Scientific Aspects of Puering and Bating," by C. E. Pickard, was read by Mr. D. J. Law, B.Sc.

An account was given of the methods of research into the chemistry of puering and bating, and a comparison was made of the results obtained by recent investigators.

In the discussion Mr. Burford asked how many bating enzymes had been isolated, and what was the action of the enzymes on collagen? Mr. Powell enquired whether pepsin could be utilised during the process? Mr. Pentecost asked if acetic acid acted upon the skin to produce shrinking or unevenness? Dr. Prideaux enquired if pancreol was not more expensive to use than old-fashioned bating materials? Mr. Barber wished to know if pure cultures of the various enzymes used in bating had been isolated?

In reply Mr. Law stated that at least five of the enzymes present in the puer liquor had been isolated. Usually trypsin will not act upon collagen, but with excess liming, the collagen becomes partially hydrolysed, and is then acted upon like gelatin. Pepsin could not be used, as it will only work in an acid medium, whereas puering was always carried out in an alkaline bath. The action of excess of acetic acid on the skin would produce swelling, but in practice only sufficient was used to neutralise the lime. The use of enzymes in bating was certainly more expensive, but gave much better conditions of working. Several enzymes used in bating have been isolated.

Mr. Powell then read "The posthumous papers of J. M. Wilkie, B.Sc., F.I.C., in collaboration with his colleagues," collected by Mr. H. Droop Richmond, F.I.C.

The estimation of morphine by using a plugged separating funnel instead of the British Pharmacopœia method of tared filter papers was first described. Details were then given of an extraction method for estimating morphine when the ordinary crystallisation method was inapplicable, and the use of Denigé's colour reaction to the quantitative colorimetric estimation of morphine was described as a satisfactory method for low limits of morphine. The use of powdered silica and tribasic calcium phosphate was suggested to aid the ignition of difficult substances, by increasing the surface exposed to air, and protecting the material of the crucible. A note on soluble filtering media described the use of camphor as a filtering medium for use in bismuth determinations.

During the discussion, Mr. Burford said he rather doubted the colorimetric estimation of small amounts of morphine, and considered that a blank parallel estimation should be performed. The addition of powdered silica to give an increased air space seemed a good idea, as calcium phosphate would appear to be a non-conductor of heat. The camphor filter also would seem to be very useful.

Mr. Powell, in reply, stated that a blank control experiment in the colorimetric method was necessary, although this method was only used where morphine was well below the minimum of the Dangerous Drugs Act.

EDINBURGH AND EAST OF SCOTLAND SECTION

The annual general meeting was held in the Hall of the Pharmaceutical Society, Edinburgh, on March 18, 1924, Dr. Alexander Lauder in the chair.

Dr. Alexander Lauder was re-elected chairman for the ensuing year, and Mr. W. A. Williams was elected vice-chairman. Mr. W. T. H. Williamson was re-elected hon. secretary and treasurer, and Dr. T. Rettie, hon. auditor. The following new members of Committee were elected: Prof. Sir James Walker, Prof. Hendrick, Dr. H. E. Watt, and Major R. Bruce.

The sixth ordinary meeting took place after the business meeting, when a lecture was delivered by Dr. N. V. Sidgwick, M.A., F.R.S., on "Co-ordination and Co-valency."

Chemical combination is due to rearrangement of the outer or valency electrons between the atoms concerned. This can occur in two ways, leading to two kinds of linkage:—

(*a*) One or more electrons are transferred from one atom to the other, the atoms being held together by the resulting electrostatic charges (electro-valency, ionisable, not directed in space).

(*b*) One or more pairs of electrons (one pair to each link) are in some way shared between the atoms so as to count for both (covalency, non-ionisable, directed).

No other form of valency need be assumed if we remember (1) that besides the 'octet' (corresponding to a covalency of 4) we may have a stable group of 12 or even 16 shared electrons (covalency of 6 or 8), as in SF_6 and OsF_8; (2) that though the two electrons required for a covalent link usually come one from each atom, they may both be provided by one of the atoms. This leads to a second kind of covalency, which we may call a co-ordinate link. Such links attach the NH_3 groups in a complex ammine.

Hence the ordinary covalency of an atom (like its electrovalency) is determined by the number of its valency electrons, *i.e.*, by its group in the periodic table. But in its co-ordinate compounds this restriction no longer holds, since there the other atom provides the electrons for the link. The covalency is, however, found to be limited in a different way by the position in the periodic table. The maximum covalency (co-ordinate or other) is for hydrogen 2; for the elements from lithium to fluorine 4; for those from sodium to about copper 6; and for the heavier elements 8. The reason for this limitation is not known, although it has a close relation to the size of the sub-groups of electrons on Bohr's theory.

An interesting discussion followed, the speakers including Prof. R. N. Craven, Prof. Wilson and Dr. J. A. Cranston, of the Glasgow Section, Prof. C. G. Darwin, Edinburgh University, and Principal Laurie, Heriot Watt College, Edinburgh.

CHEMICAL SOCIETY

The annual general meeting was held on Thursday, March 27, at 4 p.m., the President, Prof. W. P. Wynne, occupying the Chair.

The Treasurer, Prof. J. F. Thorpe, having presented the Report of the Council and the Balance Sheet, their adoption was moved by Dr. F. L. Pyman and seconded by Dr. O. L. Brady, both of whom referred with regret to the retirement of the senior Secretary, Prof. J. C. Philip, and the Editor, Mr. A. J. Greenaway. Prof. H. E. Armstrong associated himself with this expression of regret, and referred in congratulatory terms to the Council's efforts to co-operate with other Societies, particularly in the domain of publications. The Report and Balance Sheet were then duly adopted, and a vote of thanks to the Auditors was acknowledged by Dr. R. C. Farmer.

In acknowledging a vote of thanks to the Treasurer, Secretaries, Foreign Secretary and Council, Prof. Philip referred to the retirement of Sir William Tilden and Dr. Alexander Scott from the office of Vice-President, recalling that the former was responsible for the initiation of the Society's Annual Reports on the Progress of Chemistry, whilst the latter, who was President during two difficult years of the war, instituted the movement which led to the formation of the Association of British Chemical Manufacturers. He expressed his cordial thanks for the help afforded him by the Officers and Members of the Council with whom he had been associated during his eleven years' tenure of office, and to the Assistant Secretary; he also took that opportunity of emphasising the debt which Fellows owed to one particular committee, the Publication Committee, whose duties at the present time were especially arduous and delicate.

Sir William Tilden recalled the early days of the Society, of which he was elected a Fellow in 1864. In alluding to the then prevailing views of chemical constitution and interaction, he spoke of the differing character and number of the papers then and now read before the Society. He desired to congratulate the President and the Society on the progress it had made, and to wish it every success in the future.

Dr. J. F. Spencer, Prof. A. J. Allmand and Prof. J. S. Brame were elected Auditors.

The President then handed to Prof. F. G. Donnan the Longstaff Medal, saying that by his researches and inspiration he had established an unrivalled position in British physical chemistry, and referring in the briefest terms to the scope of his work on colloid systems, on the application of thermodynamical principles to chemical problems, and in the domain of ionic chemistry. Prof. Donnan expressed his appreciation of the honour thus conferred upon him.

In his Address, the President took for his theme the debt which chemistry owes to Russia, referring

first to the efforts in which the Society had joined to mitigate the acute distress existing among Russian chemists, and expressing confidence that the high tradition of their science would be maintained as time and circumstances would permit. It was largely to the fact that, except in the earlier years, the Russian language was usually employed, that he attributed some lack of appreciation in this country of so distinctive a school of research.

With a brief reference to the conditions under which chemical study and research have been carried out in the past, and to Lomonosoff's anticipation of Lavoisier's experiments on the calcination of tin and lead in air, Prof. Wynne turned to Kazan as being (apart from Petrograd, the home of Mendeléeff, Menschutkin and Beilstein) the most interesting centre of chemical learning, having an influence on the development of Russian chemistry comparable with that of the famous laboratory at Giessen. Claus, the first occupant of the Chair of Chemistry at Kazan, was best remembered for his discovery of ruthenium; Zinin, who became Professor in 1837, originated the use of ammonium sulphide in the reduction of nitrobenzene, nitronaphthalene and *m*-dinitrobenzene to the corresponding amino-compounds. His successor, Butleroff, established a school of thought which quickly became prominent, and further enhanced his reputation by the publication in 1864 of a text-book of organic chemistry which was remarkable even in a remarkable age. Butleroff, on going to Petrograd, was succeeded by Markownikoff, who was in turn followed by Saytzeff and Flawitzky. Names such as these naturally led to a brief survey of the development of the Russian Chemical Society, which was founded on 6/18 November, 1868.

The debt which chemistry owes to the Kazan school could be broadly stated to be the searching scrutiny of the property of unsaturation as manifested, on the one hand by hydrocarbons isologous with the paraffins, and on the other by carbonyl derivatives. Butleroff's work on the interaction of methylene iodide with silver acetate, and the action on the product of lime water, had laid some of the foundations of Bayer's view that the photosynthesis of sugar from carbon dioxide and water is achieved through the intermediary of hydrated formaldehyde; the part which he took in the controversies concerning molecular constitution, and particularly the constitution of isomerides (including his synthesis of *tert.*-butyl alcohol in 1864) were a not unnatural result of his association with Wurtz and Kekulé. Further, a claim might reasonably be made that the prolonged use of the zinc alkyl compounds as synthetical reagents until the discovery of the more convenient magnesium compounds was due mainly to the use made of them at Kazan by Butleroff (*e.g.*, in connexion with pinacolin), and later by Saytzeff, Wagner, and their collaborators. Polymerisation also engaged Butleroff's attention, and to him the current explanation of the course of the reaction among olefines was due.

One of Butleroff's first students at Kazan was his successor, Markownikoff, who put forward certain rules relative to the behaviour of directive influences, and the formation of additive compounds which, although not rigid, were useful, and have led by stages to modern views of partial valencies, residual affinities, and induced alternate polarities. Later he turned his attention almost exclusively to an investigation of the naphthenes, which he discovered in Caucasian oil, the change in structure which may occur when cyclic compounds are reduced by hydrogen iodide being incidentally discovered.

Much of the work of Saytzeff was concerned with the systematic synthesis of alcohols by the aid of zinc alkyl compounds; in this enquiry he was assisted by his most brilliant student, Wagner, who afterwards continued the investigations at Petrograd. By carefully-regulated reactions, Wagner was able to show that the first stage in the oxidation of an unsaturated carbon chain was the formation of dihydroxy-derivatives, with subsequent disruption at that point or elsewhere; his results led to an acceptable view of the course of the action of fused potassium hydroxide on oleic acid, and contributed towards the more recent elucidation of the probable manner in which fatty acids are broken down by the organism. Wagner's studies in the terpene series were no less noteworthy.

Prof. Wynne then spoke more particularly of the chemistry of the carbonyl group, in the earlier development of which Butleroff, Saytzeff and Wagner were all concerned, and mentioned the work of Petrieff, of Odessa, on mesoxalic acid. He also briefly referred to the once vigorous condition of the schools of chemistry in the former Russian cities of Warsaw, Riga, and Helsingfors, associated with the names of Walden, Aschan and Komppa, and recalled von Lebedeff's researches on alcoholic fermentation.

Having emphasised the advantages which would accrue to chemists from a more widespread study of the Russian language, the President concluded by saying that, with sympathy and admiration for those who are carrying on the good work, he looked forward to the time when their nation would again play a part in the advancement of chemistry no less vigorous and distinguished than was the case before the war.

Prof. H. E. Armstrong moved a vote of thanks to the President, and accompanied his proposal with a request that he would allow the Address to be printed. Seconded by Prof. H. B. Baker, the vote was carried with acclamation.

The President then declared the following to be duly elected, a ballot not having been necessary:—Secretary, C. S. Gibson; Vice-Presidents who have filled the office of President, Sir J. J. Dobbie, W. H. Perkin; Vice-Presidents who have not filled the office of President, A. J. Greenaway, J. C. Philip; Members of Council (Town) O. L. Brady, A. E. Dunstan, T. S. Moore, (Country) D. R. Boyd, B. Lambert, F. L. Pyman.

The Informal Dinner was held at the Hotel Cecil after the Annual Meeting, and some 260 Fellows and their guests were present.

Mr. H. J. Evans proposed "The Chemical Society," coupled with the name of the President.

The President, in reply, said this was the first occasion on which there had been an informal dinner,

and as it was an obvious success, he was sure the Council would endeavour to make it an annual affair.

Prof. G. T. Morgan, F.R.S., proposed "The Retiring Secretary," coupling with the toast the name of Prof. J. C. Philip, F.R.S. The speech was mainly in a humorous vein, but in referring to the valuable work which Prof. Philip has done since he became secretary, Prof. Morgan said the war came within 18 months of Prof. Philip's assumption of the office, and that fact alone increased the secretarial duties enormously, not to mention the increased membership. One outstanding fact during Prof. Philip's tenure of office was the admission of women as Fellows of the Society. This innovation, hinted Prof. Morgan, might have been the cause of the disappearance of Prof. Philip's facial adornment. Another step forward to be associated with Prof. Philip was the co-operation of the Society of Chemical Industry with the Chemical Society in the publication of chemical abstracts. That had led to the formation of the Bureau of Chemical Abstracts, a composite body representing both Societies, and of which Dr. Philip is the first Chairman. After an amusing reference to the attributes of the ideal secretary, Prof. Morgan said that Prof. Philip had all the qualities which an ideal secretary should have as well as other excellent personal qualities, all of which made it a matter of regret that he was resigning his office. They were all extremely grateful for the work he had done for the Society as senior executive officer, and hoped that they would continue to have the benefit of his mature advice.

Prof. Philip, in replying, said it would be idle to deny that the machinery of the Society was now a little more up-to-date than it was, say, 10 years ago, and he consoled himself with the reflection that the time and energy which had been put into that work had not been wasted. It was fortunate that the Chemical Society should have taken a foremost part in endeavouring to bring about the co-ordination and co-operation of the different chemical bodies. It had also assisted in bringing the Association of British Chemical Manufacturers into existence, and there was the joint Library scheme, whilst last year the separation of the Transactions from the Abstracts had rendered it possible for there to be one independent British organisation for the production of abstracts, and this might possibly ultimately lead to a sole publication in the English language. This was work accomplished of which the Society might feel proud. Finally, Prof. Philip congratulated the Council on arranging this informal dinner, because it enabled them to escape the sort of exhibition there had been at one or two recent dinners when very distinguished persons had displayed a colossal ignorance of what the chemist really was. Referring to Prof. Morgan's remark about his changed appearance, Prof. Philip said that his students had defined this as a "beavercavement."

The final toast was "The Longstaff Medallist for 1924," coupled with the name of Prof. F. G. Donnan, F.R.S. In proposing this toast, Prof. E. C. Baly, F.R.S., said that in Prof. Donnan they had a personality which had both dominated a very far-reaching school of research, and had also endeared him to all. In trying to voice appreciation of Prof. Donnan he found himself overwhelmed by the recognition of his own indebtedness to him, but he was proud to speak of Donnan as a stimulating personality, as a great philosopher, of his never failing wealth of helpful criticism and advice, and of his enthusiasm for Dame Nature and her hard work. The Longstaff medal was a triennial epoch in the annals of the Society, and he felt that the Council, in honouring Prof. Donnan, had honoured itself by inscribing a very distinguished name on an already distinguished roll.

Prof. Donnan, who was enthusiastically received, said he failed to recognise the picture which Prof. Baly had painted, but he again thanked the Council very heartily for awarding him the Longstaff medal, and the company for the manner in which the toast had been received.

There was a musical programme during the evening, part of which was contributed by members of the Society.

INSTITUTE OF CHEMISTRY

Mr. Marlow, Assistant Secretary of the Institute, speaking before the Edinburgh Section on March 20, the Glasgow Section on March 21, and the Birmingham Section on March 24, said that, although his remarks must not be taken as being an official expression of the views of the Institute, the consolidation of British chemical interests was one of such immediate importance that there were certain principles which should be discussed by the Local Sections.

The main objects of co-operation were :—

(a) *Economy in Organisation.*—As an instance, they would perhaps realise that the indiscriminate circularisation which was now going on from all the bodies was extraordinarily wasteful in labour, in materials, and in postage. Given co-operation it was a simple matter to send all this forth in an orderly economical manner.

(b) *Economy in Publications and in Printing.*—Much had already been done in this respect by the provision of a Bureau of Chemical Abstracts, but much remained to be done in other directions, and he hoped that in time we should see one Journal covering every aspect of British chemistry. This would, by reason of its large circulation, prove a still more valuable advertising medium, and reduce thereby the cost of publication. They, as Members of the Institute, could give a lead. Their own Journal was only issued every two months and, consequently, much of what it contained was already very much out of date. Reports of the sectional meetings would have appeared in *Chemistry & Industry* and in the trade papers, so that the Institute's Journal was not only out of date, but to an extent provided an unnecessary duplication. It cost £650 last year for printing and postage alone—the Institute had a good opportunity of giving a lead in this matter.

(c) *Provision of a Joint Library.*—Much had already been done in this direction, and chemists as a whole should be very grateful to the Chemical Society, who had allowed their Library to form the nucleus of a really national chemical library.

(d) *Subscription*.—All of these suggestions must nevitably lead either to an economy to the individual members in their subscriptions or to the provision or members of a great deal more for the subscriptions hey paid—or both. It was impossible to suggest what savings might be expected until one knew he whole position of each Society, but it was perfectly clear that some economies must be effected. There would be a possibility of a composite subscription, and some individuals might find that they were involved in a higher subscription. About 1800 members of the Institute belonged to no other chemical society. He was not so much concerned at the fact that the other important societies included nearly 6000 members who belonged to no other society, because these societies included people who did not consider themselves qualified chemists, but every member of the Institute was a qualified professional man; it was deplorable that so many were content to lose the opportunity of maintaining their professional equipment which was provided by membership of the scientific societies. If a composite subscription were introduced, there would clearly be an increase in subscription for such members. As to the financial mechanism, it was impossible to make very definite suggestions, but there would be a possibility of considerable economy in entrance fees, which would induce younger members to join since the main object of an entrance fee was to enable the societies to build up a capital reserve, and, if all the societies were to work together, they would have a considerable joint-capital reserve. A man at present belonging to the three main societies should get all the advantages at about two-thirds of the present cost.

Two factors were essential if they were to secure this co-operation, namely, a central organisation and common headquarters.

With regard to a central organisation, they would be wise to make the fullest use of all existing material. There already existed a Federal Council for Pure and Applied Chemistry, and if this body were given definite powers, and were really representative of all chemists, it constituted the obvious nucleus of the governing body. He conceived a Commonwealth of Chemistry in which the Federal Council or, to avoid confusion of metaphors, the newly constituted General Chemical Council, formed therefrom, would be assigned definite functions (with power over certain monies), and the separate societies would all continue to perform the useful services for which they were created, save only that the General Council would do that work which affected them all. Members of the Institute would realise that the formation of a Council superior to their own would act rather to strengthen than to weaken their professional status. If, for example, the Council contained the Councils of all three of the larger Societies, its only objection was that it would be too unwieldy. Ninety-five per cent. of the members would be found to be Fellows of the Institute, and all would be staunch supporters of the Institute's ideals.

He preferred not to discuss the question of a chemical headquarters in any detail, but he would ask those present to bear certain fundamental principles in mind.

The main object of the plan was to provide a headquarters for all the chemical organisations, including adequate meeting halls and library facilities. For convenience, and in deference to the dignity of chemistry, they should have a meeting hall at headquarters, instead of seeking the hospitality of engineers, and it was most wasteful to set up a separate library away from headquarters.

The whole problem hinged upon the question of finance. An ambitious scheme had been propounded in 1918, but nothing definite had come of it. They would agree that chemists were not prepared to pay £25 a head, and that was the amount which would be involved if their expenditure were of the order of £300,000, as had been suggested. They must, therefore, seek some other solution. The experience of the Institute in building its own headquarters only nine years ago had shown it was very unwise to put up a new building with a reasonably estimated margin for expansion. In much less than nine years the Institute building had proved quite inadequate for the purposes for which it was built, and those who planned Chemistry House as a self-contained building would have to be very long-sighted if they were to plan an adequate building. He doubted whether any man could foresee what would be the needs of chemistry in fifty years' time, or what space would be necessary for a chemical library in fifty years' time, the science was growing so rapidly.

It was very desirable that all the functions of chemical bodies should be exercised in the one building. At the present moment, the chemical bodies were spaced unevenly all over London. This lack of centralisation affected not only Londoners, but more particularly country members, who had to spend a deal of their limited time in travelling about London.

Their premises must be available to the chemical organisations at as low a rental as possible. They must remember that the Chemical Society was now living rent free, and that the Institute was, in effect, living rent free, since it had its own premises. They would be able to avoid the waste of capital so noticeable when each of the Societies had its separate Council Room and committee rooms, which remained idle except for a very few hours each week. Chemists must try to think of these matters in terms of rental. The Institute's Council Room and Library occupied about 1700 sq. ft., and if they had to rent that space they would have to pay well over £1000 for the rent of those two rooms. It was being used very extravagantly at present.

The final point was that, if they were to transfer the Chemical Industry Club to their headquarters, they would lose the great advantage which was provided at Whitehall Court, where there was a public restaurant, which formed the nucleus of the catering service. Consequently, if they wished to remove the Club, they must think of the possibility of having such a restaurant available.

This matter had recently become of considerable moment, since the Society of Chemical Industry had received as a legacy a very useful nucleus for the funds required for headquarters, either for the Society—

or for chemistry as a whole. Many schemes might be put forward but he hoped that they would think in terms sufficiently large to bring all the functions of chemistry into the one building. This would cost money, and he doubted whether that money was available on the purely voluntary basis. Therefore, he suggested that Chemistry House should be run as a business proposition; that they should float a separate company, in which the main bulk of the shareholders were chemists, in order to secure a building which was very much too large for their immediate needs and that they should let for profit the space not immediately required. He thought of a scheme which would require roughly £300,000 in capital. He hoped that the chemical societies would invest some of their capital funds in a mortgage on the property. The space actually required for the chemical bodies, including a library of the size suggested to him by the Librarian of the Chemical Society, would be nearly 20,000 sq. ft.

The professional standing of chemists in the eyes of the world depended upon the public esteem of their work, and they must neglect no adventitious aid to publicity. They should use the importance of their headquarters as a piece of propaganda by assuring that their building had a frontage on to an important thoroughfare in London. This would, however, involve a rental equivalent to nearly £9000 per annum. They would, therefore, agree that the extent of the accommodation required even now by chemistry was such that a plan conceived on a small or voluntary scale would be likely to fail.

This standing rental of £9000 represented a subscription of about 15s. per head for every individual in the chemical bodies. They should, therefore, utilise the profits from their letting—(*a*) to produce a reasonable, though perhaps small, return on the capital; (*b*) to allow the chemical organisations to live rent free; and (*c*) to devote the residue either to further interest on the capital, or to reserve. They would, however, realise that with (*b*) fixed at £9000, if the scheme were not conceived on a broad plan, (*c*) would varnish and (*a*) would be reduced to negligible quantities. On the scale he had suggested it was possible to make the scheme succeed, but he doubted whether the scale could be reduced. It had been suggested that they should not combine business and sentiment by allowing the chemical societies to live rent free, but they must remember the extent to which they were now rent free, and must realise that whether they would or not, they were considering a matter which represented one of the ideals of chemists. It did not seem to him to matter very much to their pockets whether that £9000 were used in providing an additional 3 per cent. interest on the capital, or in reducing subscriptions to the chemical bodies by the amount of about 15s.

He trusted that the Chemical Industry Club would move to headquarters as one of their first tenants, and he was assured that it was possible to secure a site which would interest some large restaurateur to take a large amount of space for a public restaurant, thereby securing not only the catering department of the club and a convenience for chemists, but a permanent advertisement of chemistry's headquarters. He hoped that the rest of the space availabl for letting would be taken up very largely by chemica manufacturers or merchants, or by others intereste in the advancement of chemistry, so that Chemistr House would be a real chemical headquarters t which the world-wide interests in British chemistr would naturally gravitate.

It had been stated that the Institute's function differed so materially from those of the other bodie that it should not enter into a scheme of co-ordinatio. Further, it had been urged that the Institute possesse its own headquarters, which were stated to b adequate.

On the first point, it should be stated that, apar from pure circularisation, the Institute's organisatio was necessarily more complex and more complet than that of any of the societies, and for this reaso was the more easily adaptable to dovetail the simila activities of the other bodies in the general interests o economies for chemists. For this reason, and because the common housing of all the bodies woul tend to their *rapprochement*, he held that the Institut should *not* hold aloof, but should throw in its weight If the Institute held back, and chemists spoke stil with two voices, none could say whether the Institute or all the other bodies speaking as a federation, was correct. At great inconvenience the office accommodation of the Institute had been made sufficient fo immediate needs, and for slight expansion. It could not be further extended without utilising space intended and specially suitable for other purposes If the Institute moved its headquarters to Chemistry House, the present building could be utilised as a research building, a purpose for which a quarter of the useful floor space was already used, thus securing a valuable additional asset.

Discussion at Edinburgh Section

Mr. Adam Watson felt that many of them would hardly ever see Chemistry House and that, therefore, the project might not appeal to the provincial members. They would be interested to know to what extent it would be possible to arrange for composite subscriptions and whether the scheme for federation would be able to conceive not only one British journal of chemistry but an international Journal of chemistry which would avoid duplication. One of the great difficulties of the Local Sections was the lack of interest shown by their members. Dr. Dobbin felt that the financial aspect was likely to prove the greatest bar to the realisation of such a scheme. Moreover, in many provincial centres they wanted to form their own chemical clubs. He would welcome economy in publications but had Mr. Marlow considered the position of the trade press? Mr. Bruce welcomed the scheme from the point of view of the advancement of science. To too many members the Institute was considered merely as a qualifying body. Mr. Williamson said that in Edinburgh they were keen on local co-operation and their only regret was that London had held the first public meeting on the subject. The scheme was most attractive, but he was intrigued to know what would be the financial position of the company when the chemical organisations wanted all the space available in

Chemistry House. Mr. Martin asked how the proposals had been received by the other main societies interested. It was perfectly clear that such a scheme of co-operation would eliminate wasteful overlapping.

Mr. Williamson interposed to say he knew that the question of accommodation of the Society of Chemical Industry was really pressing, and that the matter had already been discussed. He agreed that co-operation would reduce labour. The Chairman, Dr. Lauder, thought that the main difficulty was that so many members lived in the provinces, and since they could not get to town they would have to be persuaded of the real value to themselves and to the profession of the scheme. He could understand that it might appeal more readily to the members in the South of England. There was no doubt, however, that co-operation in the Journal and on Section meetings was valuable.

In reply, Mr. Marlow said that the advantages of a common headquarters applied just as much to provincial members as to London members. The main point they must bear in mind was the fact that the scheme would be putting the finishing touches to the quiet but effective work of fifty years of Councils of the Institute on behalf of the profession, and they must remember that it would bring their profession more prominently before the eyes of the general public by whom, in the long run, their professional status was decided. He quite realised that it would not be easy to secure the funds, but he was not pessimistic. He would like to see the consolidated organisations fathering future projects for the housing of their Sections, but they must first see that chemists as a whole were housed adequately in the interests of the whole profession, and not give primary consideration to the interests of any one Local Section. The plan was conceived upon such a scale that not even the most optimistic chemist would anticipate that all the space would be needed for chemistry. The need of accommodation was perhaps more pressing in the case of the Chemical Society.

Discussion at Glasgow Section

Dr. Rintoul, the Chairman, thought that it was desirable that chemistry as a science should function as one unit. He welcomed the proposal that there should be one entity subdivided into the different departments. He hoped that the proposals would also have the effect of eliminating the need for the formation of further bodies. He realised, however, that the financial aspect was of vital importance and by no means easy.

Mr. McCallum asked whether Mr. Marlow favoured the proposals put forward at the Liverpool Conference for the federation of scientific societies, to which Mr. Marlow replied that in his opinion the whole chain of those proposals could not be brought to fruition until the important link of chemical consolidation had been securely forged.

The meeting unanimously passed a resolution supporting the resolution of the London Section asking the Council to take steps to ensure co-operation, and, on the motion of Mr. McCallum, the Section unanimously adopted a resolution that the Local Section of the Society of Chemical Industry be invited to discuss the London resolution and to support it.

Discussion at Birmingham Section

Prof. G. T. Morgan, F.R.S., the Chairman, having expressed sympathy with the project called upon Mr. Johnson, who discussed the position of the British Association of Chemists in connexion with co-operation. Mr. Silvester said that there had been much vague talk of these projects, and they were glad to have some conception of the difficulties which were to be faced and of the principles upon which they could be faced. The proposals were ambitious but not incapable of realisation.

Mr. Marlow, in reply, said that he believed that the Association had been formed in the first instance through an under-estimate of the powers of the Institute to safeguard the interests of chemists. Their Charter expressly said that one of the reasons for the formation of the Institute was the desire to advance the attainments, character, and status of chemists. He hoped, therefore, that when all chemists were working towards one end there would be no question of any differentiation between the Institute and any other body dealing with one of the functions allocated to the Institute under its Charter. Where they might at present differ was as to the method of accomplishment of that aim, but he hoped that the two bodies would consult together on the lines suggested at Liverpool.

SOCIÉTÉ DE CHIMIE INDUSTRIELLE

The Fuel Group met on March 12, under the presidency of Monsieur R. Etienne, to hear a paper by Monsieur J. A. Hardel on the possibility of industrial treatment of the bituminous shales of Madagascar. Monsieur Hardel first discussed the subject from the geological point of view, and gave some facts showing the industrial possibilities of the deposits, certain of them being large enough to permit of exploitation for hundreds of years. At present means of transit are very rudimentary, and both roads and railways will have to be established. Navigation on the local rivers would not be possible. The best way, therefore, would be to establish roads and pipe lines. Labour, food and fire-wood are abundant and would cause no difficulty. It would be advisable to work the deposits by shafts and to refine the material on the coast. The crude oil produced is similar to Mexican oil, and the shale yields from 80 to 100 litres of crude oil per ton using surface samples, so that larger yields could be expected at greater depths. Treatment could consist of dry distillation, which would be simple as the limits of distillation are small, or steam distillation, which would be very expensive. There is a new solvent method, however, which consists of treating the shale by solvents such as kerosene, heavy oil, paraffin, carbon disulphide, which extracts the oil and leaves the residue. To separate the useful products of this pasty solution it suffices to add an aqueous solution of sodium carbonate or soap, which separates the layer of solvent laden with oil from the sand and other impurities. Volatile solvents can be recovered afterwards.

CORRESPONDENCE

"THE UNQUALIFIED CHEMIST"

Sir,—The position to-day of chemists who have no degrees is in many respects similar to that of a large number of dentists prior to the enactment of the Dental Act of 1921. Just as to-day there are hundreds of men with theoretical knowledge, manipulative skill, and years of practical experience, but with no degrees, successfully filling important posts as chemists, so there were hundreds of men practising dentistry of equal ability to the qualified dentists.

The Dental Act sought to do for dentists what the Institute of Chemistry is, to a large extent, doing—and quite rightly—for chemists, viz., to ensure—as far as examinations can ensure—that those practising the science should have attained a definite standard of ability.

But whereas the framers of the Dental Act realised that it was in a great many cases both impractical and unnecessary for men with years of practice to sit for the same examinations as those just starting in the profession, *and made provision accordingly*, the Institute of Chemistry is, apparently, not disposed to take such a just and practical view as regards those who, as chemists, have proved their ability by a greater test than academical examinations—the test of time and experience.

If the Institute really seeks, as it professes, to help the *bona fide* chemist, it must seem to many that to work in the direction of getting the older and more experienced men regarded as unqualified simply because they have no degrees—and thereby minimise their chances of advancement—is hardly in accordance either with its protestations or with justice.—I am, Sir, etc., VH_2

A QUERY

Sir,—I take the liberty of enquiring whether one of the members of your *Journal* could advise me regarding a continuous centrifugal separator which would take only the solids (fine dirt) out of a fatty emulsion. The centrifugal used was only capable of effecting separation of a batch having an equivalent amount of dirt to that which the machine was capable of retaining (about 4 lb.) and choked after running for a quarter of an hour, when it had to be dismantled and cleaned; therefore, this is an impracticable machine for our purpose.

The fatty emulsion is the diluted grease recovered from the wool washers' effluent, which floats on the waters by the action of the nascent oxygen from the decomposition of hypochlorous acid, a very successful and infallible flotation process. When floated off the residual waters, the volume of recovered grease is 160 gallons at $9\frac{1}{2}$ lb. equals 1007 lb., containing 31 per cent. fat, 12 per cent. dirt, and 57 per cent. water, which varies from 0·25–1 g. and a litre. This is the recovery from the effluents of the two first bowls of a Leviathan machine, washing 9 bales of wool in an eight-hour day. This concentrated mixture was diluted to 3 or 4 times its volume and heated to 95° C., then stirred by live steam to give it uniformity for the separator. It was slightly acid just above neutral, and proved the dirt to be free—this coincided with the experience we had with the centrifugal.

I am afraid that if a hot filter press were used the acid would play havoc with the filter cloths, and here in Australia the washing and attention required to keep them in order would be a great worry. Water and oil make a bad combination to go through a filter, and it seems to me almost impossible to obtain the desired effect.

If the emulsion is free from foreign matters—which in fact are protective colloids—the fat will dissociate from the water by heat with the addition of a little acid.

I hope my appeal for advice on this matter will be accepted by the *Journal*, for it may start the principle of the *Journal* being the medium to assist members and others with advice when they are up against a problem and may elucidate problems which would interest many. Might I suggest that you even devote a special page (printed on a different coloured paper so as to differentiate from the main body of the *Journal*) in your *Journal* for this purpose. Here in Australia we are very inefficiently informed of mechanical appliances relating to chemical industries.

Trusting soon to have a reply in answer to my request,—I am, Sir, etc., JEAN DE RAEVE

Sydney, Australia
Feb. 20, 1924

THE INSTITUTE OF CHEMISTRY

Sir,—The letters you have published on the subject of the Institute of Chemistry seem to me to be rather spoiled by what I may call a touch of rancour. Your own subtle references to a certain vulpine bolshevist pleased me much, but I have to confess that I, too, am one of the foxes though I have nothing but praise for the grapes.

Seriously, then, and without in any way wishing to cast doubts on the good intentions of the Institute, may I ask what provision exists for the case of the man trained as articled pupil (exactly as your other letters describe) who has attained to a position of responsibility and yet who cannot afford time for intensive study nor for exams., even if he still have the power to pass set tests? It must be admitted that there is a time of life for passing exams. which passes away about the thirties, and after that time it is the experience and knowledge, tact and organising ability that find responsible positions for chemists.

Will not the Institute state clearly whether or no there is a means whereby some of the older people can lend their support to what they all consider to be the accredited Institution of British Chemistry?—I am, Sir, etc., R. G. JOHNSTON,
Scientist in charge

Midland Laboratory Guild, Ltd.,
Metallurgical Laboratories,
King Alfred's Place,
Broad Street, Birmingham
March 28, 1924

ROTATORY DISPERSION

Sir,—Dr. E. E. Walker, in his letter of March 28 rather misses the point of my remarks in the discussion at the Chemical Society on March 20. As I understand the present position of the numerous investigations of rotatory dispersion, it can be summarised as follows :—

(*a*) For a long time it has been recognised that a mixture of two substances of unequal dispersive power and of rotatory powers of opposite sign will exhibit the phenomenon of anomalous dispersion.

(*b*) The most refined methods at present employed for the determination of rotatory power give results which can be expressed by not more than two terms of the Drude dispersion equation.

(*c*) The majority of substances apparently require only one term of the Drude equation to express adequately their dispersive powers.

(*d*) The hypothesis has been advanced that in the case of a substance requiring two terms of the equation to express its dispersive powers, the substance in the chemical sense is heterogeneous, and is assumed to be a mixture of dynamic isomerides.

(*e*) The greatest refinement of polarimetric measurements, however, hardly allows of a distinction between the cases in which one term of the Drude equation is sufficient and those in which two terms are required to express the rotatory dispersion, except when the two terms are of opposite sign, the case which corresponds to "anomalous rotation."

(*f*) Attempts to ascribe chemical significance to varieties of rotatory dispersion are becoming increasingly difficult as facts accumulate.

(*g*) Dynamic isomerides in the case of tartaric acid and its derivatives have not been isolated, but merely postulated.

It is true that the hypothesis of the existence of dynamic isomerides does account for the fact of the rotatory dispersion of tartaric acid and its esters as outlined in Dr. Walker's letter, but is this hypothesis necessary ? The theory underlying the Drude equation is that the rotatory dispersion is controlled by absorption bands: the addendum advanced by several authors that each absorption band indicates (or belongs to) a distinct dynamic isomeride is not supported by the experimental results so far obtained.

It therefore appears to me that Dr. Austin, Prof. Lowry and their collaborators are unwise to allow the exuberance of their enthusiasm for theoretical views to tempt them to write as if the existence of these dynamic isomerides, which have been so often postulated, has been definitely detected. It seems unscientific to do so, and is a practice, in my opinion, to be deprecated.

Messrs. Austin and Carpenter are to be congratulated on their experimental results obtained with *solutions* of the methylene derivatives of tartaric acid, but these do not, in my opinion, throw any light on Dr. Astbury's deductions from results obtained by X-ray examination of tartaric acid *crystals*.—I am, Sir, etc.,

ROBERT H. PICKARD.

PERSONAL AND OTHER ITEMS

Dr. J. I. O. Masson, M.B.E., Reader in inorganic chemistry at University College, London, has been appointed professor of chemistry and director of the Science Department in the University of Durham. Dr. Masson is one of the secretaries of the Chemical Society.

We are pleased to announce that Mr. William Cullen has become an honorary LL.D. of the University of the Witwatersrand, an honour in which he is preceded only by General Smuts.

The next meeting of the London Section will be held in the Royal Institution and Prof. H. E. Armstrong, F.R.S., will give an address on Sir James Dewar as an experimental inquirer in interpretations of his work. The meeting is open to Fellows of the Chemical Society, who are cordially invited.

The Council of the British Association has resolved to nominate Dr. Horace Lamb, F.R.S., formerly Professor of Mathematics in the University of Manchester, as President of the Association for the Southampton Meeting in 1925.

The centenary of J. Pullar and Sons, the largest dyeing and cleaning company in the world, was celebrated on March 26, in Perth. It is interesting to recall that this firm was the first to use the first coal-tar dyestuff when it was made by Perkin in 1856.

W. E. Sanger, who died recently in Chicago, was an authority on the technology of glycerin manufacture, and had done much work on the chemical engineering of various branches of the oils and fats industry.

The death is announced of Prof. H. Wolpert, formerly director of the Prussian Landesanstalt für Wasserhygiene, and co-author, with his father, of a large treatise on the theory and practice of ventilation and heating.

Prof. M. Gildemeister has succeeded the late Prof. V. Garten in the chair of physiology in the University of Leipzig.

Dr. H. Sandqvist, lecturer in the chemistry and technology of wood at the Hernösand Technical *Hochschule*, has been appointed professor of chemistry and pharmacy in the Pharmaceutical Institute of Stockholm.

The Oppau Explosion

The programme of the meeting of the Faraday Society to be held on Monday, April 14, in the Rooms of the Chemical Society, will include a Report on an investigation of the chemical, physical and explosive properties of Oppau ammonium sulphate-nitrate by Sir R. Robertson and Dr. G. Rotter, with Appendices by Dr. H. H. Thomas, Mr. A. L. Hallimond and Sir W. Bragg. A short introduction by Sir R. Threlfall will precede the report, giving briefly the conclusions of the Chemistry Research Board as to the causes of the Oppau explosion in 1921. Advance copies of the papers will be available (price 2s. to non-members) on application to the Faraday Society, 10, Essex Street, Strand, W.C. 2.

REVIEW

Cobalt Ores. *By* E. Halse. *Monograph of the Imperial Institute. Pp.* 54. *London: John Murray. Price* 3*s.* 4*d.*

"Cobalt Ores" is a compilation of information which has been published during recent years on the occurrences and sources of supply of cobalt, both within the Empire and in foreign countries. It includes such meagre and statistical information as is available and also provides a useful list of references, general and geographical, to the literature on the subject.

That part of the monograph dealing with the sources is handled well, but one is disposed to question the accuracy of some of the remarks which occur in the introductory chapter. For instance, the author says that "nickel and cobalt may be regarded as interchangeable for many purposes"; one cannot recall any commercial or industrial use of cobalt where nickel could be substituted, although it is possible that, were cobalt cheaper, it might replace nickel for electro-plating.

The author appears to be somewhat pessimistic regarding the future of cobalt unless it can be produced at a lower cost. The chief use for cobalt still lies in the ceramic industry, but, notwithstanding an actual increase in price during very recent years, its application is appreciably extending, especially in the form of metal; witness its use in the manufacture of permanent magnets to replace tungsten and other steels.

REPORT

Report on the Present State of Knowledge of Accessory Food Factors (Vitamins). *Second edition, revised and enlarged. Compiled by a Committee appointed jointly by the Lister Institute and the Medical Research Council. H.M. Stationery Office,* 1924. *Price* 4*s.* 6*d.*

To the many students of nutrition who wish for an authoritative account of the present state of knowledge of vitamins and who have not the time to follow the original literature on the subject, this report will prove most valuable. It contains practically all the material embodied in the first edition, together with accounts of research work which is being carried out by experimenters in an ever-increasing number of countries. The section on pellagra has been omitted, for whilst this is still regarded as a disease of dietetic origin, it is thought to be due to some quantitative or qualitative defect in the protein of the diet, rather than to a deficiency of some accessory food factor. It is a remarkable fact that in the early history of a subject, such as the whole study of vitamins, very little work has had to be contradicted, and that it has been found possible to reconcile the very different views on the cause of rickets, though not to explain why they are reconcilable.

Much of the earlier work on accessory food factors was necessarily undertaken to determine which foods did or did not contain the various vitamins, for the use of food substitutes during the war gave rise to very serious consideration on this point. During the last four years, however, work has been directed more to the scientific and clinical aspects of the subject. It has been possible to determine some of the physical and chemical properties of each vitamin, but no vitamin has yet been isolated, and practically nothing is known of their immediate action in the animal body.

The technique for testing for the vitamins A and B has been refined somewhat, so that more exactly quantitative comparisons can be made between different substances.

It seems to be established that the vitamin A content of the fat, milk, etc., of an animal is directly dependent on the diet, and it has been shown that this content can be greatly increased by adding cod-liver oil to a diet, otherwise poor in vitamin, such as cows receive in winter. The rich stores of this vitamin in the liver oil of the cod have been traced through intermediate animals to the diatoms eaten by the various species of copepods and other animals which form the plankton of the sea. The wide variations in vitamin content found in different samples of cod-liver oil seem to be due not so much to differences in preparation of the oil as to differences in the physiological condition of the fish when caught.

The question of the formation of vitamin A in plant tissues is dealt with, and the possibility of its growth-promoting function being due to a substance other than the rickets-preventing substance is considered. There is a short summary of its properties as at present determined, such as its solubility, stability to heat, and susceptibility to oxidation.

The more recent work on vitamin B has been chiefly chemical and physical. Its stability to oxidation has been demonstrated and some idea of the size of its molecules, or of aggregates of its molecules, has been gleaned from the fact that it will pass through permeable membranes which allow methylene blue and safranine to pass. Other work has been attempted, with varying results, on the physiological significance of vitamin B.

Similar experiments have also been carried out on vitamin C.

Perhaps the most striking part of this report is the summary of Dr. Harriette Chick's work on rickets in children in Vienna, the full account of which has been published as a separate report (No. 77 of this series). Her general conclusions are that rickets may be prevented by a diet rich in the anti-rachitic factor (which may or may not be identical with the growth-promoting vitamin A) even in the absence of sunlight, but that sunlight, such as obtains in the summer months in Vienna, prevented and even cured many sufferers from rickets when the diet was very poor in the anti-rachitic factor. Experiments performed by various workers on rats with ultra-violet light and also with sunshine have supported these conclusions. No theory of the interaction of the two factors, vitamin and sunlight, has as yet been postulated.

The report concludes with chapters on the diet of adults, the nutrition of infants, and the influence of

liet on teeth; and there is a bibliography of some ten pages, which is a significant increase on the three or four pages of the earlier issue.

The various sections of the book are interestingly written; experimental work has been accurately recorded and evidence for conflicting opinions on subjects even yet little understood has been carefully balanced. It will prove a reliable book of reference for the student of vitamins and should supply the ever-increasing demand for a sound outline of a subject which hitherto has only been obtainable in cumbersome and expensive volumes.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Dyestuffs and the German Reparation Duty

In reply to Mr. Waddington, Mr. Webb said he was aware that the price of German dyestuffs had not been reduced, but practically the whole of the German dyestuffs imported into this country during the last few months had been against contracts made prior to November 17 last, and in respect of which the German Government undertook to continue to refund the amount of reparation levy, provided that delivery were made before the end of March, 1924. The price of deliveries made after that date would have been subject to an increase corresponding to the amount of the levy. The present position was, therefore, that now the British importer pays 95 per cent. of the purchase price of any dyes imported to the German exporter, and 5 per cent. to the Customs, instead of 74 per cent. to the exporter and 26 per cent. to the Customs, as was formerly the case. Consequently no reduction in prices was to be expected.—(Mar. 20.)

COMPANY NEWS

BELL'S UNITED ASBESTOS, LTD.

A dividend is announced of 1s. 6d. per share on the ordinary shares, making a total distribution for the year of 10 per cent. It is proposed to increase the reserve by £10,000 to £38,000, and to carry forward £31,483. In 1922 the dividend was 10 per cent. and the carry forward £37,911.

BRITISH DYESTUFFS CORPORATION, LTD.

The report for the year ended October 31, 1923, reveals profits amounting to £251,422, against £102,657 in 1921-22. Depreciation is fixed at £360,025, against £411,382, the percentage allowance being the same. The fixed assets of the associated companies have been written down by £458,003 to £3,273,732, the Corporation having included £100,000 formerly held as a reserve for research. Stocks, valued on a conservative basis, stand at £1,601,708, against £1,870,000, and goodwill, patents, etc. have been reduced from £1,000,000 to £750,000 as the result of sums receivable from E. I. Du Pont de Nemours and Co.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech.	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5½d. per lb.
Potass. Chlorate	3d.—3¼d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide	Expected to advance in sympathy with the crude metal.
Golden	5½d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide	4s. per lb.
Carbon Bisulphide	£24—£26 10s. per ton according to quantity.

Carbon Black	Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.
Lamp Black	40s. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	3s. 4d.—3s. 6d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade, but these are the only products in this section which show any activity.

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£21 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 10s. per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. " " 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall. 60% O.P. Dull market.
Solvent	5s. per gall. 40% O.P. Dull market.
Wood Tar	£5—£6 per ton according to grade. Demand not very brisk. Ample supplies.
Brown Sugar of Lead	£47 per ton. Demand active.

TAR PRODUCTS

Acid Carbolic—	
Crystals	7¾d.—8d. per lb. Better demand, and firmer market. London prices reported up to 9d.
Crude 60's	2s.—2s. 3d. per gall. Market stronger; better demand.
Acid Cresylic, 97/99	1s. 11d.—2s. 1d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—2s. per gall. Steady demand.
Dark	1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	10d.—11d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Benzole, Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 4½d.—1s. 7d. per gall.
Toluole—Pure	1s. 8d.—1s. 11d. per gal
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	10½d. per gall. Few inquiries.
Middle Oil, Heavy, Standard Specification	7¾d.—8½d. per gall. according to grade and district. Market easier.
Naphtha—	
Crude	8d.—9d. per gall. Better demand. Prices show upward tendency.
Solvent 90/160°	1s. 2d.—1s. 4d.
Solvent 90/190	1s. 2d.—1s. 3d.
Naphthalene Crude—	
Drained Creosote Salts	£7—£8. Demand not so good.
Whizzed or hot pressed	£9 10s.—£12 per ton. Not much inquiry.
Naphthalene—	
Crystals and Flaked	£18—£19 per ton.
Pitch, medium soft	57s. 6d.—62s. 6d. per ton. Market dull.
Pyridine—90/140	17s. 6d.—18s. per gall. Demand well maintained.
Heavy	11s.—12s. Few inquiries.

INTERMEDIATES AND DYES

Business in dyestuffs has increased and reflects an improvement in the textile trade. Orders have been for larger quantities than of late. Prices remain firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 6d. per lb.
Acid H.	4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 10d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 4d. per lb. Steady demand.
Acid Sulphanilic	10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4¾d.—5½d. per lb. Demand moderate.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	5s. per lb. d/d., packages extra, returnable.
Dimethyaniline	2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluence—48/50°C.	8d.—9d. per lb. naked at works.
66/68°C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. 3d. per lb. d/d.
Monochlorbenzol	£63 per ton.
α Naphthol	2s. 5d. per lb. d/d.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11¾d. per lb. d/d.

p-Nitrophenol .. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol 4s. 6d. per lb. 100% basis.
m-Phenylene Diamine .. 4s. 2d. per lb. d/d.
p-Phenylene Diamine .. 10s. 6d. per lb. 100% basis d/d.
R. Salt .. .. 3s. per lb. 100% basis d/d.
Sodium Naphthionate .. 2s. 6d. per lb. 100% basis d/d.
o-Toluidine .. .. 8½d. per lb.
p-Toluidine .. .. 3s. 10d.—4s. 3d. per lb. d/d.
m-Toluylene Diamine .. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P. .. £50 per ton. Market easier.
Acid, Acetyl Salicylic .. 3s. 6d.—3s. 9d. per lb. Best known makes firmer.
Acid, Benzoic .. .. Commercial acid 2s. 6d. per lb. B.P. quality is being sold in small lots at 4s. 6d. lb.
Acid, Boric B.P. .. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric .. 19s.—21s. per lb. Advanced by 1s. per lb.
Acid, Citric .. .. 1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic .. .. 3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst. .. 6s. per lb., for 28 lb. lots.
Acid, Salicylic .. .. Prices quoted from 2s. 3d. per lb. down to 1s. 10d. for ton lots. In steady demand.
Acid, Tannic B.P. .. 3s. per lb. Market quiet.
Acid, Tartaric .. .. 1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol .. .. .. 9s. per lb. d/d.
Acetanilide .. .. 2s. 9d. per lb. for quantity. Larger supplies available.
Amidopyrin .. .. 14s. per lb. Slightly dearer.
Ammon. Benzoate .. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P. £37 per ton.
Atropine Sulphate .. 12s. per oz. for English make.
Barbitone .. .. 15s. 6d. per lb. Weak market.
Benzonaphthol .. .. 6s. 3d. per lb. Firmer.
Bismuth Salts .. .. A steady market. Prices according to quantity:
Bismuth Carbonate .. 12s. 9d.—14s. 9d. per lb.
" Citrate .. .. 11s. 4d.—13s. 4d. "
" Salicylate .. 10s. 2d.—12s. 2d. "
" Subnitrate .. 10s. 9d.—12s. 9d. "
Borax B.P. .. .. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides— Per lb.
Potassium .. .. 9d.
Sodium .. .. .. 9d.
Ammonium .. .. 10½d.
} Slightly firmer.
Calcium Lactate .. Prices vary over a wide range. Good English make can be had from 1s. 7d. to 2s. 3d. per lb.
Chloral Hydrate .. .. 3s. 9d. per lb.
Chloroform .. .. 2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate .. 6s. per lb. Little demand.
Guaiacol Carbonate .. 12s. 6d. per lb. for cwt. lots.
Hexamine .. .. 3s. 6d.—3s. 9d. per lb. for foreign makes. Weaker. Without much inquiry.
Homatropine Hydrobromide .. .. .. 30s. per oz.
Hydroquinone .. .. 4s. 3d. per lb. Foreign make.
Iron. Ammon. Citrate B.P. 1s. 11d.—2s. 3d. per lb., according to quantity.

Magnesium Carbonate—
Light Commercial .. £ per ton net.
Magnesium Oxide—
Light Commercial .. £75 per ton, less 2½%
Heavy Commercial .. £26 per ton, less 2½%
Heavy Pure .. .. 2s.—2s. 6d. per lb., according to quantity. Steady market.
Menthol—
A.B.R. recryst. B.P. .. 60s. per lb. Market firmer.
Synthetic .. .. 26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials .. .. Very much firmer in view of the rise in the price of quicksilver. Higher prices expected.
Red oxide .. .. 4s. 9d.—4s. 10d. per lb.
Corrosive sublimate .. 3s.—3s. 1d. "
White precip. .. .. 4s. 1d.—4s. 2d. "
Calomel .. .. 3s. 5d.—3s. 6d. "
Methyl Salicylate .. 2s. 7d.—2s. 9d. per lb. for carboys. Weaker than other salicylates.
Methyl Sulphonal .. 24s. per lb.
Paraformaldehyde .. 3s. 6d. per lb., without much inquiry.
Paraldehyde .. .. 1s. 4d.—1s. 7d. per lb. in free bottles and cases.
Phenacetin .. .. 7s. per lb. Firmer.
Phenazone .. .. 7s. 6d. per lb. for cwt. lots. Spot prices much lower than forward offers. Firmer tendency.
Phenolphthalein .. .. 7s. 3d.—7s. 6d. per lb. Firm.
Potass. Bitartrate—99/100% (Cream of Tartar) .. .. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate .. .. 1s. 8d.—2s. per lb.
Potass. Iodide .. .. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite .. 7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate—
B.P. Crystal .. .. 8¾d.—9d. per lb. carriage paid. English make.
Commercial .. .. 8d.—8¼d. per lb. carriage paid. English make.
Quinine Sulphate .. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin .. .. .. 6s. 3d. per lb.
Salol .. .. .. 3s. 9d. per lb.
Silver proteinate .. .. 10s. per lb.
Sod. Benzoate, B.P. .. 3s. 3d. per lb. In more plentiful supply.
Sod. Citrate, B.P.C., 1923 1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite—
Photographic .. .. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst. 37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside .. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt) .. 76s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.
Sod. Salicylate .. .. Market firmer. Powder 2s. 8d.—2s. 10d. per lb. Crystal at 2s. 9d.—2s. 11d. per lb. Flake 2s. 10d.—3s. 4d. per lb.
Sod. Sulphide—
Pure recryst. .. .. 10d.—1s. 2d. per lb., according to quantity.

Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	18s. 6d. per lb.
Tartar Emetic	1s. 4d. per lb.
Thymol	13s. 6d.—15s. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine	13s. 6d. ,,	
Amyl Acetate	2s. 9d. ,,	Cheaper.
Amyl Butyrate	7s. 3d. ,,	
Amyl Salicylate	3s. 6d. ,,	
Anethol (M.P. 21/22° C.)	4s. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. ,,	
Benzyl Alcohol free from Chlorine	3s. 3d. ,,	
Benzaldehyde free from Chlorine	3s. 6d. ,,	
Benzyl Benzoate	3s. 6d. ,,	
Cinnamic Aldehyde Natural	15s. 6d. ,,	Cheaper.
Coumarin	20s. ,,	
Citronellol	16s. ,,	
Citral	10s. ,,	
Ethyl Cinnamate	15s. ,,	
Ethyl Phthalate	3s. 9d. ,,	
Eugenol	11s. ,,	
Geraniol (Palmarosa)	35s. ,,	
Geraniol	11s.—18s. 6d. per lb.	Advanced.
Heliotropine	8s. 3d. per lb.	
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose	21s. 6d. ,,	
Linalyl Acetate	21s. 6d. ,,	
Methyl Anthranilate	9s. 6d. ,,	
Methyl Benzoate	6s. ,,	
Musk Ambrette	52s. 6d. ,,	
Musk Xylol	19s. ,,	
Nerolin	4s. ,,	
Phenyl Ethyl Acetate	12s. 6d. ,,	
Phenyl Ethyl Alcohol	16s. ,,	
Rhodinol	57s. 6d. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. [illegible] ,,	
Vanillin	25s. 3d.—26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	15s. 6d. per lb.	Dearer.
Aniso Oil	2s. 7½d. per lb.	Firmer market forward.
Bergamot Oil	17s. per lb.	
Bourbon Geranium Oil	32s. ,,	
Camphor Oil	75s. per cwt.	
Cananga Oil, Java	9s. 9d. per lb.	
Cinnamon Oil, Leaf	6½d. per oz.	
Cassia Oil, 80/85%	9s. 3d. per lb.	
Citronella Oil— Java 85/90%	5s. 3d. ,,	
Ceylon	3s. 9d. ,,	
Clove Oil	8s. 4½d. ,,	
Eucalyptus Oil 70/75%	2s. 3d. per lb.	
Lavender Oil— French 38/40% Esters	26s. per lb.	Advan[illegible]
Lemon Oil	3s 4d. ,,	
Lemongrass Oil	2¾d. per oz.	
Orange Oil, Sweet	13s. per lb.	Ad[illegible]
Otto of Rose Oil— Bulgarian	30s. per oz.	
Anatolian	24s. 6d. per [illegible]	
Palma Rosa Oil	18s. 6d. per lb.	Very short supply.
Peppermint Oil— English	75s. per lb.	Advanced 5s. per lb.
Wayne County	21s. per lb.	Again advanced.
Japanese	18s. per lb.	but very little being offered.
Petitgrain Oil	9s. 9d. per lb.	Advanced.
Sandal Wood Oil— Mysore	25s. per lb.	
Australian	21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted, those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition within two months of the date given; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, 15 days after the date given.

I.—Applications

Bingham, and Huntington, Heberlein and Co. Apparatus for separating granular materials from water. 7155. Mar. 20.

Brégeat. Purification of products using alcohol as a solvent. 7086. Mar. 19. (Austria, 15.12.23.)

Carlsson. Manufacture of finely-dispersed substances. 7284. Mar. 21. (Sweden, 6.2.24.)

Davidson and Winzer. Kilns. 7249. Mar. 21.

Field. Recovering solids. 7082. Mar. 19.

Fritz. Hydrating, heating, and refining machines. 6820. Mar. 17.

Fulcher. Straining or filtering apparatus. 7040. Mar. 19.

Golding, Pritchard, and United Alkali Co. Means for effecting absorption of gases. 7268. Mar. 21.

Imray (International Combustion Engineering Corp.). Pulverizing-mills. 6968. Mar. 17.

Koppers Coke Oven Co., Ltd. (Koppers). Tunnel ovens and kilns. 7174. Mar. 20.

Lemmens. Filters. 7066. Mar. 19.

Lomax. Preparation of solutions of solid or other soluble materials. 7337. Mar. 22. (U.S., 4.4.23.)

Mayhew and Ramsay. Grinding, milling, and pulverizing apparatus. 7354. Mar. 22.

Pink. Apparatus for separating liquids of different specific gravity. 7181. Mar. 20.

Weeker. Separating volatile substances from non-volatile etc. substances. 7091. Mar. 19. (Ger., 20.3.23.)

I.—Complete Specifications Accepted

24,045 (1922) and 5348 (1923). Woodall, Duckham, and Jones (1920), Ltd., and A. M. Duckham. Annular muffle furnaces or ovens. (212,585.) Mar. 26.

34,142 (1922). Sonsthagen, Wood, and Keenok Co., Ltd. Emulsifying-apparatus. (212,642.) Mar. 26.

8531 (1923). Arpin. Separating mixed materials. (212,752.) Mar. 26.

17,329 (1923). Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges.). Electrical precipitation of suspended particles from gaseous fluids. (212,811.) Mar. 26.

29,591 (1923). Naamlooze Vennootschaap Montaan Metaalhandel. Process for re-activating adsorption media. (207,547.) Mar. 26.

II.—Applications

Charpentier and Henneberg. Manufacture of fuel alcohol. 7152. Mar. 20. (Fr., 20.6.23.)

Charpentier and Henneberg. Manufacture of fuel alcohol. 7153. Mar. 20. (Fr., 10.12.23.)

Donald. Drying peats etc. 7231. Mar. 21.

Dupuy. Manufacture of artificial fuel. 6783. Mar. 17. (Fr., 29.3.23.)

Edser, and Minerals Separation, Ltd. Flocculation and briquetting of coal. 6933. Mar. 18.

Fox and Malone. 7007. See XXIII.

Graer. 6751. *See* VII.

Hackford and Koopman. Combustion of gaseous fuel. 7160. Mar. 20.

Hahn. Utilisation of liquid fuels. 6791. Mar. 17.

Hirchberg. Treatment of hydrocarbon oils. 6817. Mar. 17.

Illingworth Carbonization Co., Ltd., and Illingworth. Drying and mixing coals. 6835. Mar. 17.

Lowe. Retort settings for distillation of coal. 7330. Mar. 22.

Perten. Manufacture and regeneration of decolorising charcoal. 6826. Mar. 17. (Czecho-Slovakia, 19.3.23.)

Urbain. Manufacture of agglomerated carbonaceous material. 7033. Mar. 19. (Fr., 25.6.23.)

Urbain. Treatment of gases etc. 7129. Mar. 20. (Fr., 13.7.23.)

Urbain. Purification of distillation gases etc. 7230. Mar. 21. (Fr., 13.10.23.)

Urbain. Apparatus for treating gases etc. 7305 and 7379. Mar. 22. (Fr., 9 and 26.1.24.)

Wisner. Process of evolving hydrocarbon from fuel. 6816. Mar. 17. (U.S., 11.6.23.)

Zuyderhoudt. Low-temperature carbonisation. 7262. Mar. 21.

II.—Complete Specifications Accepted

20,152 (1922). Remfry. Treatment of liquid hydrocarbons and more especially cracked spirit. (212,500.) Mar. 26.

34,513 (1922). Illingworth. Manufacture of briquettes. (212,663.) Mar. 26.

34,745 (1922). Seigle. Distillation and depolymerisation of liquid or liquefiable hydrocarbons. (190,723.) Mar. 26.

34,931 (1922). Pickard. Production of explosive mixture for internal-combustion engines. (212,669.) Mar. 26.

10,526 (1923). Fairweather. Apparatus for the fractional distillation of oils from oil-shale or similar material. (212,770.) Mar. 26.

16,950 (1923). Paul-Schiff and Co., and Borchers. Arc-lamp carbons and electrodes. (201,537.) Mar. 26.

18,947 (1923). Klotzer. *See* III.

28,759 (1923). Marks (Siemens und Halske Akt.-Ges.). *See* XXIII.

III.—Complete Specification Accepted

18,947 (1923). Klotzer. Method of extracting tars and gases from bitumen-containing materials. (212,828.) Mar. 26.

IV.—Applications

Beckett, Thomas, Tonkin, and Scottish Dyes, Ltd. Dyestuffs and intermediates. 7255. Mar. 21.

British Dyestuffs Corporation, Ltd., and Hodgson. Manufacture of hydroxybenzaldehydes. 7057. Mar. 19.

V.—Application

Moses. Paper products. 7342. Mar. 22.

VI.—Applications

Ashworth. Process for finishing yarn etc. after dyeing. 6902. Mar. 18.

Farbwerke vorm. Meister, Lucius, und Brüning. Dyeing wool. 7083. Mar. 19. (Ger., 19.3.23.)

McCullum and Nelson. Dyeing fabrics. 7322. Mar. 22.

VI.—Complete Specifications Accepted

8079 (1923). Courtaulds, Ltd., and Wood. Apparatus for use in dyeing, or otherwise treating with liquid, fibrous materials in skeins. (212,749.) Mar. 26.

16,134 (1923). Gentner. Method of colouring fibrous materials. (212,804.) Mar. 26.

26,006 (1923). Ness. Apparatus for dyeing textiles. (205,812.) Mar. 26.

VII.—Applications

Chemische Fabrik Von Heyden Akt.-Ges. Manufacture of soluble antimony compounds. 7378. Mar. 22. (Ger., 23.3.23.)

Dicker (Permutit Co.). 6829. *See* XIX.

Graer. Production of pure hydrogen gas. 6751. Mar. 17. (Belgium, 17.3.23.)

VII.—Complete Specification Accepted

10,133 (1923). Sulfur Akt.-Ges., and Franck. Process and apparatus for the manufacture of sulphuric acid. (212,768.) Mar. 26.

IX.—Application

Rigby. Manufacture of cement in rotary kilns. 7097. Mar. 20.

X.—Applications

Allmänna Ingeniörsbyran H. G. Torulf. Means for sintering ores. 6929 and 6985. Mar. 18. (Sweden, 22.8.23.)

Brymbo Steel Co., Ltd., and Hollings. Heat-treatment of silicon steel. 7208. Mar. 21.

Dicker (Chief Consolidated Mining Co.). 6830. Mar. 17.

Heal, and Metals Production, Ltd. Smelting metalliferous materials. 7064. Mar. 19.

McMorland. Flux for soldering etc. 6905. Mar. 18.

New York Zinc Co., Inc., and Wade. Dehydrating minerals. 6953. Mar. 18. (U.S., 28.3.23.)

Stig. Production of alloyed steel etc. with chromium, manganese, etc. 7374. Mar. 22.

X.—Complete Specification Accepted

28,208 (1922) and 6099 (1923). Keet. Concentrators for ores. (212,598.) Mar. 26.

860 (1923). Rowley and Rowley. Blast furnaces. (212,685.) Mar. 26.

8396 (1923). Mumford and Butterworth. Soldering aluminium. (212,751.) Mar. 26.

17,252 (1923). Soc. Anon. des Hauts Fourneaux, Forges, et Aciéries de Pompey. Process in the manufacture of manganese steels. (201,539.) Mar. 26.

XI.—Applications

Burnett and Haddon. Accumulator grids or plates. 7061. 7062. Mar. 19.

Burnett and Haddon. Accumulators or storage batteries. 7063. Mar. 19.

Edridge. Galvanic batteries or cells. 6775. Mar. 17.

XI.—Complete Specification Accepted

17,329 (1923). Lodge-Cottrell, Ltd. (Metallbank und Metallurgische Ges.). *See* I.

XII.—Application

Weygang. Manufacture of soluble or miscible oils, greases, and fats. 7178. Mar. 20.

XIII.—Applications

Carr. Composition for manufacture of linoleum etc. 7005. Mar. 19.

Marston. Transfer ink for producing indelible markings upon fabrics. 6950. Mar. 18.

Pollak. 7297. *See* XX.

XIV.—Applications

Barber. Methods of covering surfaces with india-rubber etc. 6796. Mar. 17.

Jeffrey. Manufacture of rubber compositions from latex. 6954. Mar. 18.

XIV.—Complete Specification Accepted

3712 (1923). Hopkinson. Mixing compounding ingredients with rubber latex etc. (193,044.) Mar. 26.

XV.—Application

Kernot. Manufacture of glue, gelatin, and meal from fish offal, etc. 6943. Mar. 18.

XV.—Complete Specification Accepted

15,900 (1923). Tapparelli. Radio-active hides and skins, leather, furs, and the like. (212,803.) Mar. 26.

XVII.—Complete Specification Accepted

11,312 (1923). Vereinigte Mautner'sche Presshefe-Fabriken Ges. *See* XVIII.

XVIII.—Applications

Baker. Frothing of liquids. 7171. Mar. 20.

Distillers Co., Ltd., and Meyer. Dehydrating alcohol. 7361. Mar. 22.

XVIII.—Complete Specification Accepted

11,312 (1923). Verinigte Mautner'sche Pressbefe-Fabriken Ges. Process for the clarifying and purifying of molasses for the manufacture of compressed yeast. (196,926.) Mar. 26.

XIX.—Complete Specifications Accepted

Daus. Process for making preserved foods. 7307. Mar. 22.

Dicker (Permutit Co.). Treatment of glauconite for water-softening. 6829. Mar. 17.

Kernot. 6943. *See* XV.

Lainfiesta. Flavouring extract. 7070. Mar. 19.

Oelwerke Noury & Van der Lande Ges. Treatment of meal or flour etc. 7092. Mar. 19. (Ger., 19.3.23).

XX.—Applications

British Dyestuffs Corporation, Ltd., and Hodgson. 7057. *See* IV.

Naef & Co. Manufacture of dl-nerolidol. 6824. Mar. 17. (Swiss, 22.3.23).

Naef & Co. Manufacture of farnesol. 6825. Mar. 17. (Swiss 22.3.23).

Pollak. Manufacture of condensation products from urea etc. and formaldehyde. 7297. Mar. 21. (Austria, 31.3.23.)

Standard Development Co. Manufacture of metallo-organic compounds.

XX.—Complete Specifications Accepted

14,282 (1923). Durand und Huguenin Akt.-Ges. Manufacture of highly-chlorinated hydroaromatic products containing nitrogen. (198,676.) Mar. 26.

17,466 (1923). Soc. Chimique des Usines du Rhône. Process for the preparation of diethylchloracetamide. (209,706.) Mar. 26.

XXIII.—Applications

Brown. Automatic apparatus for volumetric analysis. 7006. Mar. 19.

Fox and Malone. Gas-analysis apparatus. 7007. Mar. 19.

Scholes. Calorimeters. 7008. Mar. 19.

XXIII.—Complete Specification Accepted

28,759 (1923). Marks (Siemens u. Halske Akt.-Ges.). Apparatus for testing gas mixtures. (212,852.) Mar. 26.

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—

Argentina: Paper (9401/F.L./M.C./A. 2). *Australia*: Hardware, glassware (324); Ironmongery, builders' hardware, cutlery (325); *Brazil*: Iron, paint, cement (352); *Greece*: Sugar (334); *Latvia*: Portland cement, iron, coal tar, copper, asbestos powder (9029/F.R./G.P.); *Netherlands*: Hardware tools (341); *Norway*: Shipbuilding material (345); *Spain*: Machinery and raw materials for the manufacture of paper and of earthenware (348); *Sweden*: Sulphate of alumina (349); *Turkey*: Hardware (350).

German Industry in February

According to a report by H.M. Commercial Secretary, Berlin, economic life in Germany is slowly recovering from the decline which occurred late in 1923. Output in the basic industries increased, unemployment decreased, prices fell slightly, and trade expanded. The coal industry is still in a poor state, and sales of potash have not improved, despite the reduction of prices. In the iron and steel industry, high freightage and Belgian and French competition are serious difficulties. No change is recorded in the chemical industry, and working hours may be extended and the number of workers reduced. World market prices are still lower than those prevailing in Germany. Home trade in dyes improved with greater activity in the textile industry. The glass industry is seriously depressed, but the leather industry is doing well.—(*Bd. of Trade J.*, Mar. 20, 1924.)

Trade Information

The Plauson Experimental Colloid Mill.—The Plauson Mill and Filter Press Co., Ltd., of 17, Waterloo Place, Pall Mall, S.W. 1, now produces a small colloid mill of less expensive design, adapted to the treatment of small quantities, and primarily intended to facilitate research and the application of colloid chemistry to industrial purposes. The rotor has a peripheral speed of 4000 f.s. and with charges of about 1 litre requires about 10 h.p. to drive, whilst 15 h.p. will cover most possible uses. The weight is approximately 3½ cwt., the driving pulley is 4 in. in diameter and the normal working speed 4750 r.p.m. Expensive foundations are not required. In addition to its functions as a superfine grinder, intensive mixer, etc., on a research scale it has an output capacity for most emulsions on a factory production scale. Continuous automatic circulation in conjunction with feed tanks can be employed for large outputs, or intermittent hand feeding for research operations. Difficult solutions and several chemical reactions may be accelerated. The Plauson colloid mill can be seen and tried in London and Manchester.

B. Laporte, Ltd., Luton.—We are requested to state that the recent issue of shares by B. Laporte, Ltd. has been considerably over-subscribed by the shareholders and their friends.

Messrs. Ernest Scott & Co., Ltd., Engineers and Messrs. George Scott & Son (London), Ltd., announce their registered and head offices have been removed from Kingsway House, Kingsway, London, W.C. 2 to their works at Bradfield Road, Silvertown, London E. 16, which will now be their sole address in London.

PUBLICATIONS RECEIVED

GRUNDZÜGE DER KOLLOIDLEHRE. By Prof. H. Freundlich. Pp. viii.+156. Leipzig: Akademische Verlagsgesellschaft M.B.H. 1924. Price 6 gold marks.

PUBLICATIONS OF THE DEPARTMENT OF THE INTERIOR, U.S. Geological Survey, Mineral Resources of the United States. Part I. and II. Washington: Government Printing Office, 1924:—

COBALT, MOLYBDENUM, NICKEL, TANTALUM, TITANIUM, TUNGSTEN, RADIUM, URANIUM, AND VANADIUM IN 1922. By F. L. Hess. No. 1:27. Pp. 557—583.

FELDSPAR IN 1922. By F. J. Katz. No. 11:27. Pp. 251—259.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

Vol. 43 NEW SERIES LONDON, APRIL 11, 1924 No. 15

EDITORIAL

RARELY can an address before one of the Sections of this Society have opened so impressively or been presented on such classic ground as that delivered by Prof. H. E. Armstrong, F.R.S., before the London Section in the Royal Institution on Monday evening. Before a word was spoken, slides of a giant American airship were shown on the screen, followed by one of Sir James Dewar in his laboratory. Dewar's work, said Prof. Armstrong, made that airship possible. In this way opened the address on Sir James Dewar as an experimental inquirer. The realisation that Dewar himself, not very long ago, had worked in the same building, gave added force to Prof. Armstrong's remarks, and, as experiment followed experiment, and the significance of Dewar's work became clearer and clearer, regret grew that the audience was not larger still. The lecturer pointed the moral with no little pungency, and although some might not take to heart the characteristic quotation from that delightful essay in which Montaigne describes how a young woman who had grown accustomed to carrying a calf found herself unable to forego her burden, even when the calf had become an ox, yet the reference to a calf of Scandinavian breed left no doubt as to the meaning. Whether we worship at the ikon of hydrogen-ion concentration or not, it is good that we have at least one douhter among us, for too much acquiescence is not conducive to progress, and a theory is an invitation to attack. To far too many, chemistry consists in following the " tables " and " bringing it down in group two," and one cannot but regret a recent complaint that some young chemists seemed to be limited in scope entirely by text-book information. A routine analysis can quickly be learnt by any intelligent boy or girl—as the British Aluminium Company proved long ago with routine analyses of bauxite—but of how little avail is text-book knowledge when something goes wrong in the works, when a new material, with all sorts of unknown impurities, has to be examined, if it is unaccompanied by the ability to make deductions from scanty evidence, to foresee possibilities, to ask the question " Why," and answer it. Nature herself, so simple in her complexity, is always trying experiments and forgets in one success a thousand failures. In the vast field of science nothing grows save at a price, and not by " hugging an ox " will advance be made. Long ago, another Sceptical Chemist wrote: " Having entertained a suspicion that the vulgar principles were . . . lesse considerately deduced from chymical operations, than was believed, it was not uneasie for me both to take notice of divers phænomena, overlooked by prepossest persons, that seemed not to suite so well with the . . . doctrine; and to devise experiments likely to furnish objections against it . . ."

* * *

The speech of Sir William Alexander, at the Fifth Annual General Meeting of the British Dyestuffs Corporation, is full of interest. He announces his forthcoming retirement from his position as Managing Director, and leads us to assume that negotiations for the appointment of his successor are already in progress. The composition of the Board of this company has been criticised from time to time, but if our memory be accurate, even the most vigorous of the critics have testified to the business ability of the chairman. We are in entire agreement with his statement that it is to the men who are intimately associated with the business from day to day that we must ultimately look for success. The board needs an infusion of such men; it is the men to whom we must look for success whom the shareholders will expect to guide the policy of the company; moreover, the men whose good sense and knowledge of the details of the business will make the difference between success and failure deserve the responsibility and the distinction of seats on the board. There must be some prizes or the lottery of industrial science will not attract a sufficient number of the junior men into it. Although the progress made by this company during the last two years is notable, the outlook for British dyestuffs as an industry is not one of the brightest. Dyestuffs are now—from a chemical point of view—a very chance body of compounds; they are the highly coloured derivatives of benzene, naphthalene, anthracene and some other fundamental substances. Compounds which are closely allied chemically but not highly coloured are excluded from the industry. But the chemist cannot be as illogical

and capricious as the manufacturer; he knows that some of the weaker brethren, the lightly tinted or the colourless ones, are made by similar reactions, and will in many cases behave similarly when treated by acids, by azo, izo and ozo groups. These uncoloured substances include many compounds of value as drugs, disinfectants, perfumes and reagents. From the point of view of the chemist the chemistry of dyestuffs is the chemistry of benzene derivatives, and we may go further and say that every dyestuff chemist must have a good knowledge of organic chemistry, and that what is essential to him as a dyestuff chemist will be very valuable to him if he is called upon to make ionone or coumarin, aspirin or Bayer 205. The dyestuffs and all other synthetic organic chemicals are intimately connected together in this way, and it must be remembered that of all these synthetic organic compounds the only ones manufactured on a really large scale are the dyestuffs. It is the dyestuff industry that provides the trained organic chemist with the means of earning a livelihood, it is the dyestuff chemist who can—as Sir William Alexander explains—undertake research in perfumes and disinfectants. The Germans before the war dominated the manufacture of dyestuffs; for this reason, and this reason alone, they were dominant in many other branches of organic chemistry. At the moment we have a living, even a vigorous dyestuffs industry and while this has grown up during the last six or eight years we have attained a position in the pure science of organic chemistry which we never had before.

* * *

Our dyestuffs industry is vigorous but young; it is a child which promises to be as successful as any man, but it has neither the man's experience nor resources nor friends. If the Government allows the dyestuffs industry to be destroyed or even seriously crippled by foreign competition a grievous blow will have been struck at British organic chemistry. We shall speedily lose the opportunities for research in photographic developers, in drugs and other pharmaceutical requirements. We shall again become dependent on Germany for all synthetic organic compounds. And it is to organic chemistry that the future of civilisation must look; the proportion which inorganic bears to organic steadily gets less and less. Whether we are free traders or protectionists, colour-makers or colour-users, we ought not to neglect consideration of the very important results which will follow from a blow to the dyestuff industry. Many valuable drugs are closely involved in the manufacture of dyestuffs; much teaching of organic chemistry will be of value to our industries and professions if the dyestuffs be assisted a little longer and will be wasted if the dyestuff research be again allowed to be a German preserve. What an amount of employment has been afforded by the dyestuffs makers in Germany! If a long view is taken of the situation we shall have employment in the dyestuff, drug, photographic and perfume industries steadily increasing here.

EVAPORATING AND DRYING PLANT

(Continued)

By S. G. URE, M.A., B.Sc., M.I.Chem.E.

Continuous Driers

To obviate these heat losses, and the time and cost of charging and discharging, the continuous drier has been developed in a number of forms, such as the tunnel drier, the tube drier, the drum drier, and the spray drier.

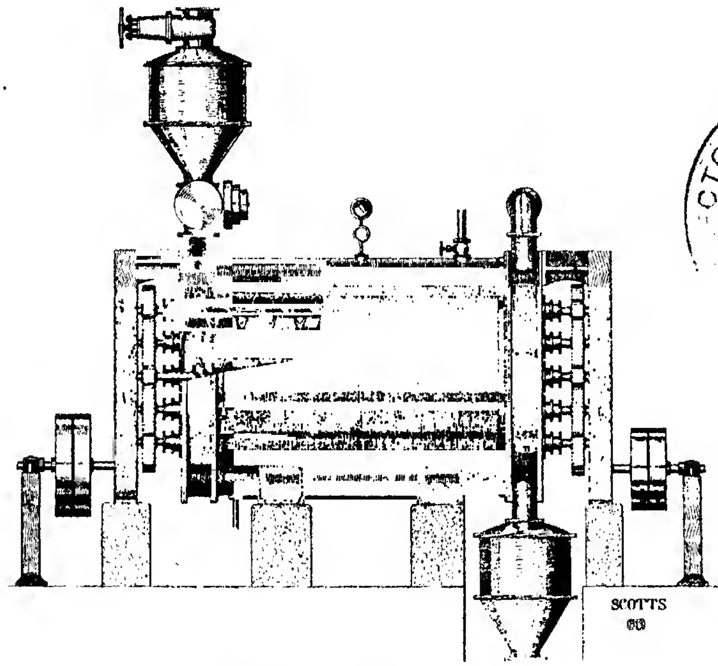
Tunnel driers consist of long tunnels, through which the goods are passed. Sometimes the goods, suitably mounted on trucks, are admitted in the wet condition at one end of the tunnel, and, after drying, discharged at the other. The flow of the hot air or gases through the tunnel may be either in the direction of the movement of the goods, giving parallel flow, or in the opposite direction, which is term d counter current flow.

Parallel flow is generally employed when the goods leaving the tunnel have to possess a definite amount of moisture. This method permits of a very accurate control and regulation of the temperature and humidity of the heating medium. When the goods, on leaving the plant, are not required to contain a definite amount of moisture, the counter-current flow is preferable, because, in this method, the driest medium is brought into contact with the driest material. In plants of the tunnel variety the heating may be done directly, by flue gas, if the material will not be damaged by being thus heated, or by heated air. Sometimes in the counter-current type of plant the heating medium is introduced into the tunnel at a point about one-third the length of the tunnel from the discharge end. Cold air enters the tunnel at the discharge end, and, passing over the dried goods at this end of the plant, cools them, and becomes preheated before entering the heating chamber. A difficulty with this type of drier is to ensure a uniform flow of the drying medium through the goods, and many ingenious devices having this object in view have been developed. A recent patent illustrates the trouble taken in this direction. In this plant the carriages are each provided with a partition at the forward end, attached to the floor of the truck, which is capable of movement across the rails. A mechanism is fitted along one wall of the tunnel, which can move all the even numbered trucks, so that the right hand edges of the floor and partition are in contact with the right hand wall of the tunnel, and all the left hand edges of the floor and partition of the odd numbered trucks are in contact with the left wall. By rotation of this mechanism a complete change over can be effected in these sets of trucks. The roof of the tunnel slopes gently downwards towards the discharge end, and leakage between the roof and the partition walls is prevented by placing on the top of the latter a layer of granular material such as sand. Metal plates attached to the floor of the trucks dip into troughs of sand on the tunnel walls, and thus prevent leakage of the heating medium into the space below the floor of the truck. By these devices

the heating medium is compelled to flow in a zig-zag path through the goods, and by changing the positions of the trucks the direction of flow through the goods can be reversed.

Fig. 7 (reproduced on p. 354 of the issue for April 4) illustrates a continuous drier manufactured by Blair, Campbell, and McLean suitable for dealing with grains, oil, seeds, etc. In this plant a reel with its axis horizontal revolves inside a steam-jacketed cast iron trough. The reel is made of two cast-iron hollow discs, connected together by a number of parallel tubes. Angle bars extending between these discs, and rigidly attached thereto, carry the shovels, which at the wet end of the machine are made of bronze. In large and long reel plants, supporting plates are fitted at intermediate points in the reel. Steam is fed into the jacket of the first section of the trough, and passes by means of U bends from section to section, the condensate being removed at suitable points. The reel is also heated by steam admitted through one trunnion into the first disc, from which it passes, by means of the tubes, to the second, which is provided with a device by which the condensate can be removed through the second trunnion. The grain is fed into the cooler end of the plant by means of a specially designed screw conveyor, and is discharged at the other end through a chute placed well above the axis of rotation of the reel. The drier is provided with a cast-iron roof which is connected to a wooden chimney, in which there is a catch-all to prevent any moisture falling back on to the grain. Brass inspection doors are fitted along the whole length of the drier on each side of the roof. The lower portion of the machine is surrounded by a hardwood box, and the air in the space thus formed, after being heated, is led through suitable ducts into the trough.

Another continuous machine suitable for drying soaps consists of a number of endless belts placed one above the other. Each belt runs inside its own casing, which is connected at either end to the casing immediately above and below it. The material, entering at one end of the machine, falls on to the upper surface of the top belt, by which it is carried to the other end of the plant and discharged into a chute. This conveys the material to the upper surface of the second belt, by which it is carried back to the charging end, where it is again directed through a chute on to the upper surface of the third belt, which carries it to the outlet of the plant. Hot air is admitted to the lowest casing at the discharge end of the plant, and, flowing to the other end, passes up through the chute into the second casing, from which it passes to the first casing through the first chute, being ultimately discharged at the charging end of the plant. If parallel flow is desired, the air passes through the casings in the same direction as the material. Fig. 8 illustrates a similar type of plant manufactured by G. Scott and Sons, but in this case the material is moved by a series of conveyors

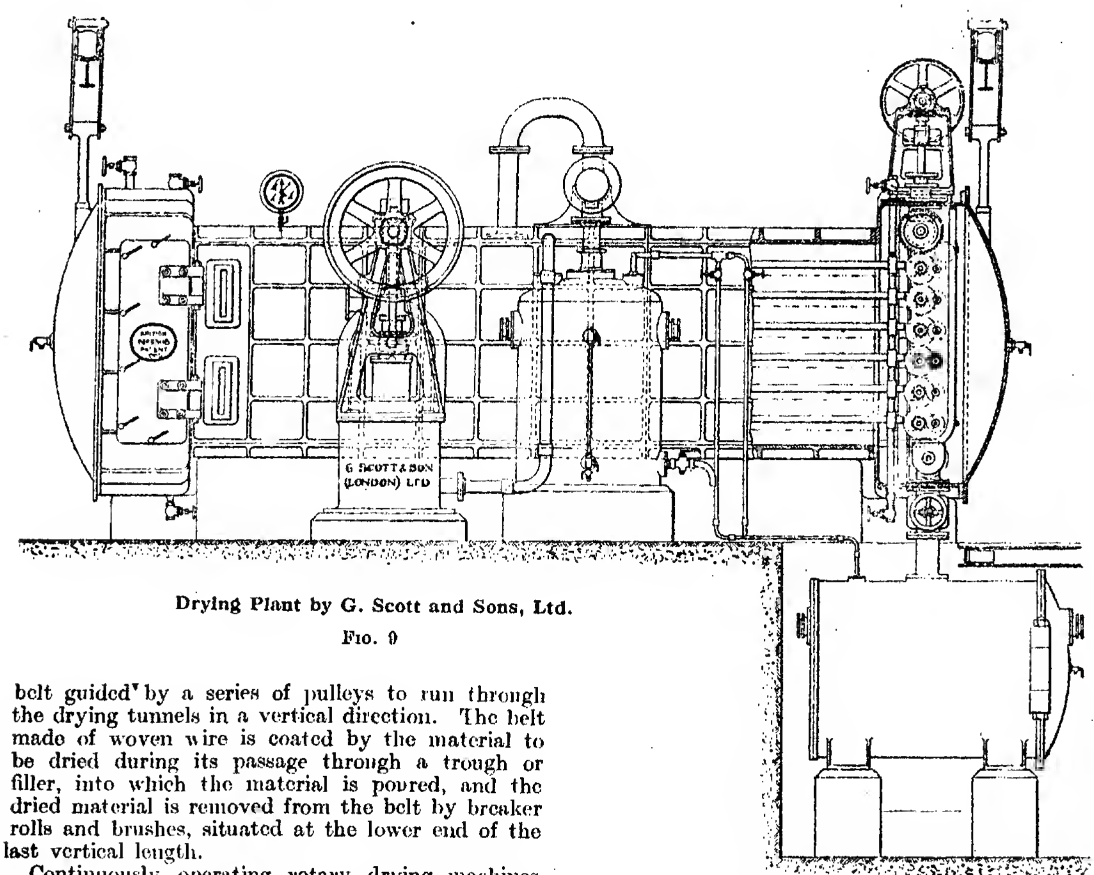


Drying Plant by G. Scott and Sons, Ltd.
FIG. 8

through a number of parallel tubes which are heated externally by steam. The next figure (9) illustrates a drying plant suitable for dealing with liquids. In this case the liquid is fed on to each of a number of parallel belts, which pass over a series of heating shelves, one belt encircling each shelf. After drying, the material is removed from the belt by a suitably placed scraper. The belts may be made of a fine mesh wire screen, coated with a gelatinous substance, and the material may be spread thereon either by rollers or as a fine spray. So far the machines described have horizontal belts, but machines have been designed consisting of one long belt guided by a series of pulleys to run through the drying tunnels in a vertical direction. The belt made of woven wire is coated by the material to be dried during its passage through a trough or filler, into which the material is poured, and the dried material is removed from the belt by breaker rolls and brushes, situated at the lower end of the last vertical length.

Continuously operating rotary drying machines are manufactured by Manlove, Alliott, & Co., Lennox Foundry, and other firms. They consist of a long hollow cylinder, usually made of mild steel and having its axis placed at a slight inclination to the horizontal. On the outer surface of the cylinder, near the ends, are mounted cast-iron path rings or tyres which rest on anti-friction rollers. In very long cylinders path rings and rollers are fitted at intermediate points in the length. Rotation is produced through a toothed wheel also fastened to the outer surface of the cylindrical shell. Radial shelves are sometimes riveted to the inner surface of the shell. If the material can be safely treated by being brought into contact with gases at temperatures between 430° C. and 490° C., the driers are generally heated by gases from a furnace. These gases may enter at the lower end of the cylinder, the material being admitted at the upper end, thus giving counter flow.

Whilst this arrangement is economical from the point of view of heat exchange, it is sometimes found unsuitable in practice, because some of the vapour in the saturated gases leaving the drier, on coming into contact with the cold material entering, may be condensed on the incoming material and convert it into a paste or cause it to form into balls, thus making drying more difficult. With this method also a considerable amount of heat is carried away by the material leaving the drier. To overcome those objections the furnace gases are sometimes admitted with the material at the upper end of the tube, a method which permits of greater control of the temperature conditions prevailing inside the tube. Sometimes the furnace is situated near the upper end of the tube and the brickwork of the furnace is arranged to envelop the tube over

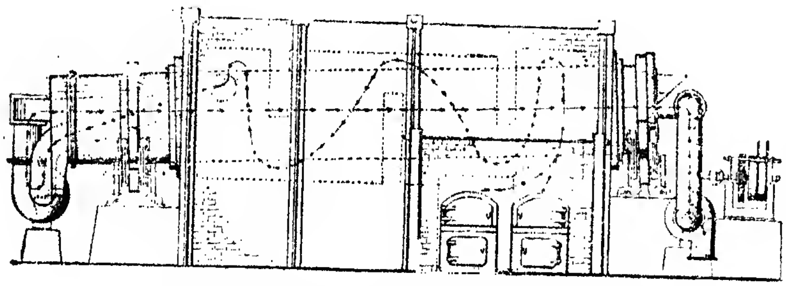


Drying Plant by G. Scott and Sons, Ltd.

FIG. 9

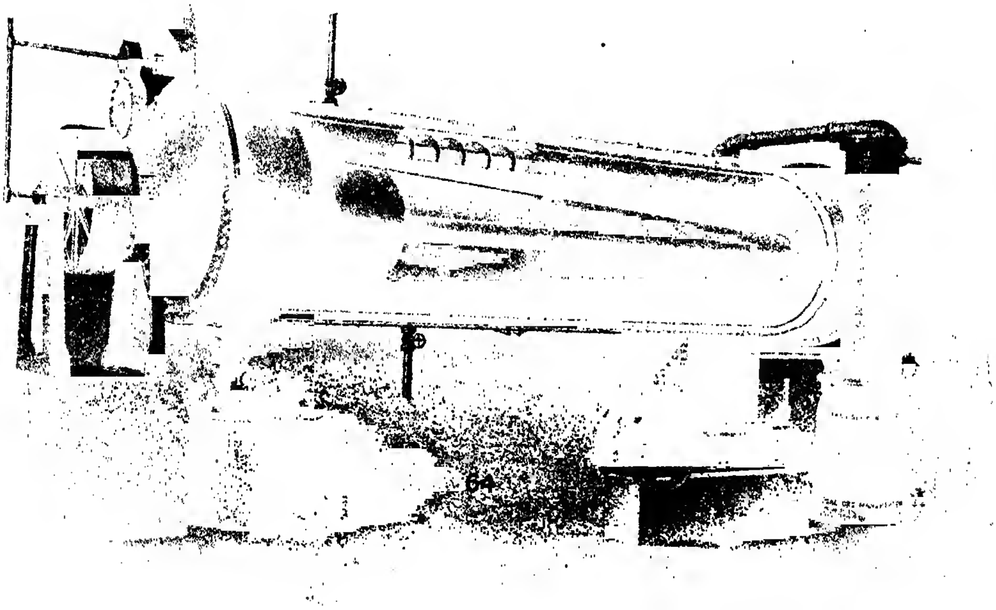
practically the whole length, as in Fig. 10. Then the hot gases from the furnace flow over the outside of the tube in the same direction as the material passing through the tube, and then entering the tube at the lower end pass over the material in the opposite direction to its flow. The brickwork surrounding the tube should be constructed to form a narrow annulus with the tube so as to create a considerable velocity in the flue gases and thus increase the rate of heat transfer. The suction required to move the hot gases through the tube may be produced by a fan or chimney, but the former is the better device since the velocity of the gases can be more easily regulated and their exit temperature may be considerably below that required to produce the draught when a chimney is adopted. A by-pass should be provided to prevent the hot gases passing round or through the tube when the drier is not in use.

Whenever the material is liable to injury from excessive heating or where its moisture content is low, rotary drying machines are generally heated by steam, and four types of heating systems are employed. In the first type the air is heated in a separate chamber and then admitted to the tube, whilst in the second type the heating element, generally in the form of a hollow cylinder, is placed inside the tube. Sometimes the tube itself is heated by means of a steam jacket, and in



Fire-heated Rotary Drier by Manlove, Alliott and Co., Ltd.

FIG. 10



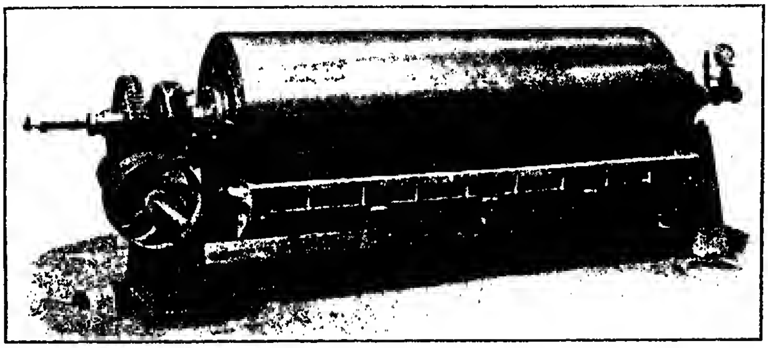
Vacuum Continuous Cone Drier by F. Shaw and Co., Ltd.

FIG. 11

this case the material being dried receives heat from the walls of the tube by conduction and radiation. A drier manufactured by F. Shaw and Co., shown in Fig. 11, illustrates the fourth type, which is really a combination of types two and three. Inside a steam-jacketed cylinder, which in this case remains stationary, is placed a hollow shaft which extends through the covers of the cylinder and can be rotated by a suitable driving gear. Attached to this shaft and mounted concentrically with it is a conical tube made of light sheet steel. The material is fed into the machine at the top left hand corner of the outer casing, by means of a specially designed rotary device which is vacuum tight, and is then transferred by a worm conveyor to the other end of the cylinder where it falls into a chute which discharges it into the narrow end of the conical tube. Steam is admitted to the outer jacket and the hollow shaft, both of which are provided with suitable drainage devices for the removal of the condensate. The plant is designed to withstand considerable steam pressure in the jacket and tube, whilst a high degree of vacuum is maintained within the cylinder. Plants of this type are also made in which the inner and outer-heating elements revolve together. Sometimes the term rotary drier is confined to plant having a stationary casing and an internal heating element which rotates, the name revolving drier being used to denote a plant with a rotating outer tube. The working temperatures of steam heated driers of this type generally vary between 50° C. and 100° C.

The drum type of drier consists of a hollow cylinder mounted with its axis horizontal. Steam is admitted to the drum through one of the trunnions and the condensate is removed through the other. The liquid to be dried is applied to the outer surface of the drum as a thin film and after drying is removed by scrapers or knives. The commonest method of applying the liquid is to make the drum dip into a shallow tray containing the liquid. With this method, however, there is always the possibility of heating the liquid in the tray and if the plant is working under a high vacuum the resulting evaporation may cause the liquid to become so concentrated that a proper film is not obtained on the roll, and with some liquids precautions have to be taken against settlement in the tray. To obviate these difficulties the liquid is sometimes sprayed on to the surface of the roll, but this necessitates the installation of pumping plant for the spray and, as can be easily understood, difficulties may be encountered at the nozzles. Complete removal of the dried material is necessary for efficient working of plants of this type.

Figure 12 illustrates a drum drier in which careful attention has been given to the feeding so as to produce a uniform film over the surface of the drum. In this plant several small knives are used to remove the material. These knives overlap one another and thus ensure complete removal of the dried material from the drum. On leaving the knives the material falls into a trough and is then conveyed to one or other of the receiving boxes placed at the ends of the plant. The worm is operated in such a manner that each box is filled alternately. Inspection ports are provided so that the working of the machine is under thorough observation. Kestner's also manufacture a non-vacuum type of drum drier, and it has been found that owing to the short time the material is in contact with the roll, this type of plant can be used for drying delicate materials. The other illustration Fig. 13, shows a double drum drier made by J. P. Devine. In this type of drier the material is fed into the space above and between the drums. From this point it is spread uniformly over the surfaces of the drums. The drums themselves are mounted in such a manner that the distance between the surface of the drums can be varied. By this means the thickness of film on the drum can be altered to ensure the material being properly dried when it is removed by the knives. Any material which is not taken up by the drums is collected in a trough placed underneath and can be returned to the feed hopper. After being removed by the knives the material drops into suitably placed receivers.



Drum Drier by the Kestner Evaporating and Engineering Co., Ltd.

FIG. 12

The double drum drier is suitable for dealing with pastes and materials which only adhere to the drum surfaces when applied under pressure. In machines of this type the drums usually rotate from one to four revolutions per minute and with properly designed bearings require very little driving power. Blair, Campbell and McLean also manufacture a rotary twin drum atmospheric drier which is used for drying milk and other products. Driers of the drum type can also be used for drying materials like paper. In this case the drier consists of a number of drums over which the paper is passed in such a manner that each surface of the paper comes alternately into contact with the drum surfaces.

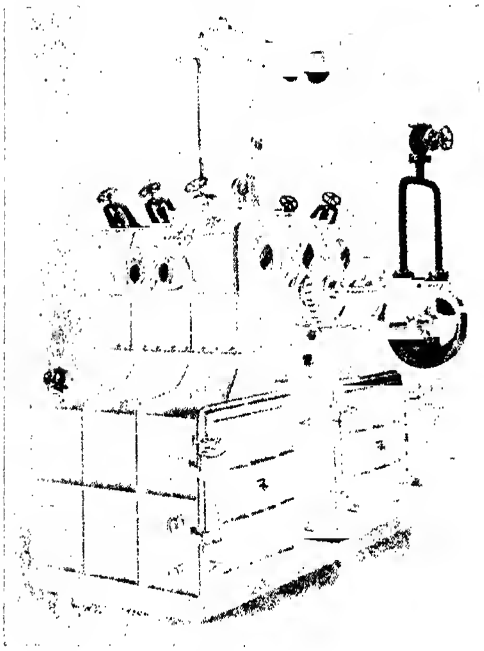


FIG. 13

Devine double-drum vacuum dryer

In spray driers the material to be dried is blown in the form of a fine spray into a chamber through which passes a current of hot air. The hot air takes up the moisture from the spray and the dried material can be separated from the moisture-laden air in a cyclone.

Acknowledgment must be made of the kindness of the various plant manufacturers mentioned in the article in supplying information and in courteously permitting the use of illustrations.

Prof. H. Carmichael, late professor of chemistry in Bowdoin College, Montana, died on January 29, aged 77.

THE REMOVAL OF CARBON BISULPHIDE BY A NICKEL CATALYST

In a paper of recent date read before the Royal Society, E. V. Evans and H. Stanier deal with some interesting chemical aspects of the so-called Carpenter-Evans catalytic process in which carbon bisulphide is removed from coal gas by hydrogenation in contact with metallic nickel. The anomalous behaviour of the nickel catalyst in resisting the poisonous action of sulphur compounds receives especial attention. From a consideration of the conditions of equilibrium in the system hydrogen-hydrogen sulphide in contact with nickel at the working temperature of the process, it is concluded that the concentration of sulphur in the gas is such that practically complete sulphidation of the catalyst must take place and this is verified by experimental observations. It is shown that nickel sulphide, whether obtained from the oxide or by precipitation, is quite a satisfactory substitute for the metal although, in the case of the sulphide, an initial period of reduction is to be observed during which the catalyst does not properly fulfil its function. A study of the reduction of the precipitated sulphide in hydrogen under the temperature conditions of the process discloses the fact that the reduction takes place in two distinct stages, first very rapidly to a lower sulphide and finally exceedingly slowly to metallic nickel. The lower sulphide is proved to have the composition represented by the formula Ni_3S_2 and appears to be the compound discovered by Bornmann in a cryoscopic examination of a nickel-sulphur melt. The authors conclude that it is this subsulphide which is the true catalyst in the process no matter whether nickel or the normal sulphide is initially used.

A section of the paper is devoted to a study of the velocity of the interaction in so far as it is affected by temperature and promoter action. A very appreciable increase in the rate of change is affected by addition to the nickel of various oxides such as thoria, alumina, chromium oxide and beryllium oxide. Thoria produces the maximum effect and the activity of a mixture of this oxide with nickel sulphide is compared at different temperatures with that of nickel sulphide only. It is shown that the thoria mixture gives the optimum acceleration at 350° C. at which temperature the speed of the interaction is about doubled whilst it is interesting to note that, at a given speed of change, the mixture can be used at a temperature 40° lower than the sulphide alone.

The function of the nickel subsulphide in the reaction is discussed and it is shown that normal nickel sulphide is one of the products of change. Further the speed of the reaction is shown to approximate very closely to that of the reduction of the normal sulphide present, and thus the rate of regeneration of Ni_3S_2 from NiS determines the velocity of the main catalytic interaction. A hypothesis is given indicating the possible nature of the reactions taking place at the surface of the catalyst.

AN INTERNATIONAL LANGUAGE FOR CHEMISTRY

By Prof. T. S. PATTERSON, D.Sc.

A remark by one of your correspondents in a recent issue of *Chemistry and Industry* prompts me to raise this subject, which I feel for several reasons to be of considerable importance, and upon which it might be of interest to elicit the views of chemists generally. Doubtless many people would advocate the adoption of English, but it is quite possible that the French and the Germans might not agree with them, and exactly the same kind of attitude would probably be taken by other nations towards French and German. It may be true that some one of the modern European languages will ultimately survive as a universal means of common expression, but it is quite certain that this could only occur after very many years of struggle between the different modern European languages, and in the end it might perhaps be simpler, and I believe that from an intellectual point of view it would probably be better, in any case, if the different nations could agree to use Latin as a universal means of communication. It would, of course, only be possible to make such a change very gradually. In the first place, Latin might be recognised as an official language. Secondly, arrangements should be made to teach it in a reasonable manner in all schools, so that in the course of some twenty years or less it would be possible to issue an international publication containing abstracts in Latin of chemical papers which had appeared in any of the other languages.

The claims of Latin to be adopted for this purpose seem to me to be as strong now as they were two hundred years ago. Most of us study at school at least three languages, and surely it seems reasonable that one of these should be a language recognised, and for the most part studied, already by all nations. If one must learn another language it would surely be better to learn Latin—largely the foundation of the English language—with its great literature and traditions behind it, and against the adoption of which there is not likely to be any international jealousy, rather than some artificial makeshift like Esperanto. If Latin, French, and English were studied in schools in one group, and their mutual interdependence insisted upon, and if, further, Latin were taught as a living language in the same kind of way that French is usually taught, these three languages should greatly help one another and make all of them much more valuable educational instruments than they are at present.

There would, I think, be three very great advantages in the universal adoption of Latin. In the first place, the interest of chemists generally could hardly fail to be awakened in that great classical literature, of which at the present time the vast majority of scientists are oblivious, and of which as a class they are constantly becoming more and more ignorant. In the second place, it is important to remember that the foundations of most of our sciences are laid in Latin, and, surely, since it cannot be said that the writings of men like Newton, Huygens, Kepler, Descartes, Stahl and others are obsolete, these fundamental works ought not to be forgotten. On these foundations we are still building, and it seems to be a very great pity at the least that so few of us are able to read these scientific classics for ourselves, since many of them do not exist in translations; even Isaac Newton's work is not yet all available in English. I certainly believe, firstly, that it would not be more difficult to adopt Latin rather than any other language, natural or artificial, as an international language for science; and, secondly, that even if it were more difficult any difficulty would be far more than compensated for by gains in other directions.

Organic Chemistry Department
University of Glasgow
March 27, 1924

FORTHCOMING EVENTS

Apr. 11. ROYAL INSTITUTION OF GREAT BRITAIN, 21, Albemarle Street, London, W. 1, at 9 p.m. "... Stains, and Dyes," by Prof. J. Thorpe.

Apr. 11. INSTITUTE OF METALS, *Sheffield Section*, University, St. George's Square, Sheffield, at 7.30 p.m. Annual general meeting. Protection of Aluminium by Electro- ... by Mrs. A. Vellan and Prof. Desch.

Apr. 11. SOCIETY OF DYERS AND COLOURISTS, *Manchester Section*, the College of Technology, Manchester, at 7 p.m. Annual meeting. "The In... tion of Insoluble Azo Colours on the F... of Azo Pigments in Substance," by F. M. Rowe and Miss C. Levin.

Apr. 15. HULL CHEMICAL AND ENGINEERING SOCIETY, Hull Photographic Society's Rooms, Great ... Street, Park Street, Hull, at 7.45 p.m. Annual general meeting.

Apr. 16. SOCIETY OF GLASS TECHNOLOGY. Annual Meeting to be held in Sheffield.

Apr. 22 to 24. INTERNATIONAL CEMENT CONGRESS, London, under the aus... of the Inst... Structural Engi...

Apr. 23. ROYAL MICRO... SOCIETY, *Applications Sec...* ... Hanover ... London, W. 1, a... "... Using a Microscop... of Observation ... Images," by J. E. ...

Apr. 24. INSTITUTE OF ELECTR... Place, Victoria Em... 6 p.m. "Kelvin and ... Generation and Distr... Energy," by G. Semenza.

Apr. 25. INSTITUTION OF ENGINEERS ... Royal Society of Arts, John ... London, W.C. 2, at 8 p.m. ... Inspection," by Dr. V. E. ...lin.

May 2. INSTITUTE OF METALS, *Swansea Local Section*, University College, Singleton Park, ... 7.15 p.m. Annual general meeting.

May 2. SOCIETY OF CHEMICAL INDUSTRY, ... *Section*, Textile Institute, 16, St. ... sonage, Manchester, at 7 p.m. "Se... Sulphur Compounds" (in relation to ... mination of total sulphur in petrol... Atkinson, M.Sc., and L. Guy Radcliffe.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

The following is a Preliminary Programme of the meetings to be held in Liverpool on July 9-12 inclusive.

WEDNESDAY, JULY 9.—*Morning:* Council Meeting. Annual General Meeting in the Arts Theatre, University. Presidential Address by E. Frankland Armstrong, D.Sc., F.R.S.; *Afternoon:* Business Session in the University. Visit to White Star Liner "Cedric," and tea on board by invitation of the White Star Line. *Evening:* Reception and Dance at the Town Hall by invitation of the Right Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.).

THURSDAY, JULY 10.—*Morning:* Messel Memorial Lecture by the Right Hon. Viscount Leverhulme, in the Arts Theatre, the University, and presentation to the Lecturer of the Society's Messel Medal for 1924. Visit to the works of Messrs. Joseph Crosfield & Sons, Ltd., Warrington. Luncheon by invitation of the Directors. *Afternoon:* Inspection of the Works. *Evening:* Annual Dinner of the Society at the Midland Adelphi Hotel.

FRIDAY, JULY 11. *Morning:* Business Session in the University. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of the United Alkali Co., Ltd. Visit to a Works of the United Alkali Co., Ltd. *Evening:* Dinner at Lady Lever Art Gallery by invitation of the Chairman and Directors of Messrs. Lever Brothers, Ltd.

SATURDAY, JULY 12.—Visit to Lake Vyrnwy. Inspection of Liverpool Corporation Water Works.

A detailed programme will be sent later to every member of the Society.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

OFFICIAL NOTICE

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

[illegible]ighth volume of these Reports is now ready, [illegible]ies have been despatched to purchasers.

[illegible]rice of the book is 7s. 6d. to members of the [illegible] and 12s. 6d. to non-members, post free in [illegible]e.

[illegible]mber of the Society may purchase a set of [illegible] to VIII inclusive at the reduced price of [illegible]d., and a Non-Member can procure a set at [illegible]uced price of £3 15s., post free in each case. [illegible]ull particulars see page ix. of the Advertisement [s]ection of this issue.

LONDON SECTION

A joint meeting with the London section of the Institute of Chemistry was held in the Institution of Mechanical Engineers, on March 31, when two cinematograph films, prepared under the auspices of the Association of British Chemical Manufacturers and entitled "Heavy Chemicals" and "Coal and its Products," were shown by permission of Mr. W. J. U. Woolcock, C.B.E. (General Manager of the Association of British Chemical Manufacturers). Dr. Bernard Dyer, who presided, called upon Mr. Woolcock to address the meeting.

Mr. Woolcock said he wished to point out what was aimed at in preparing industrial films dealing with branches of chemical industry, in order that those present might appreciate their proper value. Publicity was first begun by the man who, instead of having a blank shop window, decided to put some of his goods into it. Others followed suit, and the shop window with goods displayed in it soon became common. Following that, there was the newspaper advertisement, which carried us up to the present, but those who were really anxious for the success of any particular industry had to go one step further. Now, the industrialist could not put his goods into his shop window with any marked effect, because everybody else did the same, and he could not do very much by advertisement. No industrialist could afford not to advertise in technical journals, but that was a species of blackmail—perfectly legitimate blackmail—in which the newspapers combined to see that the man who did not advertise was regarded as peculiar, and was out of the public eye. We had, however, got past the point where the success of the individual firm, except as a unit in an industry, was a predominating factor. One hoped for the success of each unit, because if every unit was successful the whole industry flourished, but we had got to the point that, in the big public campaign, apart from the campaign which must be waged between seller and buyer, it was now essential that the public should be familiar with the value of the industry to the nation, and that we should not be so insistent that X's brand was the best, and the only brand worth having. What we wanted to do was rather to encourage the public to think that the chemical industry as a whole was something for the British public to be interested in and to take a pride in, and gradually to instil into their minds the fact that they should insist, in all things, upon having what was provided by Great Britain. It was quite possible for a man who was advertising in the ordinary way to say that he got a certain return for his advertisements in a particular newspaper, but there was something very much bigger than that, more intangible, and much more difficult to do, and that was to impress upon the whole world that anybody connected with British chemical industry was connected with an industry which was bound to succeed and which supplied finer material than any comparable industry in any other part of the globe. Hence a mass action was going on in propaganda nowadays which was quite different from anything we had had before. The same idea was being carried out at the

British Empire Exhibition. What would be seen there was the combined effort of all the chemical firms in a particular space of 40,000 sq. ft., and behind all that—behind the big industrial show, nobody's particular show, but Great Britain's always —in a space of 2500 sq. ft., would be seen what the scientific chemists of the country had done during the past 20 or 30 years. But what was meant by that? The intelligent observer walking through the hall would say: "Yes, this is British chemical industry; looks very well; result of the war effort; quite good. But will it last?" If the observer came abroad his first question would be: "Would it last?" The effect which it was desired to create on the mind of that observer was this. He would not be asked to take any notice of what the industry is to-day. He would be asked to go into the smaller hall, where he would be shown that the flow of invention in this country, and the stream of research work going on in Great Britain to-day, is an absolute guarantee that the industry will continue, and that those connected with the industry are in business to stay. The films to be shown might appear to those present, from their own particular point of view, to be child's play. But these films were intended for the public. They were intended to be shown all over Great Britain, in all sorts of cinemas. They were, therefore, brought down, as one might say, to the level of the public, and he asked those present not to consider the films from their own technical point of view, but to ask themselves: "Are these the sort of films, prepared for the public and not for us, that we would wish to be shown to the public of Great Britain as representing two sections of British chemical industry?"

Mr. Carey (of the South Metropolitan Gas Co.) then presented another film, dealing with the decomposition of cyclohexane, on behalf of Mr. E. V. Evans (Chief Chemist to the South Metropolitan Gas Co.), who was unable to attend the meeting. At a recent lecture at the Royal Society of Arts, he said, Mr. Evans had wished to portray certain organic reactions, and had used the cinema for the purpose. The film was not intended for an audience of chemists, who might be rather displeased with the way in which the reactions were shown. For the purpose of the lecture for which it was used originally, it was decided, as the audience was composed of technologists engaged in the gas industry, to explain the reactions by means of the cinema without making them too complicated. The film was divided into five sections, the first dealing with the decomposition of cyclohexane to cyclohexene, the second from cyclohexane to n-hexylene, the third from n-hexylene to amylene, the fourth from cyclohexene to hexadiene, and the fifth representing the possibilities of the combination of those two diolefines (cyclohexene and hexadiene) to form tetrahydrophenylbutylene, finally, by dehydrogenation, giving naphthalene.

Prof. Gronover, director of the chemical laboratory of Altona, has been appointed director of the food-testing station of Karlsruhe.

LIVERPOOL SECTION

The annual meeting was held on April 4, Mr. Alfred Smetham in the chair. The following officers were re-elected for the coming Session:—Chairman, Mr. Edwin Thompson; Vice-Chairman, Dr. G. C. Clayton, M.P.; Hon. Treasurer, Dr. Alfred Holt; Hon. Secretary, Mr. E. Gabriel Jones. Prof. C. O. Bannister was elected representative on the Chemical Engineering Group and the following were chosen to fill the vacancies on the Committee:—Dr. E. F. Armstrong, F.R.S., Prof. I. M. Heilbron, Mr. W. Mansbridge, Associate-Professor W. H. Roberts, and Dr. R. Thomas.

A Paper was read by Mr. E. H. Rideout on "Agriculture and Chemical Industry: Some suggestions for increased co-operation between Chemical Manufacturers and Farmers."

The lecturer first dealt with his subject from the point of view of sales and stated that a modern sales campaign demands first the determination of the particular class of person to whom the goods are to appeal, and secondly the fixing of definite geographical boundaries to the district containing these customers. The fertiliser manufacturer is particularly concerned with the farmer, whose peculiarities distinguish him quite clearly from other men. Advertisements must be short, attractive, and well chosen, as the farmer is easily impressed but by nature cautious. The great secret of successful dealings with the farmer is to emphasise the personal nature of the transactions; and each peculiar problem needs careful study. A successful first sale is important, and every care should therefore be taken to secure the application of the correct fertiliser under appropriate conditions of soil and crop. Lime is the most important factor. All fertilisers depend for their successful action on its presence, but some, for example sulphate of ammonia and superphosphate, depend upon it in quantity. Hence if lime is deficient the land must be limed and where possible other fertilisers substituted. Both here and abroad firms are slowly realising the value of lime tests as an aid to sales. A laboratory properly equipped for soil tests, a good technical staff, and an information bureau should be regarded as essential to any sales scheme. Zoning of suitable districts can be readily carried out, if the geology and climatic factors be considered.

Feeding stuffs can and should be sold in a similar manner. It is not difficult to imagine in the future the complete defeat of the unscrupulous manufacturer and his agents by such open methods of trading. For it is particularly important that a customer once obtained should be retained, so that a bond of interest can be set up between the farmer and the manufacturer to their mutual and lasting advantage.

A meeting was held on March 21, Mr. Alfred Smetham in the Chair, in the absence, through illness, of the Chairman of the Section and an address was delivered by Associate-Professor W. H. Roberts, entitled "Some Aspects of a City Analyst's Work."

The lecturer discussed in some detail the various classes of analyses which the Public Analyst of a

large city is called upon to undertake. These included the analysis of foods and drugs, fertilisers and feeding-stuffs, water, paints, oils, varnishes, steels, non-ferrous alloys, india-rubber hose, and many other materials used by the various Departments of the Corporation; investigations required in connexion with Coroners' inquests and for the purposes of evidence in criminal prosecutions. At the present day the analysis of foods was not merely a matter of routine testing but frequently necessitated laborious investigations, particularly when new food stuffs appeared on the market. The question of preservatives in foods was treated at length and the various arguments advanced for and against their use were discussed. The lecturer said he had been impressed in the course of some investigations by the marked poisonous effects of borax on plant life. He condemned the indiscriminate use of preservatives and suggested that the time had arrived when more stringent regulations should be made to prohibit or restrict their use. The possible danger of metallic poisons arising from the greatly increased use of tinned foods was mentioned, and the lecturer finally gave some interesting details of several criminal cases in which he had been engaged.

SOUTH WALES SECTION

At the meeting in the Technical College, Cardiff, on March 7, Mr. E. A. Rudge, B.Sc., read a paper on "Metal Colouring," Mr. W. R. Bird being in the chair.

Recent developments in metal colouring processes had been quite extensive. The functions of such processes were (*a*) to produce by artificial means surface colours on metals to give an artistic appearance, or to simulate an antique appearance, and (*b*) to give a coating to the metal which would be resistant to corrosion. The methods involved could roughly be classified as processes :—(1) Involving the oxidation (or formation of sulphide) of the metallic surface; (2) involving the precipitation of one metal on another, either by simple immersion, or by electrolysis, or by forming a metallic couple in the solution; (3) comprising both (1) and (2) above; (4) for coating produced by chemical methods; (5) comprising mechanical devices, such as tinted celluloid, gelatin films, painting, enamelling and engraving.

The lecturer then discussed examples of these types of process and demonstrated the methods of production of colours by each class of process. As examples of oxidation processes, he mentioned the colouring of iron and steel by heating in air between 220°—300° C.; the oxidation of copper and brass and similar alloys by heating in solutions of perchlorates or alkaline persulphates, which gave beautiful bronze effects; the anodic oxidation (bronzing) of brass by electrolysis in an alkaline carbonate bath; the sulphiding (so-called oxidising) of copper and silver by exposure to sulphur vapour, by washing with ammonium sulphide or alkaline polysulphides.

The second group of "immersion" processes was then dealt with. This method of deposition, involving simultaneous equivalent solution of the less electro-positive metal, usually gives a coating lacking in coherence, and is only employed therefore in the manufacture of cheap goods, such as are produced by the coppering of iron.

The electro-deposition methods mentioned included the coating of iron and steel with copper, silver or brass. By subsequent colouring treatment by one or other of the methods previously mentioned a wide variety of commercial coloured surfaces can be produced, such as the silver-plated copper articles, with a black-shaded finish produced by sulphiding.

Under the miscellaneous methods, that of treating steel by heating in media such as rape oil or linseed oil in the presence of potassium carbonate, was mentioned, which gives a firm black coherent coating of carbon with a matt finish, which is an effective preventive of corrosion. "Black-nickelling" by cathodic deposition from a bath containing nickel thiocyanate was also dealt with. An interesting method of producing a variety of iridescent tints was to be found in the immersion of the metallic article in a solution of sodium lead thiosulphate, which was then warmed to 70° C. A coherent layer of lead sulphide is deposited on the surface, a wide range of colours being obtainable.

Of the mechanical devices, the one of chief interest is the application of solutions of gelatin or of celluloid suitably tinted with dyes, for colouring tinplate, photo frames, and the like.

An interesting discussion followed, during which Mr. H. J. Bailey raised the question as to the possible formation of surface alloys in some cases of metal deposition.

The annual general meeting was held on March 28. After the conclusion of the formal business, during which Mr. W. R. Bird was elected Chairman for the ensuing session, and Mr. Clarence A. Seyler, F.I.C., Vice-Chairman, Capt. Hugh Vivian, the retiring chairman, read some "Notes on the History of Copper Smelting at Swansea."

The first copper works in South Wales was established at Neath in 1584, and Swansea had its first works in or about 1724, considerable opposition being met with from farmers, owing to fears of the effects of fumes given off during smelting. In 1820 Faraday was called in to investigate the question, and from then onwards continual experiments were made in the endeavour to mitigate the nuisance. In the years 1820-22 Vivian and Sons thus spent over £13,000, a very large sum for those days. Cornish ores were at first smelted, but were gradually replaced by foreign ores, largely from South America. The extreme cheapness of coal in the earlier part of the last century had probably retarded the development of economical methods of smelting; for example, as early as 1844 a patent was taken out embodying the principle of preheating the air in reverberatory calcining furnaces and mixing it with the furnace gases at the bridge; but the method was abandoned after a few years, the cost of installation and repairs probably being too great.

About 1840 silver was extracted from South American ores by amalgamation with mercury,

but in 1843 the Augustine process was introduced, in which the silver was chloridised by roasting with salt, most of the sulphur having been driven off by a previous roasting. The process was not entirely successful, and in 1845 the Ziervogel process was introduced. In 1850 the extraction of gold from copper was commenced; and in 1895 electrolytic methods of copper refining were introduced. At a later date the slimes from the electrolysis were worked for extraction of platinum and palladium, besides silver and gold. Copper smelting in this country was now a dying industry, due to economic conditions changing, but the working up of various copper-bearing materials still went on, and, of course, the manufacture of copper sheets, tubes and rods.

Mr. Bird proposed a hearty vote of thanks to Capt. Vivian for his paper, and for his services as chairman during the session. The motion, seconded by Mr. Green and supported by Mr. H. J. Bailey, was carried with acclamation.

BIRMINGHAM AND MIDLAND SECTION

A meeting was held jointly with the Chemical Engineering Group at Birmingham on April 4, Dr. E. B. Maxted presiding. There was a representative attendance, and members of the Chemical Engineering Group were present from various parts of the country. Prior to the meeting the members visited Bournville, where, by invitation of Messrs. Cadbury Bros., they inspected the works, and some of the special machinery, and later partook of tea. A dinner followed the meeting.

Professor G. T. Morgan, F.R.S., and Dr. J. D. Main Smith gave a contribution on "The Separation of Cobalt from Nickel-ferrous Ores by the Purpureo-Cobalt Chloride Process."

In a paper on "Emulsifying Mills," Capt. F. J. China described the Premier and other disintegrating mills and their applications to industry. Considerable attention had been devoted to obtaining machinery, by means of which certain materials could be obtained in a very much finer state of division than was obtainable by ordinary grinding machinery. The Premier mill was of the type in which a film of liquid was subjected to a shearing action at very high speed. It consisted of a cone which rotated in very close proximity to a conical seating. An outer case surrounded the rotor which consisted of a perfectly smooth steel cone machined to extremely fine limits, and fixed to a spindle mounted in special bearings. This cone worked in close relation to a fixed surface which formed part of the casing, the arrangement being very similar to the action of the clutch on a motor car, except that the two surfaces did not touch. The working surface of the rotor was arranged so that there was a fine clearance between it and the surface of the casing. With this arrangement a metal surface rotated very closely to a fixed surface at a speed which might vary between 1000 and 5000 revolutions per minute. The rotor acted largely as a centrifugal pump and assisted by drawing the material between the working surfaces. It then passed through a narrow space between the conical surfaces in a fine film and, owing to the enormous speed of the rotor, the particles of solids suspended in the film are rapidly torn apart. The mill was claimed to ensure the perfect emulsification of liquids and the intensive mixing of liquids and solids and the blending of differently miscible constituents in various proportions.

Dr. E. B. Maxted thought progress might be made by means of the mill in the domain of liquid fuel. Prof. J. W. Hinchley said the colloid mill might be most useful in various directions, though he thought its scope must be rather limited at present. Mr. Barnes (Manchester) said these high-speed mills were of great use, economically, when dealing with materials ground in water. For the time being, he believed their scope in the paint trade must be confined principally to the cheaper grades of paint.

GLASGOW SECTION

The annual business meeting was held in Ferguson and Forrester's Restaurant, Glasgow, on April 3, Mr. W. E. Moodie in the chair. Dr. J. A. Cranston read the honorary local secretary's report, which was duly adopted. The report of the representative of the Section, Mr. D. A. MacCallum, to the Glasgow Chamber of Commerce, was read and approved. It was emphasised that the Glasgow Section was discharging a good office towards chemical industry in being represented on the directorate of the Glasgow Chamber of Commerce.

The following members were elected to fill the vacancies on the local Committee:—Mr. D. A. MacCallum, Chairman; Mr. W. E. Moodie, Vice-Chairman; Dr. J. A. Cranston, Hon. Secretary; Messrs. C. Chapman, J. Robertson, R. F. Stewart, and J. F. Young, Members of Committee. On the call of the chairman, votes of thanks were accorded to the retiring members of committee, and to Prof. R. M. Caven for reporting the meetings during the session to the local press. The retiring chairman was then, on the motion of Mr. S. B. Langlands, accorded a hearty vote of thanks for his services during the past two years.

Following the business meeting a joint smoking concert was held with the local section of the Institute of Chemistry.

PATENTS IN ESTHONIA

Owing to the accession of the Republic of Esthonia to the International Convention for the Protection of Industrial Property, an Order in Council was made on February 20, 1924, applying the provisions of Section 91 of the Patents and Designs Act, 1907, as amended by the Patents and Designs Act, 1914, and the Patents and Designs Act, 1919, to the Republic of Esthonia as from February 12, 1924. A copy of the Order may be seen in the Patent Office Library, 25, Southampton Buildings, London, W.C. 2. (*Official.*)

CHEMICAL SOCIETY

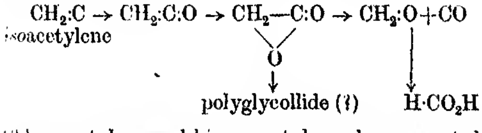
At an ordinary meeting, held on Thursday, April 3, the president, Prof. W. P. Wynne, who occupied the chair, announced that the council had accepted with regret the resignation of the senior secretary, Prof. J. I. O. Masson, who was shortly leaving London; a resolution had been adopted which put on record their appreciation of the value of his services to the society. Dr. T. Slater Price had been nominated by the council to act as senior secretary until the next general meeting. In announcing the composition for the ensuing year of the Finance, House, Library, Publication and Research Fund Committees, the president paid tribute to the services rendered by the retiring chairman of the Library Committee, Prof. J. M. Thomson, who would be succeeded in that office by Prof. J. R. Partington.

The Research Fund Committee would, he announced, meet early in June; applications for grants must be made before June 2.

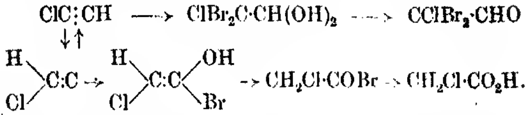
Mrs. E. H. Ingold discussed:

The tautomerism of dyads. Part II. Acetylene and its halogen derivatives.

The suggestion (*Chem. and Ind.*, 1923, **42**, 1247) that acetylene, although consisting mainly of CH⋮CH, is in equilibrium with a minute amount of *iso*acetylene, $C{:}CH_2$, has now been experimentally verified in two ways. In the first place the specific heat of acetylene has been shown to vary with temperature in such a way as to indicate the existence of a mobile equilibrium similar to that shown to be present in hydrocyanic acid, where H·C⋮N is in equilibrium with a little H·N:C. Secondly, chemical evidence of the existence of detectable quantities of *iso*acetylene at moderate temperatures has been obtained by a study of the mechanism of oxidation. The first product, previous even to formaldehyde (Bone and Andrew), is keten $CH_2{=}CO$, which is the normal oxygen addition product of *iso*acetylene $CH_2{=}C$, just as *iso*cyanates R·N=C=O are the normal first products from isonitriles, R·N=C. It is possible that the low-temperature oxidation of acetylene takes place mainly through the *iso*acetylene form, since Bone and Andrew's results receive ready interpretation on this basis:—



Chloroacetylene and bromoacetylene also appear to be tautomeric substances of a similar character, and not, as Nef supposed, purely *iso*acetylene (acetylidene) derivatives. Thus chloroacetylene polymerises under the action of light to *s*-trichlorobenzene (evidence for HC⋮CCl), whilst with iodine it yields the compound $I_2C{:}C{<}^{Cl}_{H}$ (evidence for $C{:}C{<}^{Cl}_{H}$), and with hypobromous acid it gives both chloroacetic acid and chlorodibromoacetaldehyde (evidence for both structures):—



Further confirmation of the mobility of these substances is provided by the properties of the static dihalogeno*iso*acetylenes. Like all bodies of this kind, the tendency to acquire the hydrogen atom necessary for tautomerism is so great that spontaneous reduction will occur. This is true of the static substance $CBr_2{:}C$ (Laurie), which is spontaneously reduced to the monobromo-compound in the presence of alkalis, and so readily does the same reaction take place with $CCl_2{:}C$ that all attempts to prepare this compound resulted in the isolation of the tautomeric monochloro-derivative.

Prof. E. C. C. Baly doubted whether, on the energy quantum theory, it was necessary or desirable to postulate the existence of tautomeric equilibria. He asked how the author was able to recognise the scarce isomeride by treatment with hydrogen bromide.

Dr. T. Slater Price, recalling the fact that hydrogen cyanide in quantity has an unpleasant odour reminiscent of that of *iso*nitriles, asked whether the fact that the halogeno-derivatives of acetylene, in contrast with the parent hydrocarbon, possessed unpleasant odours might indicate a greater prevalence of the *iso*-form.

Dr. R. H. Pickard congratulated the author on her work, but queried the use of the term "dyad" in this connexion.

Prof. C. K. Ingold said that thermodynamics could not decide the structure of the more highly energised form; collateral evidence was required for that. Quantic energy distribution and the co-existence of molecules having many grades of energy applied to gases possessing normal specific heat values as well as to abnormal substances like hydrogen cyanide, acetylene, and probably also formaldehyde, the energised form of which was regarded by Prof. Baly as that with bivalent carbon. The relative ease of spontaneous reduction of the dihalogenoacetylenes was in conflict with Macbeth's polar theory of this reaction, and provided an offset against the case of the dihalogenodinitromethanes recently quoted in support by Gotts and Hunter.

Mrs. Ingold, replying, pointed out that chemical evidence of the existence of the *iso*-form was obtained only in the case of the halogenoacetylenes which must have much longer *iso*-phases than is the case with acetylene itself. Doubtless the greater stability of the *iso*-phases accounted for the pronounced odour and physiological action of the halogen derivatives as compared with the hydrocarbon, as well as the enhanced reactivity of the former. The nomenclature "dyad" and "triad" as applied to tautomeric systems was introduced by Laar.

Prof. H. Bassett described experiments on:

The potassium salts of phenolphthalein.

A PHASE rule study of the system phenolphthalein—potassium hydroxide—water at 25° has shown that the conditions which prevail are very similar to those found in the analogous system containing sodium hydroxide (Bassett and Halton, *J. Chem. Soc.*, 1923, **123**, 1291). Although a number of hydrated forms of the mono-, di-, and tri-potassium salts of phenolphthalein can separate from aqueous solutions at 25°, they are all colourless. The behaviour of the tripotassium salt on heating to 150° suggests that a solid red salt is formed by elimination of one or two molecules of potassium hydroxide. No method of obtaining a pure red salt was found.

Prof. H. Bassett also read a paper on:

The hydrolysis of potassium ferricyanide and potassium cobalticyanide by sulphuric acid.

POTASSIUM ferricyanide was hydrolysed by sulphuric acid of varying concentrations, and the different products of hydrolysis were determined. With concentrated sulphuric acid, ferrous sulphate and carbon dioxide were obtained, a fact previously unnoticed, and the reaction could be represented by the equation:—

$$2K_3Fe(CN)_6+11H_2SO_4+13H_2O=3K_2SO_4+6(NH_4)_2SO_4+2FeSO_4+11CO+CO_2.$$

With more dilute acid the reaction followed the course indicated by the equation:—

$$2K_3Fe(CN)_6+6H_2SO_4=3K_2SO_4+Fe_2(SO_4)_3+12HCN.$$

The hydrolysis of potassium cobalticyanide by concentrated sulphuric acid was analogous to that of potassium ferricyanide, and could be represented by a precisely similar equation. With more dilute acid, hydrocyanic acid was obtained as in the case of ferricyanide, but the hydrolysis was slow owing to the greater stability of the cobalticyanide. By long digestion under a reflux the amount of hydrocyanic acid obtained with dilute acid was that required by the equation:—

$$2K_3Co(CN)_6+6H_2SO_4+2H_2O=3K_2SO_4+2CoSO_4+(NH_4)HSO_4+11HCN+CO_2.$$

A white compound of cobalt which appeared as an intermediate product of hydrolysis with dilute acid, was separated, whilst a white complex cobalticyanide was also obtained by the action of bromine on potassium cobalticyanide in aqueous solution. These substances appeared to be potassium aquopentacyanocobaltiates, analogous to the corresponding ferricyanide derivatives prepared by Briggs (*J. Chem. Soc.*, 1920, **117**, 1026), but they were not fully investigated.

Prof. J. C. Philip recalled an observation made in his laboratory by Dr. A. Bramley that in the case of solutions of ferric thiocyanate, spontaneous reduction to ferrous iron was accompanied by oxidation of the carbon to carbon dioxide.

Dr. N. V. Sidgwick instanced the removal of the residual colour of alkaline cuprous solutions by the action of carbon monoxide.

Prof. Bassett's final paper was entitled:

A study of the cupro-, argento-, auro- and thallo-cyanides of potassium according to the phase rule.

THE paper gives an account of a phase rule investigation (at 25°) of the four systems KCN, H_2O and CuCN, AgCN, AuCN or TlCN. In the case of the cuprous cyanide system the salts $K_3Cu(CN)_4$, $K_3Cu(CN)_4,H_2O$, $KCu(CN)_2$ and $KCu_2(CN)_3,H_2O$ were found to exist. Of these all except $K_3Cu(CN)_4,H_2O$ were previously known. Three potassium argentocyanides were obtained, viz., the well-known compound $KAg(CN)_2$ and two new ones $K_3Ag(CN)_4,H_2O$ and $KAg_2(CN)_3,H_2O$. The conditions under which the latter can be formed are very restricted. The bearing of the results obtained on Liebig's volumetric method for determining cyanides is discussed. Only one aurocyanide $KAu(CN)_2$ was obtained. In the case of thallium, a thallocyanide $KTl(CN)_2$ was found to exist, although it is stable in contact with solutions over only a very small range of concentrations. This compound is of interest because it contains univalent thallium in the anion.

Dr. N. V. Sidgwick, commenting on the author's triangular diagrams, remarked that the vertical solubility line was not fortuitous, but would be expected if there were complete formation of the compound $KAg(CN_2)$ from the insoluble cyanide.

Dr. T. Slater Price said he was interested to observe that the author had isolated salts of the existence of which he had some years ago obtained electrometric indications.

Prof. Bassett, replying to Dr. Sidgwick, said that one might expect to find the compound $KAg_2(CN)_3$ in solution as well, coming, as it did, intermediately between $KAg(CN)_2$ and AgCN. It was also interesting to note that he was unable to obtain the compound $K_3Ag(CN)_4$, the monohydrate always being produced.

SOCIETY OF GLASS TECHNOLOGY

The president, Prof. W. E. S. Turner, presided at the meeting held in Stourbridge on March 19.

The first paper dealt with the "Properties of lead-containing glasses." Prof. Turner, who communicated this paper, described the special properties of the alkali-lead oxide glasses, with particular reference to their thermal expansion, chemical durability and electrical properties.

Mr. J. Northwood followed with a paper entitled, "The Art of British Glass Decorators—The Duplication of the Portland Vase." The Portland Vase, he said, was regarded as the greatest achievement of the ancient glass-makers. The vase is composed of two glasses, the inner body or groundwork being of a very dark blue transparent glass, and the outer casing of white opal glass out of which the ornament and figures are sculptured. This decoration stands up in relief from the blue ground. The reproduction of the Portland Vase was accomplished by the late John Northwood, with the aid of his relative, Philip Pargeter. The casing of the blue body with a uniform outer layer of opaque white was considered at that time as a matter requiring great skill on the

part of the glass maker. It was believed that the actual maker of the glass used in this English Portland Vase was Daniel Hancock, of Wordsley. The work was begun in 1873. The exterior opaque white was slightly acted on by hydrofluoric acid, and the design drawn upon it. Then commenced the hard labour of removing the surplus white glass from round the figures and design, right down to the blue body-ground. Extreme care and patience were necessary to chisel out, without mishap, the delicate details in order to create a true reproduction. The vase was very nearly completed when it suddenly cracked, owing probably to a difference in coefficients of expansion of the two glasses. Still, the artist was not discouraged, and in 1876 the work was completed. The vase is now in the collection of Mr. P. Pargeter, of Stourbridge.

ACADÉMIE DES SCIENCES

On March 3 Prof. Moureu described his researches with Monsieur Dufraisse on the theory of catalytic auto-oxidation. Iodine and its compounds have been found to play an important part in oxidation by free oxygen. Thus a trace of iodine prevents any auto-oxidation of benzoic aldehyde whilst strongly accelerating the auto-oxidation of styrolene.

Monsieur Richet described work on the action of insulin on hyperglycæmia due to caffein. Prof. Lindet drew attention to a new class of micro-organisms discovered by Monsieur Guitoneau, and called by him micro-siphonaceœ, which reproduced many soil reactions such as the digestion of nitrogenous matter, and possibly the absorption of atmospheric nitrogen.

Monsieur Le Chatelier discussed the absorptive power of cuprous sulphate for carbon monoxide, a reaction which should be useful in analytical work, and which may prove useful industrially, as thanks to it, it becomes possible completely to eliminate carbon monoxide when making hydrogen from water gas.

On March 10, Monsieur Le Chatelier communicated a note by Monsieur Charrioux on a new process for the electrolytic purification of colloidal precipitates. The process, which gives good results with a colloidal suspension of alumina, cannot be applied to crystalline precipitates.

Monsieur A. Desgrez was elected a member of the Section of Free Academicians. Monsieur Desgrez, who has been general secretary of the French Association for the Advancement of Science for many years, and has organised many of that body's annual meetings, is a chemist whose researches have always had a biological and medical bent such as cancer and diabetes. To him was due the solution of the problem of regenerating vitiated air by means of sodium peroxide, and during the recent war he did valuable service in the work of protection against poison gases.

On March 17, the Académie heard the funeral oration of Count Chardonnet (*cf. Chem. & Ind.* March 28, 1924). Prof. Moureu described researches carried out at the University of Copenhagen on methods of estimating bismuth in the organism, utilising radioactive phenomena.

CORRESPONDENCE

CHEMISTS AND THE PUBLIC

Sir,—May I beg space to comment upon your recent Editorials in which you touch upon the question of the Chemical Societies.

Your remark, "If chemists wish to make an impression on the public they should abandon the practice of reading papers to each other . . .," seems very pertinent. And at the risk of appearing to indulge in cheap wit, I should like to supplement your words of wisdom by suggesting that it should be regarded as a breach of professional etiquette for a chemist to address a gathering of chemists, except on very special occasions. Let his addresses be confined to audiences of laymen, and let them be in a popular style.

Academic chemists, who are accustomed to speaking, and those technicists who are gifted in that line, would do far more good by public lecturing than by attending meetings of their fellow chemists and reading papers. Some sort of local club would afford the necessary opportunities for meeting one another. I have vivid recollections of a club run by the English-speaking colony in a small German town. We met there on Saturday nights; and social contact was assisted by a piano and card tables, with a small cask of beer as a catalyst; quite a small cask.

It appears to me that the study and practice of chemistry is in danger of being degraded to the level of a hobby. We have societies and associations for model engineers, pigeon and rabbit fanciers, philatelists and countless others. The members are enthusiasts in a particular subject and meet to discuss it. Their influence on public opinion is nil.

By continually addressing his fellow members a chemist advances himself within the limited range of a profession which is scarcely recognised as such by the general public. If the profession happened to be widely recognised, respected and exercising a powerful influence, such means of advancement within it would be excusable. But when the contrary is the case, it seems a waste of time. The most important parts of these addresses are usually printed, and can then be much more easily digested by their fellow chemists.

What the profession of chemistry needs is propaganda work. This may go against the grain in many cases, but without it there seems little to hope for. Reach the man in the street or adopt some other profession—bricklaying, fitting, plumbing or coal mining—these at least are essential trades and are recognised as such.

May I suggest that chemists cut out one of their subscriptions to journals—many of us take out more than are strictly necessary—and turn over the money to the support of some organisation devoted entirely to propaganda work. Something after the style of the *Children's Newspaper*, but with a wider range of appeal, might be useful. Say, one-third devoted to racing and football, one-third to news, and the remainder to general scientific information, reports of new discoveries,

and especially to emphasising the important part played by science in the life of the nation.

It may seem degrading to drag the bright flame of scientific enthusiasm through the gutter—I hate the idea myself—but it seems the only way.

I know that great difficulties have to be surmounted before chemists can present a united front to the world. There are so many divisions and subdivisions, so much fighting and wrangling with one another, this society with that, the academic chemists with the technical, and those with degrees with those lacking degrees. And in addition to the difficulty of securing recognition from the non-educated public there is the difficulty of securing it from the educated and literary classes; the task of overcoming the mutual suspicion and thinly veiled contempt which exists between scientific and literary men, between scientific men and business men, between the new order and the old. Within the profession there is the difficulty that it contains so many of widely different social position—an almost insuperable bar to unity.

Chemists may claim that they are united. It is, I fear, only a pleasant fiction. What kind of unity is there between the higher orders of academic chemists and the newly fledged industrial chemist? Nothing like the same unity as between the eminent consulting medical and the youngest hoister of a brass plate. Nothing like that which exists between the eminent K.C. and the rawest recruit at the Bar.

I do not wish, Sir, to disparage in any way the efforts now being made by our leading chemists to cope with some of these evils; nor do I underrate the value of this journal. On the contrary, I regard the decision to publish it in a semi-popular form, as the first step in the right direction.

You have remarked upon the exasperation which some people have displayed towards elementary articles appearing in your columns. I differ from them in believing that it would be advantageous to make these even more elementary and to increase their number.

This generation can scarcely hope to feel the benefit of any reforms. But we must try to ensure that the chemists of the coming generation have a chance of occupying the position they deserve in our everyday life; and to do this it is essential that we should reach the generation of laymen now growing up. It seems much more important that the man in the street should have his eyes opened to the wonders of a paving stone, than that a chemist should lecture to a physicist or *vice versa.*

I fear, that in the exuberance of the moment, I have used expressions that savour of sarcasm. If so, I crave pardon of any who may feel inclined to take offence. Stripped of their verbiage and reduced to a common denominator of moderation, in which "is and must" are replaced by "might and may," the views expressed are perhaps not without truth. They are really only the expression of a train of thought suggested by your editorials.—I am, Sir, etc., ROBERT GILMOUR

Belfast
March 31, 1924

THE INSTITUTE OF CHEMISTRY

Sir,—I have read the letters in recent issues of *Chemistry and Industry* and your editorial note in the issue of the 28th ult.

The letters serve a useful purpose in bringing to light misconception of the regulations of the Institute on the part of your correspondents. Possibly this is the explanation of the letters, and that they have not any necessary connexion with the attitude of mind of the quadruped to which you make reference.

Neither "A Chemist" nor "An Unqualified Chemist" appears to be aware that since 1917 it has been possible for a candidate to enter the Institute by the front door and yet without further examination, provided that he has complied with certain reasonable regulations.

With regard to the criticism of public analysts, by reason of the alleged action of one or two, it may be well to remark that the Council have invariably required candidates for the examinations of the Institute to take systematic courses in properly equipped universities and colleges, and have consistently for over thirty years discouraged training in private laboratories unless, in addition, adequate provision be made for such systematic instruction.

The Council are further aware that in many private and industrial laboratories there must inevitably be a number of unqualified assistants, but they have rendered it possible for such assistants to secure the qualification of the Institute.

Pupil apprentices and assistants who really wish to qualify can attend systematic evening courses at one of the institutions recognised by the Council of the Institute, and will thereby be enabled to qualify for admission to the examinations of the Institute. Many have so qualified, but it is our common experience to find that the complaints come from men who have neglected to take such courses until they consider themselves past the age for doing so, and past the age for taking the examinations.

If the writers of the letters will address themselves to me, I will gladly give them what assistance I can.—I am, Sir, etc.,

RICHARD S. PILCHER
Registrar and Secretary

Institute of Chemistry
30, Russell Square, W.C. 1

CHEMICAL CO-OPERATION

Sir,—Your editorial upon the above subject in the issue of the 4th inst. touches upon points that appeal to the business instincts of many members of the Institute of Chemistry and the Society of Chemical Industry. But your call for a pioneer leader to sally forth from the wilder parts of the Kingdom, and assume an "irregular and undignified disregard of rules and regulations," has been partially anticipated by the Bristol section of the S.C.I.

During the session 1922-3, under the chairmanship of my predecessor Mr. C. J. Waterfall, one joint ordinary meeting was arranged and held by the two local sections of the societies named, and during the session just concluded, one joint ordinary meeting and a dinner were held with such success, that at a

recent committee meeting of the Bristol section of the S.C.I., a resolution was passed and forwarded to the local section of the Institute, asking their members to throw in their lot entirely with us next session, as far as ordinary meetings are concerned.

This has been accepted, and for the session 1924-5, the six winter meetings will be held jointly, and although each section will still retain its own officials, the expenses of printing and postage will be somewhat curtailed. But what is more important, the policy of peaceful penetration has commenced, and it is believed that both sections will gain by this closer contact with each other.—I am, Sir, etc.,

Bristol M. W. JONES
April 7, 1924

QUALIFIED CHEMISTS

Sir,—The British Association of Chemists has followed with considerable interest the correspondence touching "unqualified" chemists which has appeared in your *Journal*; and the more so, since those who have engaged in it, and who very properly express a desire that their status should be more exactly defined, can accomplish this through membership of the Association.

But it ought to be understood once and for all, that those who criticise the Institute of Chemistry from the point of view of these "unqualified" chemists, do not mete out to it that measure of justice to which it may properly lay claim. The Institute is a body conferring an academic qualification, and therefore is subject to the restrictions that such an activity must necessarily impose.

Doubtless necessity has from time to time dictated to the Institute a policy which, to some, may have appeared unwise; but statements as to the elasticity of their regulations where personal influence has been brought to bear ought not to be made unless ample and exact means of verification are at hand. It is not suggested that these have been lightly or carelessly made; but such statements when unaccompanied by exact and final verification, we must necessarily deprecate and deplore.

The Association is, however, an opponent of the thesis—attributed by some to the Institute of Chemistry—that those who are not members of the Institute are, by that fact, unqualified persons. And the nature of the Association's constitution is such as to give it an elasticity to which neither the Institute nor any other academic body can properly lay claim. Qualification, a word to which much violence has been done, can be other than academic; and the Association includes within its ranks some who are not academically qualified. Rigid investigation, however, is in all cases made, the standard being, of course, necessarily high.

Among the many advantages at the disposal of the members of the Association may be mentioned the unemployment benefit and legal aid funds; while the defence of the professional chemist, his dignity and economic status are the Association's first concern.—I am, Sir, etc., HENRY T. F. RHODES
(Assistant Editor *B.A.C. Journal*)
108, Baker Street, London, W. 1

SUMMARIES OF PAPERS

Sir,—Summaries fulfil the important function of enabling a reader to see at a glance the scope of a paper and the results obtained. If his attention is then sufficiently attracted he will decide for himself whether to read through the paper closely or not.

Time is thus saved to the reader, and most authors now follow the excellent practice of providing such summaries—at the end of their papers. I make the suggestion that they should come at the beginning of the paper, immediately following the title and the author's name.

Logically on account of their function this is their proper place, and to put them there would only be following the practice of putting the table of contents of a book at the beginning thereof. For a similar reason indexes should be placed at the beginning, and not at the end of a book.—I am, Sir, etc.,

A. A. JONES
Huddersfield Technical College

GASEOUS COMBUSTION AT HIGH PRESSURES

Sir,—I believe at the conclusion of my correspondence with Calorifer last year I said that, if he would possess his soul in patience until the publication of some further experimental results, he might find them luciferous. These results have now been published in a paper entitled, "Gaseous Combustion at High Pressures. Part IV.—The Influence of Varying Initial Pressures upon the Rate of Pressure Development and the Activation of Nitrogen in Carbon Monoxide-Air Explosions," by Messrs. D. M. Newitt, D. T. A. Townend and myself, which appears in the current issue of the Proceedings of the Royal Society, A., Vol. 105, pp. 406—433. We would commend a perusal of this paper to any of your readers who may be interested in the subject, as I think it makes everything perfectly clear.—I am, Sir, etc.,

WILLIAM A. BONE
Imperial College of Science and Technology
April 3, 1924

ROTATORY DISPERSION

Sir,—I agree with Dr. R. H. Pickard that the existence of dynamic isomerism in solutions of tartaric acid and its esters has not been completely proved and I regret that, through inadvertence on my part, the abstract of my paper, which appears in your issue of March 28, reads as if I held the opposite view. Dr. Pickard's objections to the application of dynamic isomerism to the tartaric acid series appear to be based upon theoretical arguments, which cannot be tested experimentally until more perfect instruments are available. My view is that there is abundant evidence to justify the retention of the only working hypothesis in existence which enables us to interpret all the available experimental evidence. More evidence is needed and more is being accumulated. It will be soon enough to abandon the hypothesis when it has been clearly shown to be contrary to facts. This has been pointed out by Dr. Walker in his letter of March 28.

So far the only other explanation of anomalous rotatory dispersion that has been given is that of Dr. W. T. Astbury (Proc. Roy. Soc., 1923, A, 718, p. 527), who attributes the anomalies of tartaric acid and many of its derivatives to the combination of two opposing spiral formations. One of these is dextrorotatory and, since it is a property of the 4-carbon nucleus of the molecule, it is stable. The lævorotatory spiral, on the other hand, is easily broken up by solvents, etc., since it depends upon the junctions between the hydroxyl groups of neighbouring molecules.

Dr. Pickard fails to see what the bearing of my work is on these deductions. The reply is perhaps best given by a quotation from Dr. Astbury's paper, in which after discussing at some length the Bakerian Lecture for 1921 (without acknowledging my share in it), he proceeds to "the conclusion that the two extremes of rotatory power are the dextro in the very dilute solutions or when the hydroxyl groups are 'fixed,' and the lævo in the crystalline form . . ." and again (in italics this time): "The dextrorotatory property of ordinary tartaric acid is associated with the carbon nucleus of the molecule."

It seems to me that these views are difficult to reconcile with the facts :

(1) That the "fixed" molecule of methylene tartaric acid is strongly lævorotatory.

(2) That its specific rotation is practically constant over a wide range of concentrations, and

(3) That the curve of its rotatory dispersion, so far as it can be explored, can be represented by one term of Drude's equation.

Further evidence on tartaric acid itself will shortly be available for publication.—I am, Sir, etc.,

P. C. Austin

Westminster Training College
April 6, 1924

THE EPILATION OF SKINS

Sir.—I have again read Mr. Wood's paper to which he refers and which contains the test for enzyme action that he claims shows that my researches are wrong. It apparently consists of mixing a dilute solution of gelatin with a powdered extract of a conglomeration of organs of a dog's alimentary tract. If, after a certain time, at a certain temperature, the gelatin refuses to coagulate on boiling, he says that it is all peptonised by enzyme action, or, if the reverse, there is no enzyme present. Heavens! how can he genuinely assert either? He makes the same assertion, using the same tests for limes and soak liquors in the tannery. How can he preclude that the gelatin has become so swollen with dropsical imbibition that it can no longer coagulate, or that there are no new coenzymes, or inhibiters, or adsorption compounds that may bring the enzymes to equilibrium, etc., in his conglomerate mixture? Further, he asks us to trust his German test with gelatin as one for the effect of the limes on the skin. There is no gelatin in the skin as the tanner uses it. There may be a hundred fallacies in his test.

But it is of little use arguing with Mr. Wood and his preconceived ideas. He, like several others, seem to have missed the gist of my researches tha[t] if you remove the two enzymes from the ski[n] neither lime nor ammonia nor xylol, etc., will unhai[r] it. He states that thrombase is not a proteoclasti[c] enzyme and that it will not unhair a hide. O[n] my table as I write are many yards of artificia[l] furs made out of the hair and epidermis remove[d] from hides by thrombase proteoelasm, and th[e] leather made from the same pelts is, according t[o] experts, as good as or even better than what i[s] usually made to-day. "The proof of the pudding . . ."—I am, Sir, etc.,

H. C. Ross

PERSONAL AND OTHER NOTES

The President and Council of the Royal Society have appointed Prof. O. W. Richardson, F.R.S., to be the third Yarrow research professor of the Royal Society. Prof. Richardson, who is Wheatstone professor of physics in King's College, London, will remain a member of King's College and will continue to carry out his researches there.

We regret to announce the death, on March 28, of Mr. A. E. Tucker, at the age of 70. Mr. Tucker had practised in Birmingham for 40 years, mainly in metallurgical research and analysis, and had held the office of official analyst to the London Metal Exchange. He was a member of several scientific societies, and had served as chairman and member of the committee of the Birmingham and Midland Section, before which he read, some time ago, a paper on metal colouring. He leaves a widow and three sons.

Prof. G. Poma, professor of industrial chemistry in the Royal School of Engineering, Padua, and technical director of the Bonelli dyestuff factory, has died, aged 42 years.

Prof. E. Paternò has been appointed professor emeritus in the faculty of science of the University of Rome. Prof. R. Nasini has been appointed director of the pharmaceutical school of the University of Pisa. Prof. M. G. Levi has been nominated a member of the committee for the preparation of the national mobilisation of Italy.

Gilbert Baldwin, the chief chemist to the Mathieson Chemical Co., Niagara Falls, N.Y., was killed on February 22 by an explosion in the synthetic ammonia plant.

By the will of Miss Caroline Harrold, who left estate of the value of £26,681, the ultimate residue of the estate is to go to the University of Birmingham, for affording facilities and opportunities for research in the Faculties of Science and Medicine.

Dr. A. E. Houlehan, who died at Delaware on March 11, aged 39, was assistant director of the Wilmington experimental station of the Du Pont Co., and was responsible for important developments in the manufacture of organic chemicals required during the war. He later took a prominent part in organising research in dye manufacture for the Du Pont Co. Dr. Houlehan was a member of the Society of Chemical Industry.

The Royal Society has received from Messrs. Brunner, Mond & Co., a gift of 500 guineas for use in publishing the results of research in chemistry, physics and allied sciences.

The executive committee of the National Italian Congress of Industrial Chemistry, which is to be held in Milan from April 12 to 17, has decided to award the sum of 50,000 lire, as a whole or in part, for the best original papers dealing with applied chemistry read by Italian authors at the Congress.

The Council of the University of Manchester has received £507 to be invested and known as the "Professor Harold Baily Dixon Bursary Fund." The income of this fund, which will be administered by a committee appointed by the Council, will be used to assist students in the Department of Chemistry who may be in need of financial assistance in order to complete their degree courses. This sum represents the balance left after defraying the cost of the bust of Prof. Dixon, which has been placed in the Chemical Theatre of the University.

Dr. W. R. Ormandy has been elected president of the Institution of Automobile Engineers for the session 1924-1925.

On April 2, states the *Chemiker Zeitung*, Prof. Oscar Loew, "the Nestor of German agricultural chemists and plant physiologists" celebrated his eightieth birthday. Investigations on the chemical problems of life, the formation and properties of formaldehyde, the nutrition of plants, the use of lime and magnesia as soil dressings and many other subjects show the extent of Loew's interests.

German Dye Agreement

It is reported from Berlin that a large number of shares have been exchanged between the Basel Farbstoff Werke, Switzerland, and a large German dye company, as the result of an agreement regulating prices, conditions of sales and areas of market.

Methods of Analysis of Coal—Determination of Nitrogen

Experiments made subsequent to the issue of the description of the methods of analysis recommended by the Sampling and Analysis of Coal Committee of the Fuel Research Board have shown that the particular modification of the Kjeldahl method for the determination of nitrogen, described on pages 7 and 8 of their interim report (Fuel Research Board, Physical and Chemical Survey of the National Coal Resources, No. 2, "Interim Report on Methods of Analysis of Coal," 1923. H.M. Stationery Office. Price 1s. 6d. net) gives perfectly reliable results; there is a close agreement between the results of this method and those obtained by a proved modification of the Dumas method ("The Estimation of Nitrogen in Coal," by A. Baranov and R. A. Mott, *Fuel*, 1924, 3, 31, 49). It has also recently been proved that copper sulphate is *not* a suitable substitute for mercury, as stated in a footnote on page 7 of the interim report, since its use yields, in general, low results.

The Chartered Electrical Engineer

The following is part of a new by-law of the Institution of Electrical Engineers, which was adopted at a Special General Meeting of the Corporate members, held on February 28, 1924, and was allowed by the Lords of His Majesty's Most Honourable Privy Council on March 20, 1924:—

"Every member and associate member is, and is entitled to describe himself as, a Chartered Electrical Engineer, and in using that description after his name shall place it after the designation of the class in the Institution to which he belongs, stated in accordance with the following abbreviated forms, namely, M.I.E.E. or A.M.I.E.E., as the case may be."

Errata

In the account of the meeting of the Biochemical Society, published in the issue for March 21, the following corrections should be made:—P. 313, col. ii., line 1, for "doses of 15 c.c." read "doses of 5 c.c." Line 11, for "Mr. E. M. Luce," read "Dr. E. M. Luce." Line 40, for "than pasture-fed milk" read "than 5 c.c. of pasture-fed milk."

FRANCE

Potash in 1923

The French production of potash salts in 1923 totalled 1,275,429 metric tons, equivalent to 248,698 t. K_2O, compared with 1,052,217 t. (207,119 t. K_2O) in 1922. The production in 1923 included 409,535 t. of crude salts (12 to 15 per cent. K_2O), 350,039 t. of manure salts (20 to 22 per cent. K_2O), 110,529 t. of manure salts (30 to 40 per cent. K_2O) and 156,638 t. of chlorides (with over 50 per cent. K_2O). The chief exports were: United States, 5583 t. chloride; Great Britain, 18,195 t. chloride, and Netherlands, 40,100 t. chloride. In January, 1924, the production of potash salts was 125,914 t. (27,487 t. K_2O).

Milk Production in France

According to official statistics of the French Ministry of Agriculture, the production of milk was 106,503,550 hectolitres in 1921, 113,276,970 hl. in 1922, and 112,058,120 hl. in 1923.

AUSTRALIA

Pulverised Coal in Victoria

Experiments by the Victorian Railways on the use of pulverised brown coal as engine fuel, have given satisfactory results, including, it is stated, a large saving in fuel, labour and time, and similar results have been obtained under boiler plant at Newport.

UNITED STATES

Improved Catalyst for Nitrogen Fixation

It is announced from the United States that the Fixed Nitrogen Research Laboratory of the Department of Agriculture has developed a new catalyst with which yields of 14 per cent. of ammonia has been obtained during continuous running. The German catalyst gives a yield of 7 per cent. and its life is much shorter.

REVIEWS

Chemisch-Technische Vorschriften. *By* Dr. Otto Lange. Vol. III. Harze, Oele, Fette. *Pp.* xix+796. *Third edition, enlarged, and fully revised. Leipzig: Otto Spamer,* 1923. *Price, paper 50 goldmarks, bound 75 goldmarks.*

The volume forming the subject of the present review deals with the chemistry and technology of rubber, resins, gums and turpentine; petroleum and its products, including asphalt, tar and pitch; fatty oils and waxes and their related industries; hydrogenation; stearine, oleine and the soap and candle industries; perfumes and toilet preparations; disinfectants, sterilising agents and preservatives; water and industrial effluents; insecticides, fungicides and germicides.

When one reflects that Dr. Otto Lange's *Chemisch-Technische Vorschriften* is a work of six volumes each more or less comparable in bulk with this under review, one wonders whether to admire or to condole with him in essaying unaided the task he has undertaken. There is in the present volume alone material requiring the collaboration of at least half a dozen experts each having an exhaustive and critical knowledge of some main section of the work, for, frankly, it is impossible for one author to deal effectively with the many and diverse subjects included here for the all-sufficient reason that to do so requires an intimate working knowledge of the various industries which are within the purview of the volume and one is not convinced that the author at all times possesses this necessary qualification. Consequently, the faults are such as one expects to find: there is a want of balance, a disposition to give much detail where brevity would suffice with the corresponding fault of dealing only scantily with subjects of well-recognised importance, and an absence of that critical discussion of data which, in many cases, would help to guide the reader.

Despite the bewildering amount of information contained in this volume—and its closely written 800 pages contain thousands of references to patent specifications and published technical and scientific papers—one is impressed by the omission of much that is of real importance and more particularly by the fact that the books, technical papers and patents to which reference is made in the text are almost entirely German and this partiality, for which there is no possible justification, constitutes a very serious defect in the volume, a defect which greatly detracts from its value as a work of reference.

The general plan of the book is quite good and its sub-division into chapters with appropriate headings facilitates a grasp of the subject-matter. Commencing with an account of the occurrence and characteristics of the raw materials dealt with in each section, we are shown how these are exploited, converted into intermediate and final products, and the relationship of these to and bearing on other branches of chemical industry is indicated. The chemical aspect of each subject appears to be adequately treated and the author has wisely refrained from giving analytical details which can always be found in any of the well-known textbooks. The statistical information accompanying many of the chapters is useful though not always very adequate and more frequently not up-to-date.

Within the compass of a brief review it is impossible to refer in any detail to more than one or two sections, but in a careful reading of those sections which embrace the fatty oil industries one is surprised at the small amount of space devoted to the seed-crushing industry though the allied subject of extraction receives much fuller treatment. The great developments that are taking place in the cultivation of the oil palm in plantations in West Africa, and more particularly in the Dutch East Indies, leading to improved yields of the fruit, better methods of dealing with the kernels and the production of a commercial grade of palm oil greatly superior to what has usually been produced in the past, are facts which appear to have escaped the author's notice. The rendering and refining of such animal fats as tallow and lard require much fuller notice than has been accorded to them, and the same may be said in respect of butter and margarine which receive only passing mention.

The chapters devoted to an account of the methods and materials used in refining, bleaching and deodorising the fatty oils and waxes are well done and the same may be said of the treatment of such subjects as saponification, the production of stearine and oleine, the preparation of emulsified and sulphonated oils and hydrogenation. In the sections dealing with soap a good account of detergents other than soap itself is given and several interesting chapters are devoted to an account of the occurrence and properties of those curious bodies, the saponins, and their allies which frequently find use in the manufacture of vegetable soaps.

The volume will be found useful by the reader who uses it to supplement, but not to supplant, his own searches amongst chemical literature. To the very full index which has been provided an index of authors' names would have been an addition which many readers would have welcomed.

H. M. Langton

Chemical Synonyms and Trade Names. By W. Gardner. Pp. 280. London: Crosby Lockwood & Son, 1924. Price 25s.

Owing to the rapid advance of chemical industry, chemical trade names have become both numerous and confused, several different names often serving to designate a single product, and new names often giving no indication of the real nature of the product. Anything that will serve to prevent this confusion is to be welcomed, and of the attempts so far made the book under review is quite the best seen by the reviewer. A very wide ground is covered, and no noteworthy name appears to have been omitted, many uncommon names being included. Further editions will probably be wanted, and one will hope to see further condensation and the replacement of superfluous headings such as "soap" and "metal polish" by new and useful names.

LEGAL INTELLIGENCE

SAFEGUARDING OF INDUSTRIES ACT, 1921

The Referee's Award on the "rongalite" case runs as follows :—

"The question in this reference is whether sodium formaldehyde sulphoxylate and zinc formaldehyde sulphoxylate and the various forms in which they are marketed are properly included in the list published by the Board of Trade. It is unnecessary to decide whether they are fine chemicals or analytical reagents as in my opinion they are properly included in the list as synthetic organic chemicals."

"It is scarcely contended that the substances are not organic, but it is strenuously urged that the definition of synthetic organic chemicals ought to be restricted to such organic compounds as are built up from their elements or from such other organic groups as can themselves be built up from their elements. It is sought to exclude from the conception of organic synthesis those syntheses in which an inorganic molecule is combined with an organic molecule."

"In the Camphor case I refused to accept such a restricted view and I am not prepared to do so now. I think that such combinations are organic syntheses provided that they result in the formation of a structure not previously present.

"I think that the complainants have probably proceeded with this complaint relying on a recent article in the CHEMISTRY AND INDUSTRY REVIEW by Sir William Pope. They would have a strong case if that article expressed the whole view of Sir William Pope, but I am satisfied that it does not. I accept entirely his evidence as to that. Incidentally I may point out that the statement in the article that I decided that calcium carbide was not synthetic is wholly inaccurate. The question of synthesis was not dealt with at all in my award dealing with calcium carbide. Calcium carbide was not in the Board of Trade list, and I declined to order it to be inserted because I was satisfied that the Board was right in taking the view that calcium carbide was not so generally regarded as an organic chemical as to justify its inclusion."

EXCESS PROFITS DUTY

On April 4 the British Dyestuffs Corporation appealed from a judgment by Mr. Justice Rowlatt, holding that the Corporation was liable to pay excess profits duty on sums paid to them by the E. I. Du Pont de Nemours Co., for a process for synthesising indigo.

The appellant company claimed that these payments were not income, but payments for a capital asset. In 1916 the appellant company acquired a German factory at Ellesmere Port, and with it a secret process for synthesising indigo. For the right to use the process the American company agreed to pay ten annual sums of £25,000, ending in 1927. This was the sale of part of the appellant company's assets, and therefore it was wrong to regard the money received as profits.

Lord Justice Bankes said the question was whether the transaction was a sale of property for a price, or a method of trading, the price being part of the gains of trading. He read the agreement as a trading convention as to how and where the parties' respective businesses would be carried on. The annual payments were of the nature of royalties, and must be regarded as profits, so that the appeal failed.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Dyes and Dyestuffs

In a written reply to Mr. Hannon, Mr. Webb gave the following statement showing the quantities of dyes and dyestuffs (except dye-woods and raw dyeing substances) imported into and exported from the United Kingdom during the year 1923 :—

	Imports Cwt.	Exports (U.K. manufactures Cwt.	Foreign and Colonial merchandise Cwt.
Intermediate coal-tar products used in the manufacture of dyes (including aniline oil and salt, and phenylglycine)	1349	43649	75
Finished coal-tar dyestuffs—			
Alizarin	8409	22,150	7
Indigo, synthetic	8274	19,604	1
Other sorts	39,474	40,813	1577
Extracts for dyeing—			
Cochineal	773	31	450
Cutch	48,395	1395	18,807
Fustic	5997	310	173
Logwood	55,698	2140	6650
Other sorts	10,436	7584	1468
Indigo, natural	757	4	261

The direct foreign trade of the Irish Free State has been excluded from the above particulars as from April 1, 1923.—Mar. 25.

Indigo-dyed Cloth

Mr. Hartshorn, replying to Mr. Th[illegible]ne, said it had not been the practice for many y[illegible]rs past to require the use of natural indigo in the [illegible]e of Post Office uniforms; and he was inform[illegible] that by doing so additional expenditure would be incurred with no corresponding advantage. Therefore he did not feel that a deputation from the dyers would serve any useful purpose.—Mar. 25.

Lactose

Replying to Mr. Baker's enquiry as [illegible] the reasons which actuated the Department of A[illegible]culture to decide to stop the experiments in the production of lactose, Mr. Buxton said he hoped it might be possible to continue experiments at the Ministry's lactose factory.—Mar. 31.

Oil Fuel Supplies

Mr. Trevelyan, answering Sir H. Brittain, stated that the question of the production of motor spirit and other oils from British coal was under continuous investigation by the Fuel Research Board, both by researches at the Fuel Research Station, Greenwich, and by a close study of other attempts to solve the problem at home and abroad.—Apr. 2.

Chilled Meat (Formaldehyde Preservative)

Answering Captain Viscount Curzon, Mr. Wheatley said that the quantity of chilled meat being imported on the s.s. "Kent" is 463 quarters, and he was not aware that any arrangements had been made for further consignments of meat treated by formaldehyde. The Departmental Committee on Preservatives in Food had proposed to arrange for the inspection and investigation of the process for the general purposes of their enquiry.—April 1.

Fuel Research Board

In answer to Sir H. Brittain, Mr. Trevelyan said that the Board had produced from coal on a large experimental scale both a suitable fuel oil for naval and commercial purposes and an efficient solid fuel to take the place of raw coal. The Board, however, believed that neither its own work nor that of any outside body had yet proved the economic possibility of such production on a national scale.—Apr. 2.

Patent and Trade Mark Laws

In a written answer to Mr. Hannon, Mr. Webb said that he was aware of the lack of uniformity in the patent and trade mark laws of the countries signatory to the Industrial Property Convention of 1883, which was last revised at Washington in 1911. Every effort had been made in the past to obtain greater uniformity in the general principles of patent and trade mark legislation in the contracting States, and it was hoped that at the next Convention a further advance in this direction would be made.—Apr. 2.

COMPANY NEWS

BRITISH ALUMINIUM CO., LTD.

Including a carry forward of £15,778, the net profit for 1923 is £111,123, after providing for taxation, debenture stock, and setting aside £50,000 for depreciation, and £60,000 for reserve (now at £280,000). After providing for the dividend on the preference shares and an interim dividend of 5 per cent. on the ordinary shares, a final dividend is recommended of 10 per cent. per annum on the ordinary shares, making 7½ per cent. for the year, and leaving £18,071 to be carried forward. In 1922, the profit was £83,804, £30,000 was placed to depreciation reserve, £10,000 to reserve, and after paying 5 per cent. on the ordinary shares, £15,778 was carried forward. The report states that all the works operated at full production during 1923 and the demand for metal showed a continued increase.

BELL'S UNITED ASBESTOS CO., LTD.

The net profit for 1923 was £36,525 (£36,850 in 1922), and £37,911 was brought forward. It is proposed to pay a final dividend on the ordinary shares of 7½ per cent., making 10 per cent. for the year; to place £10,000 to reserve, leaving £31,483 to be carried forward. The report states that following the amalgamation of the Poilite and Everite businesses substantial savings have been effected by co-operative working.

MIRRLEES WATSON, LTD.

Credit balance on profit and loss account after deducting depreciation, directors' fees, and other provisions, amounts to £15,601, which, with balance brought forward, £4,086, makes available £19,687. It is recommended that £14,404 be applied in payment of dividend of 10 per cent., leaving £5,283 to be carried forward. Balance of profit for previous year was £2,929, and similar dividend was paid.

THARSIS SULPHUR AND COPPER CO., LTD.

A dividend of 10 per cent., less tax, is recommended for 1923. After writing off £27,486, £30,225 is carried forward.

LEVER BROTHERS, LTD.

The profit balance is £5,071,978 (an increase of £146,960), leaving £4,326,858 for dividends on the preference and preferred preference shares, £197,427 for the co-partnership dividend, and £240,000 (10 per cent.) for the ordinary dividend. £250,000 is placed to reserve and £57,693 carried forward. The capital of the company stands at £51,475,363 and reserves stand at £2,732,664.

ASSOCIATED PORTLAND CEMENT MANUFACTURERS, LTD.

The directors regret inability to recommend the payment of a dividend on the ordinary shares for 1923. After providing for preference dividend and placing £218,600 to reserve, £227,478 remains to be carried forward, as against £227,400 brought in. The decrease in profits is largely due to low export prices.

BRITISH PORTLAND CEMENT MANUFACTURERS, LTD.

At the ordinary general meeting it was stated that the debentures had been reduced by £28,347, sundry creditors had increased by £117,040 to £452,875, and investments and loans had increased by £645,202. The net profit for the year was £208,669 (£210,578) and including the carry-forward £393,812 remained for disposal. Investments had given satisfactory returns, but the Indian company had made a loss, owing to over production in India. The ordinary shares of the Humber Portland Cement Co. had been acquired for £600,000 by a subsidiary company. The demand for cement, though better, fell short of expectations, and competition was very severe, but a larger demand was anticipated in the future. It was decided to pay the preference dividend and a dividend of 10 per cent. on the ordinary shares, leaving a carry-forward of £187,751.

UNITED GLASS BOTTLE MANUFACTURERS, LTD.

Sir E. F. Oldham, speaking at the general meeting, said the company was in a sound financial position and that its business continued to expand, particularly in the export trade. The net profit was £43,388, and after making substantial depreciations and reserves, and including other amounts, there remained a net balance of £130,280. After paying debenture interest, enough remained to cover the interest on the preference shares, but it was considered advisable to defer payment for the present, in order to provide more working capital.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech. ..	£24 per ton. Fair inquiry.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¾d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76% ..	£17—£19 10s. per ton, according to quality.
Soda Crystals .. .	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton carr. paid.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton according to quantity. f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide ..	Expected to advance in sympathy with the crude metal.
Golden	5¼d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide ..	4s. per lb.
Carbon Bisulphide ..	£24—£26 10s. per ton according to quantity.
Carbon Black	Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.
Carbon Tetrachloride ..	£56 per ton, drums free.
Chromium Oxide ..	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.
Lamp Black	40s. per cwt., barrels free.
Lead Hypo sulphite ..	7½d. per lb.
Lithopone	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep ..	3s. 4d.—3s. 6d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade, but these are the only products in this section which show any activity.

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£21 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 10s. per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall., 60% O.P. Dull market.
Solvent	5s. per gall. 10% O.P. Dull market.
Wood Tar	£5—£6 per ton according to grade. Demand not very brisk. Ample supplies.
Brown Sugar of Lead ..	£47 per ton. Demand active.

TAR PRODUCTS

Acid Carbolic—	
Crystals	7¾d.—8d. per lb. Better demand, and firmer market. London prices reported up to 9d.
Crude 60's	2s.—2s. 3d. per gall. Market not so good.
Acid Cresylic, 97/99 ..	1s. 11d.—2s. 1d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—2s. per gall. Steady demand.
Dark	1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40% ..	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	10d.—11d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor ..	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 4½d.—1s. 7d. per gall.
Pure	1s. 8d.—1s. 11d. per gall.

Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 10½d. per gall. Few inquiries.
Middle Oil .. } 7¾d.—8½d. per gall. according to grade and district. Market again weaker.
Heavy .. .. }
Standard Specification }
Naphtha—
Crude .. .. .. 8d.—9d. per gall. } Better demand.
Solvent 90/160 .. 1s. 2d.—1s. 5d. } Prices show up-
Solvent 90/190 .. 1s. 2d.—1s. 3d. } ward tendency.
Naphthalene Crude—
Drained Creosote Salts £6—£7 10s. Demand not so good.
Whizzed or hot pressed £9 10s.—£12 per ton. Not much inquiry.
Naphthalene—
Crystals and Flaked .. £17—£18 per ton.
Pitch, medium soft .. 52s. 6d.—57s. 6d. per ton. Market again weaker.
Pyridine 90/140 .. 18s.—19s. per gall. Demand well maintained. Price again advanced.
Heavy .. 11s.—12s. Occasional inquiries; little business.

INTERMEDIATES AND DYES

Business in dyestuffs has increased and reflects an improvement in the textile trade. Orders have been for larger quantities than of late. Prices remain firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. .. 4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 9d. per lb. 100% basis d/d.
Acid Salicylic, tech .. 1s. 4d. per lb. Steady demand.
Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 7½d.—8½d. per lb. naked at works.
Aniline Salts .. .. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 3d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 19/31° C. .. 4¾d.—5¼d. per lb. Demand moderate.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. [illegible] moderate.
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethylaniline .. .. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluene 48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 3s. 2d. per lb. d/d.
Monochlorbenzol .. .. £63 per ton.
α-Naphthol .. .. 2s. 5d. per lb. d/d.
β Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. 1s. 4½d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 5s. 3d. per lb. d/d.
p-Nitraniline .. .. 2s. 4d. per lb. d/d.
Nitrobenzene .. .. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol .. 2s. per lb. 100% basis d/d.
Nitronaphthalene .. 11¾d. per lb. d/d.
p-Nitrophenol .. .. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol 4s. 6d. per lb. 100% basis.
m-Phenylene Diamine .. 4s. 2d. per lb. d/d.
p-Phenylene Diamine .. 10s. 4d. per lb. 100% basis d/d.
R. Salt .. .. .. 2s. 9d. per lb. 100% basis d/d.
Sodium Naphthionate .. 2s. 6d. per lb. 100% basis d/d.
o-Toluidine .. .. 8½d. per lb.
p-Toluidine .. .. 3s. 10d.—4s. 3d. per lb. d/d.
m-Toluylene Diamine .. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The market is lifeless, values remaining at a low level.

Acid, Acetic 80% B.P. .. £48 per ton. Market easier.
Acid, Acetyl Salicylic .. 3s. 5d.—3s. 9d. per lb. Easier.
Acid, Benzoic .. .. Commercial acid 2s. 6d. per lb. B.P. quality is being sold in small lots at 4s. lb.
Acid, Boric B.P. .. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric .. .. 19s.—21s. per lb.
Acid, Citric .. .. 1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic .. .. 3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst. .. 6s. per lb., for 28 lb. lots.
Acid, Salicylic .. .. Prices quoted from 2s. 3d. per lb. down to 1s. 10d. for ton lots. Market rather weak.
Acid, Tannic B.P. .. 3s. per lb. Market quiet.
Acid, Tartaric .. .. 1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol .. .. .. 9s. per lb. d/d.
Acetanilide .. .. 2s. 6d. per lb. for quantity. Very weak.
Amidopyrin .. .. 13s. 6d. per lb.
Ammon. Benzoate .. 3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P. £37 per ton.
Atropine Sulphate .. 12s. 6d. per oz. for English make.
Barbitone .. .. 15s. 6d. per lb. Weak market.
Benzonaphthol .. .. 6s. 3d. per lb. Firmer.
Bismuth Salts .. .. A steady market. Prices according to quantity:
Bismuth Carbonate .. 12s. 9d.—14s. 9d. per lb.
" Citrate .. .. 11s. 4d.—13s. 4d. "
" Salicylate .. 10s. 2d.—12s. 2d. "
" Subnitrate .. 10s. 9d.—12s. 9d. "
Borax B.P. .. .. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides— Market very firm and advancing. Heavy increase in price of bromine.
Potassium .. .. 10d.—10½d. per lb.
Sodium .. .. 10d.—10½d. "
Ammonium .. .. 11d.—1s. "
Calcium Lactate .. Prices vary over a wide range. Good English make can be had from 1s. 7d. to 2s. 3d. per lb.
Chloral Hydrate .. .. 3s. 9d. per lb.
Chloroform .. .. 2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate .. 6s. per lb. Little demand.
Guaiacol Carbonate .. 13s. per lb. for cwt. lots.
Hexamine .. .. 3s. 6d.—3s. 9d. per lb. for foreign makes. Weaker. Without much inquiry. Large stocks.
Homatropine Hydrobro-

Hydroquinone .. .. 4s. 3d. per lb. Foreign make.
Iron. Ammon. Citrate B.P. 1s. 11d.—2s. 3d. per lb., according to quantity.

Magnesium Carbonate—
Light Commercial .. £36 per ton net.
Magnesium Oxide—
Light Commercial .. £75 per ton, less 2½%.
Heavy Commercial .. £20 per ton, less 2½%.
Heavy Pure .. .. 2s.—2s. 3d. per lb., according to quantity. Steady market.

Menthol—
A.B.R. recryst. B.P. .. 67s. 6d. Strong upward movement due to disappointing Japanese crop.
Synthetic .. .. 20s.—35s. per lb., according to quantity. English make. Steady demand.

Mercurials .. .. Very much firmer in view of the rise in the price of quicksilver. Prices have been advanced by 6d. per lb.
Red oxide .. .. 5s. 3d.—5s. 4d. per lb.
Corrosive sublimate .. 3s. 6d.—3s. 7d. „
White precip. .. .. 4s. 7d.—4s. 8d. „
Calomel .. .. 3s. 11d.—4s. „
Methyl Salicylate .. 2s. 7d.—2s. 9d. per lb. for carboys. Weaker than other salicylates.
Methyl Sulphonal .. 25s. per lb. neglected.
Paraformaldehyde .. 3s. 6d. per lb., without much inquiry.
Paraldehyde .. .. 1s. 4d.—1s. 7d. per lb. in free bottles and cases.
Phenacetin .. .. 6s. 6d. per lb.
Phenazone .. .. 8s. per lb. for cwt. lots. Spot prices much lower than forward offers. Firmer tendency.
Phenolphthalein .. .. 7s. 3d.—7s. 6d. per lb. Firm.
Potass. Bitartrate—
99/100% (Cream of Tartar) .. .. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate .. .. 1s. 8d.—2s. per lb.
Potass. Iodide .. .. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite .. 7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate—
B.P. Crystal .. .. 8¾d.—9d. per lb. carriage paid. English make.
Commercial .. .. 8d.—8¼d. per lb. carriage paid. English make.
Quinine Sulphate .. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin .. .. .. 6s. 3d. per lb.
Salol .. .. .. 3s. 9d. per lb.
Silver proteinate .. 9s. 6d. per lb.
Sod. Benzoate, B.P. .. 3s. 3d. per lb. In more plentiful supply.
Sod. Citrate, B.P.C., 1923 1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite—
Photographic .. .. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst. 37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside .. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt) .. 76s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.
Sod. Salicylate .. .. Market firmer. Powder 2s. 5d.—2s. 9d. per lb. Crystal at 2s. 9d.—2s. 11d. per lb. Flake 2s. 10d.—3s. 4d. per lb.
Sod. Sulphide—
Pure recryst. .. .. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous £27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal .. .. .. 18s. 6d. per lb.
Tartar Emetic .. .. 1s. 4d. per lb.
Thymol .. .. .. 13s. 6d.—15s. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone .. .. 12s. 6d. per lb.
Aubepine .. .. .. 13s. 6d. „
Amyl Acetate .. .. 2s. 9d. „ Cheaper.
Amyl Butyrate .. .. 7s. 3d. „
Amyl Salicylate .. .. 3s. 3d. „
Anethol (M.P. 21/22° C.) 4s. „
Benzyl Acetate from Chlorine-free Benzyl Alcohol 3s. 3d. „
Benzyl Alcohol free from Chlorine .. .. 3s. 3d. „
Benzaldehyde free from Chlorine .. .. 3s. 6d. „
Benzyl Benzoate .. 3s. 6d. „
Cinnamic Aldehyde Natural .. .. .. 15s. 6d. „ Cheaper.
Coumarin .. .. 20s. „
Citronellol .. .. 16s. „
Citral .. .. .. 10s. „
Ethyl Cinnamate .. 15s. „
Ethyl Phthalate .. .. 3s. 9d. „
Eugenol .. .. .. 11s. „
Geraniol (Palmarosa) .. 35s. „
Geraniol .. .. .. 11s.—18s. 6d. per lb. Advanced.
Heliotropine .. .. 8s. 3d. per lb.
Iso Eugenol .. .. 15s. 9d. „
Linalol ex Bois de Rose .. 22s. 6d. „
Linalyl Acetate .. .. 22s. 6d. „
Methyl Anthranilate .. 9s. 6d. „
Methyl Benzoate .. 6s. „
Musk Ambrette .. .. 52s. 6d. „
Musk Xylol .. .. 19s. „
Nerolin .. .. .. 4s. „
Phenyl Ethyl Acetate .. 12s. 6d. „
Phenyl Ethyl Alcohol .. 16s. „
Rhodinol .. .. .. 57s. 6d. „
Safrol .. .. .. 1s. 10d. „
Terpineol .. .. .. 2s. 9d. „
Vanillin .. .. .. 25s. 3d.—26s. 6d. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. .. .. .. 15s. 6d. per lb. Dearer.
Anise Oil .. .. .. 3s. per lb. Firmer market forward.
Bergamot Oil .. .. 18s. per lb.
Bourbon Geranium Oil .. 35s. „
Camphor Oil .. .. 75s. per cwt.
Cananga Oil, Java .. 8s. 9d. per lb.
Cinnamon Oil, Leaf .. 6½d. per oz.
Cassia Oil, 80/85% .. 9s. 3d. per lb.
Citronella Oil—
Java 85/90% .. .. 5s. 3d. „
Ceylon .. .. .. 3s. 9d. „
Clove Oil .. .. .. 8s. 4½d. „
Eucalyptus Oil 70/75% .. 2s. 3d. per lb.
Lavender Oil—
French 38/40% Esters 26s. per lb. Advanced.

Lemon Oil ..	.. 3s 4d. „
Lemongrass Oil ..	.. 2¾d. per oz.
Orange Oil, Sweet	..13s. per lb. Advanced.
Otto of Rose Oil—	
Bulgarian ..	.. 27s. 6d. per oz.
Anatolian ..	.. 23s. 6d. per oz.
Palma Rosa Oil ..	.. 18s. 6d. per lb. Very short supply.
Peppermint Oil—	
English	.. 75s. per lb. Advanced 5s. per lb.
Wayne County	.. 21s. per lb. Again advanced.
Japanese ..	.. 20s. per lb. but very little being offered.
Petitgrain Oil ..	.. 10s. per lb. Advanced.
Sandal Wood Oil—	
Mysore	.. 25s. per lb.
Australian ..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patent those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before June 2nd.; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, 15 days after the date given.

I.—Applications

Andrews. Grading powdered material. 7627. Mar. 25.

Bechhold, Gutlohn, and Karplus. Production of emulsions. 7749. Mar. 26. (Ger., 29.3.23.)

Campbell. Separating solids from liquids. 7719. Mar. 26.

Dunstan and Renfry. Use of adsorbent substances. 8060. Mar. 29.

Ernst. Manufacture of bimetallic thermostats. 7843. Mar. 27. (Ger., 28.3.23.)

Graham. Apparatus for separating gases from liquids. 7708. Mar. 26.

Marks. 7604. *See* II.

Marks. Centrifugal apparatus. 7605. Mar. 25.

Mayhew and Ramsay. Grinding, milling, and pulverising apparatus. 7706. Mar. 26.

Pessell. Appliances for separating liquids etc. 7522. Mar. 25.

Seligman. Apparatus for effecting interchange of heat. 7616. Mar. 25. (July 18, 1923.)

Soc. Chimique de la Grande-Paroisse (Azote et Produits Chimiques). Purification of gases. 7697. Mar. 26. (Fr., 4.6.23.)

Urbain. Treatment of gases etc. 7187. Mar. 24. (Fr., 13.2.23.)

I.—Complete Specifications Accepted

31,807 (1922). Nielsen and Laing. Rotary retorts, kilns, dryers, or the like. (212,961.)

34,477 (1922). Reynolds and Brewin and Dickin. Grinding-mills. (212,978.)

34,850 (1922). Dorr Co. Treatment of pulps. (190,727.)

35,441 (1922). Tanier. Furnaces. (213,014.)

8769 (1923). Monkbridge Iron and Steel Co., Ltd., Kitson and Brown. (213,119.)

12,890 (1923). Young and Greene. Crushing machines. (213,151.)

63 (1924). Lawes, Apthorpe, and Cambridge and Paul Instrument Co., Ltd. (213,210.)

II.—Applications

Box, Davies, and Thompson. Separating fuel from ashes, clinker, etc. 7407. Mar. 24.

Brun. Manufacture of briquettes etc. 7979. Mar. 28. (Fr., 10.4.23.)

Cutter, Drew, and Duncalf. Process for manufacture of active absorbing carbon and phosphoric acid and its compounds. 8048. Mar. 29.

Donald. Drying peats etc. 7386. Mar. 24. 7812, 7813. Mar. 27.

Imray (Curtis). Carbonisation of coal. 7502. Mar. 24.

Marks (Peoples Saving and Trust Co. of Pittsburgh). Recovering heat of fuels at high temperatures, and recovering fusible solids in molten condition. 7604. Mar. 25.

Mons. Draining and pressing peat. 7848. Mar. 27.

Power-Gas Corp., and Rambush. Production of combustible gases and coke from bituminous fuel. 7750. Mar. 26.

Ramage. Low-temperature distillation. 7483. Mar. 24. (U.S., 9.4.23.)

Records. Liquid fuel. 7509. Mar. 24.

Soc. Chimique de la Grande-Paroisse. 7697. *See* I.

Soc. Française des Glycérines. Production of a decolorising and deodorant black composition. 7866. Mar. 27. (Fr., 1.5.23.)

Urbain. 7487. *See* I.

II.—Complete Specifications Accepted

1641 (1923). Davies. Carbonisation of coal, lignite, etc. (213,040.)

1974 (1923). Stalli. Distilling petroleum or mineral oil from oil shales, bituminous coal, etc. (213,046.)

7078 (1923). Perry. Apparatus for distilling carbonaceous material. (213,106.)

8708 (1923). Berl. Producing mixtures of oil and coal. (195,408.)

23,965 (1923). Bloxam (A.-G. für Anilin-Fabrikation). Manufacture of charcoal. (213,195.)

IV.—Application

Soc. of Chemical Industry in Basle. Manufacture of indigoid dyestuffs. 7622. Mar. 25. (Swiss, 18.7.23.)

IV.—Complete Specifications Accepted

25,351 (1922). Poma and Pellegrini. Process for the manufacture of H acid (amino-naphthol-disulphonic 1, 8, 3, 6). (190,114.)

34,368 (1922). Shannan, Siderfin, Adam, and Gas Light and Coke Co. *See* XX.

V.—Applications

Case, Garrow, and Novocretes, Ltd. Treating fibrous materials. 7823. Mar. 27.

Dreyfus. Manufacture of artificial textile products. 8059. Mar. 29.

Faust. Manufacture of artificial fibres, silk, etc. 7879. Mar. 27.

Hilton. Decorating fabrics from solutions of cellulose etc. 7772. Mar. 27.

Huebner. Production and utilisation of viscous solutions. 7882. Mar. 28.

King's Patent Agency (Duryea). Artificial fabrics. 7941. Mar. 28.

Vineke. Cork products. 7440. Mar. 24.

Vineke. Composition cork. 7441. Mar. 24.

V.—Complete Specifications Accepted

34,998 (1922). McRae. Extraction of cellulose from bamboo, bagasse, and other fibres. (213,003.)

11,009 (1923). Levy. Production of artificial filaments. (213,138.)

VI.—Applications

British Cotton and Wool Dyers' Association, and Robinson. Printing yarns etc. 7472. Mar. 24.

Geigy Soc. Anon. Dyeing or printing on acetyl cellulose. 7817. Mar. 27. (Ger., 31.3.23.)

Mairesse. Colour printing upon textiles, leathers, etc. 7436. Mar. 24. (Fr., 24.3.23.)

VI.—Complete Specification Accepted

19,187 (1923). Schlumpe. Hank-dyeing and like machines. (201,565.) July 31.

VII. Applications

Coley. Reduction of carbonates or bi-carbonates. 7427. Mar. 24.

Coloy. Reduction of sulphates. 7428. Mar. 24.

Cutter, Drew, and Duncalf. 8048. *See* II.

Henkel et Cie. Manufacture of mouldings of solid oluble alkali silicates. 7875. Mar. 27. (Ger., 2.5.23.)

Kassner. Manufacture of nitric acid etc. 7484. Mar. 24. (Ger., 31.3.23.)

Meyerhofer. Process of producing inorganic acids. 7862. Mar. 27. (Ger., 28.3.23.)

VII.—Complete Specification Accepted

5499 (1923). Cruse. Manufacture of acetate of alumina by electrolysis. (213,088.)

VIII.—Application

Cachemaille (Westinghouse Lamp Co.). Application of ranslucent coatings to vitreous objects. 8040. Mar. 29.

VIII.—Complete Specification Accepted

34,651 (1922). Vivian. Drying china clay. (212,986.)

IX.—Applications

King. Hard-setting compositions. 7856. Mar. 27.

Rekord-Zement Industrie Ges., and Tetens. Manufacture of concretes and mortars. 7620. Mar. 25.

IX. Complete Specification Accepted

17,139 (1923.) Cullerier. Treating marble to render it ranslucent. (202,282.)

X.—Applications

Coley. 7427 and 7428. *See* VII.

Metallbank und Metallurgische Ges. A.-G. Alloys and metals. 7519. Mar. 24. (Ger., 31.3.23.)

Rondelli. Testing corrosion of ferrous etc. materials. 7760. Mar. 26.

X. Complete Specifications Accepted

28,618 (1922). Jackson (Soc. Anon. J. Cockerill). Treatment of ores containing iron or other metal. (197,903.)

34,600 (1922). O'Donovan. Hardening steel articles. (205,037.)

XI.—Application

Pourbaix. Production of ozone. 7973. Mar. 28.

XI.—Complete Specifications Accepted

4813 (1923). Weissmann. Dry cells. (213,082.)

5499 (1923). Cruse. *See* VII.

XII.—Applications

Bechhold, Gotlohn, and Karplus. 7749. *See* I.

Bray. Manufacture of oil from vulcanized rubber. 7691. Mar. 26. (Belg. 18.12.23.)

Francesconi and Gaslini. Refining fats and oils. 7967. Mar. 28. (Italy, 26.11.23.)

Franke. Cooling-apparatus for production of crystallised oap powder etc. 7538. Mar. 25.

Pourbaix. 7973. *See* XI.

XII.—Complete Specification Accepted

34,743 (1922). Petroff. *See* XX.

XIII.—Application

King. Paints. 7857. Mar. 27.

XIV. Applications

Bray. 7691. *See* XII.

Ditmar. Manufacture of india-rubber etc. articles. 7844. Mar. 27. (Austria, 9.4.23.)

Ditmar. Manufacture of cellulose-caoutchouc products. 7845. Mar. 27. (Austria, 9.4.23.)

Peachey and Skipsey. Vulcanisation of caoutchouc. 7648. Mar. 26.

XV. Applications

British-American Tobacco Co. (Beckley). Obtainment of printed reproductions of photographs on metal. 7826. Mar. 27.

Mairesse. 7436. *See* VI.

XV. Complete Specification Accepted

22,129 (1923). Hoffmans. Cooling and drying glue, gelatin, and the like. (213,190.)

XIX.—Applications

Anderson and Karpinsky. Manufacture of butter. 7606. Mar. 25. (Fr., 16.4.23.)

Radcliffe. Purification of waste effluents. 7563. Mar. 25.

Sonsthagen. Treating chocolate etc. 7835. Mar. 27.

XIX.—Complete Specifications Accepted

17,500 (1923). Schoen. Flours etc. (203,661.)

1921 (1924.) Declercq. Water-purifying apparatus. (210,438.)

XX.—Applications

34,368 (1922). Shannon, Siderfin, Adam, and Gas Light and Coke Co. Manufacture of organic compounds by reactions involving replacement of substituent atoms or groups with liquid reagents. (212,970.)

34,743 (1922). Petroff. Separating oxidised fatty acids from non-oxidised fatty acids. (212,900.)

XXI.—Application

A.-G. für Anilin-Fabrikation, and Wilmanns. Negatives for photomechanical printing. 7754. Mar. 26.

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—

Argentina: Aluminium, chinaware, earthenware, iron, cutlery, glassware, paper, paint and varnish (391); *Australia*: Iron and steel (353); Hardware, paint (Official Secretary, Commercial Bureau, Australia House, Strand, W.C. 2, No. 412/7/1/1/222): *Canada*: Brass foundry, hardware (355); Builders' hardware, paint, cutlery, crockery (358, 359); Plumbing supplies (13.396/E.D./G.C./2); *Chile*: Earthenware, hardware (393); *Dominican Republic*: Soap (394): *Egypt*: Leather (Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, London, S.W. 1); *Latvia*: Asbestos packing (8842/F.R./M.C./2); *Netherlands* Cutlery, leather (366); Brass tubes (368): Silk (370); *New Zealand*: Artificial silk (360); *Sweden*: Chemicals (375).

Foreign Company News

The Société de Soie Artificielle de Tubize has acquired at Lyons a large area of land for the construction of a factory for the manufacture of cellulose acetate silk by its associated company, La Célanèse Française. Plant to produce 500 kg. of artificial silk per day will be installed at first, but the plans provide for an ultimate daily production of 4000 kg. The production at Tubize is now 6000 kg. per day of collodion silk, and 500 to 600 kg. of viscose silk, and in 1924 it is expected to produce a total of from 8000 to 9000 kg. per day. The production of associated companies comprises 1500 kg. per day at Sarvaar, 25 kg. per day at Tomafzew, and 600 kg. per day in America, where production is increasing rapidly. The problem of dyeing cellulose acetate silk has been solved and at Lyons the dyers are taking great interest in it.

Owing to the amalgamation of the Société Industrielle du Celluloide with the Société Générale pour la fabrication des matières plastiques, the new company will be entitled Société Industrielle des Matières Plastiques.

Santonin

The Eastern and Russian Trading Co., Ltd., has sent a booklet and other literature, describing the properties and production of santonin, a valuable anthelmintic obtained from *Artemisia cenæ*, a plant which grows abundantly in Turkestan. Some of the literature received describes tests carried out by the Pharmaco-Therapeutic Institute, Leyden, on "santoperonin": the tests seem to show that this compound is inadvisable as a substitute for santonin.

Trade Information

Messrs. Williams Bros. & Co., of Hounslow, have sent a series of pattern cards illustrating the wide range of colours for all purposes which they manufacture. Special prominence is given to the Nigrosines and Blacks with which this firm is particularly associated, but all kinds of colours for varnish, lacquers, wood, leather, polishes, inks, soap makers and dyes for a variety of textiles are also made. Colours are provided for lake makers suitable for use with any material or solvent, and a speciality is the supply of harmless colours for foodstuffs. Careful matching to requirements is undertaken by a special staff, and Messrs. Williams are glad to supply special lists on application.

Messrs. Meldrums, Ltd., of Timperley, near Manchester, have sent a leaflet (F. D. Supplement) describing the Meldrum forced draught furnace, which was the pioneer in steam-jet furnaces 35 years ago, but which has been continuously improved. Special features claimed for these furnaces are their sturdy construction, efficiency, adaptability to all types of steam-boilers and their ability to utilise all classes of fuel. Messrs. Meldrums have introduced a new design of acid pump in Meldrum metal proof against mineral acids at any strength or temperature. The new design gives greater efficiency and a pamphlet (C 25/6) is supplied in which a graph is given showing the relation between head and output at different speeds, together with a table giving lifts, capacities and speeds of pumps from 1 to 6 in.

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during March has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee. The total number of applications received during the month was 534, of which 415 were from merchants or importers. To these should be added 17 cases outstanding on March 1, making a total for the month of 551. These were dealt with as follows:—

Granted, 420 (of which 380 were dealt with within 7 days of receipt).

Referred to British makers of similar products, 83 (of which 69 were dealt with within 7 days of receipt).

Referred to reparation supplies available, 26 (all dealt with within two days of receipt). Outstanding on March 31, 1924, 22.

Of the total of 551 applications received, 475, or 86 per cent., were dealt with within 7 days of receipt.

PUBLICATIONS RECEIVED

THE PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS. *No.* 6, 1923. *Pp.* 977—1202. *London: The Institution of Mechanical Engineers.*

TESTED METHODS OF MINERAL ANALYSIS. *By* B. T. KITTO, *with a foreword by* BENEDICT KITTO, F.I.C. *Pp.* 127. *London: H. F. and G. Witherby*, 1924. *Price* 7*s*. 6*d*.

LUNGE AND KEANE'S TECHNICAL METHODS OF CHEMICAL ANALYSIS. *Second edition, edited by* CHARLES A. KEANE, D.Sc., PH.D., *and* P. C. L. THORNE, M.A., M.Sc. *Vol. I. Pp. xx*+704. *London: Gurney and Jackson*, 1924. *Price* £3 3*s*.

COLLOID CHEMISTRY. WISCONSIN LECTURES. *By* THE SVEDBERG. *Pp.* 265. *American Chemical Society Monograph Series. New York: Chemical Catalog Co., Inc.*, 1924.

FUEL OILS AND THEIR APPLICATIONS. *By* H. V. MITCHELL. *Pp. xii*+171. *London: Sir Isaac Pitman and Sons, Ltd.*, 1924. *Price* 5*s*.

ANNUAL REPORTS OF THE SOCIETY OF CHEMICAL INDUSTRY ON THE PROGRESS OF APPLIED CHEMISTRY. *Vol. viii.*, 1923. *Pp.* 618. *Edited by* T. F. BURTON. *Price* 7*s*. 6*d*. *to members and* 12*s*. 6*d*. *to non-members.*

REPORT ON THE COMMERCIAL, INDUSTRIAL, AND ECONOMIC SITUATION IN ITALY, *December*, 1923. *By* J. H. HENDERSON, O.B.E., *and* H. C. A. CARPENTER. *Department of Overseas Trade. Pp.* 96. *London: H.M. Stationery Office. Price* 2*s*. 6*d*. 1924.

REPORT ON THE TRADE, INDUSTRIES AND ECONOMIC CONDITIONS IN PORTUGAL. *By* S. G. IRVING. *Department of Overseas Trade. Pp.* 43. *H.M. Stationery Office*, 1924. *Price* 1*s*. 6*d*.

THE MINERAL INDUSTRY OF THE BRITISH EMPIRE AND FOREIGN COUNTRIES, PETROLEUM AND ALLIED PRODUCTS, 1913—1919. *Imperial Mineral Resources Bureau. Pp.* 296. *H.M. Stationery Office*, 1924. *Price* 6*s*. 6*d*.

THIRD AND FINAL REPORT OF THE MINE RESCUE APPARATUS RESEARCH COMMITTEE. *Advisory Council, Department of Scientific and Industrial Research. Pp.* vi+32. *H.M. Stationery Office*, 1924. *Price* 1*s*.

REPORT ON THE ECONOMIC AND FINANCIAL CONDITIONS IN BELGIUM, DECEMBER, 1923. *By* J. PICTON BAGGE, *together with an Annex on the Economic Situation in the Grand Duchy of Luxemburg. Department of Overseas Trade. Pp.* 112. *H.M. Stationery Office.* 1924. *Price* 3*s*.

SECOND REPORT OF THE COMMITTEE ON CONTACT CATALYSIS. *By* WILDER D. BANCROFT. *Reprint and Circular Series of the National Research Council. Number* 50. *Pp.* 801—841. *Washington: National Research Council*, 1923. *Price* 50 *cents*.

REFRACTORIES FOR ELECTRIC FURNACES. *Published by the American Electrochemical Society. Pp.* 94. *New York: Columbia University*, 1924. *Price* $1.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

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EDITORIAL

THE discussion and consideration of the schemes for Chemistry House proceeds with that alacrity which is possible when complicated and revolutionary ideas are evolved which affect some ten thousand chemists. No doubt there are some who wish and intend that some definite step be taken at once, no doubt there are many whose imagination is only fired by such a scheme to an extent which produces a slow and low-temperature carbonisation. The scientific spirit which pervades the majority of chemists tends to a careful and methodical study of the problem in a tranquil frame of mind free from every trace of passion, and with no feeling of surprise or prejudice because the scheme is, or is not, the offspring of some particular individual or body or is, or is not, approved by bodies only indirectly concerned. The great majority of chemists already favour the scheme, the details are as yet known only to a few and when the details are disclosed and approved by a council or a committee which has the confidence of the great body of chemists the force behind the scheme—if any further force is needed—will steadily increase. No question of *amour propre* on the part of those who have propounded schemes which are accepted, rejected or postponed, need enter into consideration. All those who have been or are now busy with the scheme are devoting their time and energy unselfishly for the common good. The resolutions passed at the Club at last Monday's meeting show how great an advance has been made in the last few years.

* * *

How many perils do environ the man that meddles with cold iron! The engineering section of the British Empire Exhibition shows that chemists have meddled with cold iron to some purpose. We do not remember that we have ever seen any pure iron, but we assume that it is a disappointing material. The introduction of carbon into it is so long past that the memory of man runneth not to the contrary. The introduction of manganese, molybdenum, nickel, chromium, vanadium and titanium is due to the chemist as is the scientific investigation of the effect of the varying proportions of carbon, silicon, sulphur and phosphorus. Will the fulness of time give us a new metal? We have delved into the bowels of the earth to a distance of a few thousand feet and the geologist can assure us of the nature of the rocks for during a vertical distance of perhaps half a dozen or ten miles. We are apt to assume that what we know is a fair sample of the bulk, and we have often seen calculations of the relative proportions of the elements and how much is contributed by those of odd, and of even, atomic numbers. But we have every reason to think that the ·1 per cent. or whatever it is which we know is not a representative sample. The rocks at the surface have a density of about two and a half; the earth as a whole has a density of twice as much. We can no more judge of the nature of the earth from the thin skin we have observed than we can judge of the British Empire Exhibition from the first restaurant visited. Next week we shall give a long account of this great achievement in the Special British Empire Exhibition Number which we are now engaged in preparing.

* * *

The last days before the opening of the British Empire Exhibition are upon us. There is feverish activity in all the wide spaces of the Palace of Industry and the last exhibits are being delivered in lorries, carts, trains and any means of conveyance that can find a way down the crowded aisles. The dignified and continuous front of the exhibit of the chemical industries is adorned with the effective frieze depicting familiar operations in the chemical world, industrial and scientific, and tall, handsomely gilt columns with lotus capitals border the thoroughfares, bearing emblems appropriate to the particular industries before which they stand. The exhibit relating to pure science is—but that must await the official opening and our Special Number, there are so many good things.

THE FERMENTATION OF CACAO

By A. W. KNAPP

It is not possible by reference to published records to compile a complete scientific explanation of the fermentation of cacao. Many planters know how to carry out the process to the satisfaction of the buyers of cacao beans (as the seeds of the cacao tree are called), but those who superintend the work on the cacao estates have generally lacked the training and equipment to investigate the theory of the subject. On the other hand the scientists in Europe seldom have an intimate knowledge of the process, and are unable to obtain the fresh seeds on which to experiment. Even if they had the knowledge and the material, they would still find it difficult to lay down the best conditions to maintain, as the cocoa and chocolate manufacturers as a body have never stated exactly what they want. However, they do go so far as to indicate a preference for fermented cacao by paying more for it than for unfermented cacao from the same country.

Now that we have Agricultural Colleges in Trinidad and other tropical places we may expect to see great advances in this subject, as there is no doubt that a well-equipped bio-chemist on the spot could unravel many of the problems in a short time. It is proposed to give a critical review of the position as it stands to-day, together with an account of some experiments of the author.

The Cacao Seed or Bean

The fresh seed consists of two folded fleshy cotyledons and a white radicle (germ), enclosed in a leathery skin. As taken from the pod it is surrounded by a whitish mucilaginous pulp. There are two distinct kinds of seeds, those from the Criollo variety of tree and those from the Forastero variety. The principal difference is that the Criollo beans are white throughout, whilst the Forastero are purple. As over 90 per cent. of the world's cacao is Forastero, this paper deals mainly with this variety. Until we have more knowledge we may assume that the Forastero bean contains the same chemical substances as the Criollo, and in addition a purple tannin.

The beans have to be dried to make them a stable article of commerce, and as they dry more easily if they have been fermented, this was probably the original object of fermentation. It is an easy way of getting rid of the pulp. In Ceylon, where the pulp is removed by washing, it is first loosened by fermentation.

The amount of pulp on the seeds varies with the season. The pulp contains about 80 per cent. of water. Roughly speaking, 100 lb. of seeds fresh from the pod, if merely dried, lose about 61 lb. of water. During fermentation they lose about 11 lb. by evaporation, and 13 lb. of a liquid, known as "sweatings," runs away. On drying the fermented bean a further loss of 40 lb. by evaporation occurs, making a total of 64 lb. According to Hudson[5] from 100 lb. of fresh beans one obtains 39 lb. of unfermented cacao beans of commerce by merely drying, or 36 lb. of fermented beans of commerce by fermentation and drying.

The beans may be fermented by being put in heaps or in boxes, the latter being the more usual method. The bottoms of the boxes are usually perforated to allow the "sweatings" to run away, and the beans are generally covered with a layer of plantain leaves. The beans are usually turned from one box to another once a day, or every other day. The temperature of the mass rises, and the pulp breaks down and partly runs away. With Forastero cacao after six or seven days the pulp on the outside of the beans is a dirty brown, and the planter judges whether the cacao is fermented and ready for drying solely by observing this colour.

Fermentation of the Pulp

The following analyses of the "sweatings" (made in Messrs. Cadbury's Research Laboratory mainly by Mr. R. V. Wadsworth) give a good idea of the composition of the pulp. Analyses which the author and others have made of the liquid from the pulp show that it contains about 10 per cent. of reducing sugars (presumably dextrose and laevulose) and 2 per cent. of mucilage and pectin.

Cacao Sweatings

	From Trinidad			From Ceylon	
	0–18th hour	17th–18th hour	40th–42nd hour	From beans straight from pod	After 12 hours' fermentation
Specific gravity	1·066	1·050	1·039	1·0635	1·011
Acidity (as acetic acid)	1·4%	1·2%	2·0%	1·4%	1·08%
Solids	15·2%	10·9%	7·9%	15·1%	3·6%
Ash	0·60%	1·36%	0·83%	0·68%	0·63%
Rotation (in 100 mm. tube)	−1·0°	−0·9°	+0·1°	−1·4°	+1·4°
Theobromine	0·02%	0·03%	0·03%	nil	nil
Caffeine	nil	·005%	·005%	nil	0·002%
Odour	Sweet, alcohol and vinegar	Acid, vinegar	Sweet, alcohol and vinegar	Sweet, alcoholic, pleasant	Sharp, sweet and alcoholic
Colour	Light buff, cloudy	Deep yellow, cloudy	Buff, deeper than 1st, cloudy	Dirty yellow, cloudy	Dirty brownish yellow, cloudy
Pectin and mucilage	1·9%	2·1%	1·6%	—	—

The pulp and "sweatings" are obviously excellent media in which to grow yeast, and, later, acid-producing bacteria.

The cacao-pods are always broken, and the beans extracted, in the plantation, and the juicy beans are carried to the fermentation boxes, sometimes a considerable distance away. They are thus exposed

to any micro-organisms that may be in the air, as well as to those in the boxes. I examined cacao beans in Trinidad, as put in the box, and could find very few organisms. After 24 hours the pulp swarmed with yeast cells, but the numbers varied greatly in different parts of the box. It has been pointed out by Nicholls that a minute fruit fly (*Drosophila melanogaster*) assists materially in distributing yeasts and bacteria. After about 40 hours there were many budded yeasts, and after 60 hours the pulp contained great quantities of bacteria. Nicholls[5] states that there is no acetic acid, or other volatile acid, in the fresh fruits. The pulp of the bean as taken from the pod is acid, containing from 0·6—1·4 per cent. (estimated as acetic), and according to my observations the acidity of the pulp does not increase appreciably during the first 40 hours. In other words, acid-producing bacteria are not yet present in quantity. Observers have found a variety of yeasts and bacteria.

MICRO-ORGANISMS FOUND ON FERMENTING CACAO

Observer	Kind of cacao	Micro-organisms
Chittenden (1899)	Trinidad	(1) *Saccharomyces cerevisiæ* and probably *Penicillium glaucum*. (2) Lactic acid and possibly butyric acid bacteria.
Preyer (1901)	Ceylon	(1) *Saccharomyces theobromæ* (Preyer), resembles *S. ellipsoideus* (Hanson) and *S. membranæfaciens*. Length ·006 mm., diameter ·003 mm. (2) Bacilli and moulds (*Penicillium*).
Loew (1907)	Porto Rico	(1) *Saccharomyces ellipsoideus* with some *S. apiculatus*. (2) Acetic acid bacilli.
Nicholls (1912)	St. Lucia	*1st stage.*—Yeast, mainly "wild" yeasts (including *S. theobromæ*). *2nd stage.*—Acetic acid producing bacteria (bacilli and micrococci). *3rd stage.*—Putrefactive bacteria, and moulds.
Bainbridge and Davies (1912)	Jamaica	*1st stage.*—*S. apiculatus*, small quantities of *S. anomalus*. *2nd stage.*—Enormous development of true saccharomyces. *3rd stage.*—Acetic acid bacteria. *4th stage.*—Spore-bearing bacilli of *B. subtilis* type.
Lutz	..	*S. theobromæ*, *Sterigmatocystis niger*, *Pseudo-absida vulgaris*, and a new fungus, *Fusarium theobromæ* (Lutz).

It would appear from the above table that *S. cerevisæ*, *S. ellipsoideus*, and *S. theobromæ* have all given satisfactory cacao fermentations. Preyer and Nicholls have both emphasised the advantage of using a culture of the special yeast, *S. theobromæ*. In my experience the addition of yeast when the cacao is put in the box is an advantage—it saves waiting 24 hours whilst the yeast cells accidentally present multiply—but I have no evidence that there is any special merit in *S. theobromæ*. The addition of 1 pint of yeast obtained from a brewery started the fermentation earlier, and produced as good a cacao in one day less than the ordinary fermentation. A sample of tinned yeast, as sold to bakers, assisted the fermentation in the early stages, but did not produce quite so good an effect.

TEMPERATURES

It may be interesting to compare the temperatures which I obtained under a variety of conditions using the same cacao (mainly Trinidad Forastero).

TEMPERATURES OBSERVED IN VARIOUS SWEAT BOXES IN TRINIDAD

Quantity of beans 8-10 cwt. unless otherwise stated.

Beans turned after 16, 40, 64, 88 and 112 hours.

Curve 3 shows a normal fermentation of 10 cwt. of beans. The temperature in this case rises to 51° C. in 5 days, and then falls. Curve 5 shows a normal fermentation in a barrel (containing 3 cwt.) placed in a shed. This having relatively more area exposed rose more slowly, but being protected from the wind, gave good results. Curve 6 shows what happens if one attempts to ferment as little as ½ cwt. in a box, which is not protected from air-currents. The temperature rises only a few degrees, and the beans are only partially fermented. Curve 2 shows one of the experiments in which brewers' yeast was added. From the 24th-48th hour the temperature was at least 3° C. higher than usual, and at the end of the third day the beans were as advanced in appearance as the ordinary after four days. A similar advantage was obtained, as is indicated by Curve 1, by adding the "sweatings" (from beans which had been in the box 24 hours) to beans which had just been placed in the box. In order to obtain greater aeration perforated bamboo pipes were arranged horizontally through the mass of beans; the temperatures are shown in Curve 4.

I made a number of observations in Trinidad and Grenada of the temperature of fermenting cacao beans. The majority were in boxes which held about 8 cwt. of beans, but some held as much as 30 cwt. The beans were usually about 3 ft. deep. The averages are recorded below, together with certain related temperatures:—

TEMPERATURES OF CACAO FERMENTATION

Temperatures of a good cacao fermentation		Related temperatures
After 0 days	25° C.	
,, 1 day	30° C.	33° C. Cacao butter melts.
,, 2 days	37° C.	40° C. Action of yeast impaired. 42° C. Action of acetic acid bacteria (*B. Pasteurianus*, *B. Aceti* and *Mycoderma Vini*) and *B. Lactis Acidi* impaired. 44° C.–47° C. Cacao seed killed.
,, 3 days	47° C.	
,, 4 days	48° C.	
,, 5 days	49° C.	
,, 6 days	49° C.	50° C. Action of zymase ceases? 70–75° C. Cacao oxidase destroyed. Diastase destroyed.

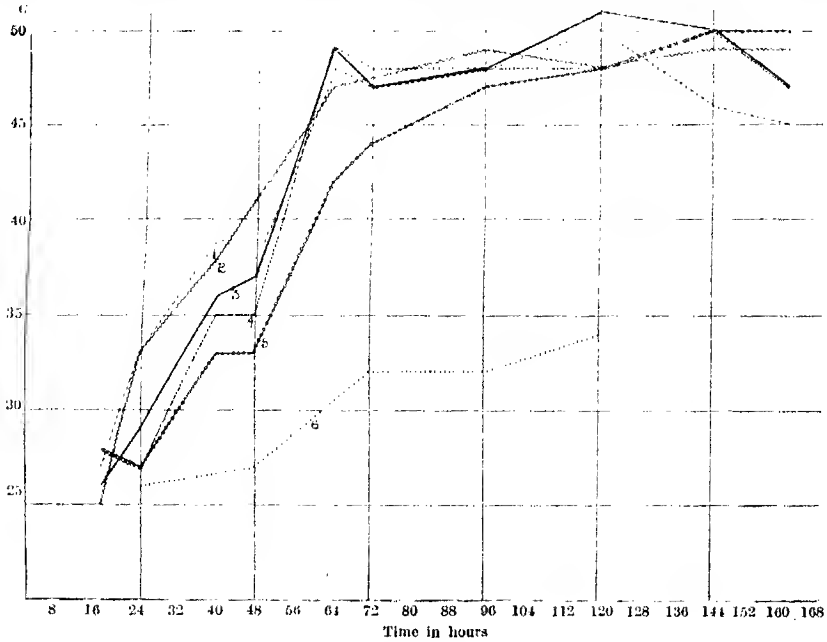
No one seems to have called attention to the very high temperatures which are maintained in cacao fermentation. It is well known that in the production of wine the action of the grape yeasts is impaired

above 40° C., and the temperatures favourable to cacao fermentation are those at which wine develops diseases. I certainly found some yeasts on the pulp, but after the fourth day the micro-organisms present were mainly non-motile rod-like bacteria, some isolated, others in pairs and chains.

Changes in the Pulp

The alcoholic and acetic fermentations break down the cells of the pulp, and the liquid they contain flows away. What one actually sees is that the pulp gradually loses its glutinous nature and finally becomes a thin coat of paste. It also changes colour. The first day it is white to pink; second day, pale pinkish-brown; third day, pinkish-brown; fourth day, light brown; fifth day, brown. This brown colour is due to oxidation of a tannin in presence of an oxidase, but whether the tannin was originally present in the pulp, or was acquired from the bean, I do not know. After the fifth day I examined the pulp under the microscope, and found that it contained a number of brownish-yellow spherical bodies, which I assumed to be yeasts stained by this brown colour.

The beans when put in have a delicate melon-like odour. After three days this has changed to a heavy, sharp, fragrant odour, such as might be given by a mixture of ethyl and amyl esters with a little acetic acid. Later, the odour suggests sour barm. Bainbridge and Davies[6] found amyl propionate, amyl acetate, and amyl butyrate in the essential oil of cacao. In relation to the presence of amyl butyrate, it may be mentioned that the production of butyric acid, because of its objectionable odour and taste, should be avoided. It is liable to be produced where the period of fermentation is long, and the aeration insufficient.



The "Sweatings"

The liquid portion of the pulp which flows away is slightly turbid, and of a pale brownish-yellow colour; the taste is faintly acid and sweet, the odour yeasty and apple-like. The addition of strong alkali causes it to gelatinise. The first "sweatings" are richest in sugars, the last richest in alcohol and acetic acid. This liquid is at present a nuisance to the planters, and at least ten million gallons must run to waste every year. Planters might with advantage use the first day's "sweatings" to pour over fresh cacao put in the box. It is evident that it could also be used to produce a drink resembling cider, which would contain, besides alcohol, small quantities of the stimulants, caffeine and theobromine. Hudson[5] has shown that it gives a mild, but strong, rose-coloured vinegar. To exploit these possibilities on a commercial scale the "sweatings" would have to be collected and treated at a central factory under scientific control.

(To be continued)

SAFEGUARDING OF INDUSTRIES ACT

Mr. Webb stated in the House of Commons that the Government had decided not to introduce legislation to extend the duration of the provisions of Part II of the Act, dealing with the making of Orders on the ground of depreciation of foreign currency. These provisions, and the duties imposed in accordance with them, will lapse on August 19.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool, on Wednesday, July 9, 1924, at 11 a.m.

A preliminary programme appears on this page.

In accordance with the provisions of by-law 23 intimation is hereby given that the following members of Council retire from their respective offices at the forthcoming Annual General Meeting: Dr. E. F. Armstrong, F.R.S., *President*; Mr. Julian L. Baker, Mr. C. S. Garland, Sir Max Muspratt, Bart., and Sir Wm. J. Pope, K.B.E., *Vice-Presidents*; Mr. John Allan, Prof. J. W. Hinchley, Dr. J. H. Paterson, and Mr. W. J. U. Woolcock, C.B.E., *Ordinary Members.*

Mr. W. J. U. Woolcock, C.B.E., has been nominated for election to the office of President under by-law 19; Dr. E. F. Armstrong, F.R.S., Prof. J. W. Hinchley, Prof. J. C. Philip, F.R.S., and Sir Richard Threlfall, K.B.E., F.R.S., have been nominated Vice-Presidents under by-law 20.

Mr. E. V. Evans has been re-elected Hon. Treasurer, and Sir Wm. J. Pope, K.B.E., has been re-elected Hon. Foreign Secretary.

Members are requested to nominate, on or before May 9 next, fit and proper persons to fill the four vacancies among the Ordinary Members of Council. Forms for this purpose can be obtained from the General Secretary of the Society.

By-law 22.—An Ordinary Member of Council shall be nominated by five or more members upon Form B in the Schedule, a copy of which form shall be furnished by the General Secretary upon the written or verbal request of any member, but a member shall not be eligible to sign more than one such nomination form, and the member nominated shall sign the declaration set forth on the form.

A nomination shall be declared invalid by the Council if:—

(*a*) The member thereon nominated is disqualified for election, or ineligible to be elected, as provided by the by-laws.

(*b*) The nomination is not made on the authorised printed form, or substantially not in the manner directed thereon.

(*c*) The nomination form is signed by less than five members not disqualified or not ineligible to nominate as provided by the by-laws.

(*d*) The nomination form is not received before or upon the day appointed therefor.

(*e*) The member nominated has not signed the declaration printed upon the form.

A member whose nomination aforesaid is declared to be invalid shall receive notice thereof from the General Secretary, and shall not be submitted for election.

J. P. Longstaff,
General Secretary

The following is a Preliminary Programme of the meetings to be held in Liverpool on July 9-12 inclusive.

Wednesday, July 9.—*Morning*: Council Meeting. Annual General Meeting in the Arts Theatre, the University. Presidential Address by E. Frankland Armstrong, D.Sc., F.R.S.; *Afternoon*: Business Session in the University. Visit to White Star Liner "Cedric," and tea on board by invitation of the White Star Line. *Evening*: Reception and Dance at the Town Hall by invitation of the Right Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.).

Thursday, July 10.—*Morning*: Messel Memorial Lecture by the Right Hon. Viscount Leverhulme, in the Arts Theatre, the University, and presentation to the Lecturer of the Society's Messel Medal for 1924. Visit to the works of Messrs. Joseph Crosfield & Sons, Ltd., Warrington. Luncheon by invitation of the Directors. *Afternoon*: Inspection of the Works. *Evening*: Annual Dinner of the Society at the Midland Adelphi Hotel.

Friday, July 11. *Morning*: Business Session in the University. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of the United Alkali Co., Ltd. Visit to a Works of the United Alkali Co., Ltd. *Evening*: Dinner at Lady Lever Art Gallery by invitation of the Chairman and Directors of Messrs. Lever Brothers, Ltd.

Saturday, July 12.—Visit to Lake Vyrnwy. Inspection of Liverpool Corporation Water Works.

A detailed programme will be sent later to every member of the Society.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

MEETING OF COUNCIL

The monthly meeting of Council was held on April 11, 1924, the President, Dr. E. F. Armstrong, F.R.S., in the Chair.

The President reported that the Société de Chimie Industrielle had invited delegates from the Society to attend the fourth Congress of Industrial Chemistry to be held at Bordeaux on June 15. It was agreed to ask any members who might be in Bordeaux at that time to attend as representatives of the Society.

The President gave further particulars regarding the scheme for "Chemistry House" which he had previously outlined, and after full discussion he was unanimously authorised to consult with the President of the Chemical Society and with any other interested Societies, including the Federal Council, with a view to at once carrying the Scheme into effect if it be found practicable.

Reports of various Committees were submitted, and 16 new members were elected:—Home 10; Overseas 6.

Mr. W. J. U. Woolcock, C.B.E., was nominated as President of the Society for the year 1924-25, and Dr. E. F. Armstrong, F.R.S., Prof. J. W. Hinchley, Prof. J. C. Philip, F.R.S., and Sir Richard Threlfall, K.B.E., F.R.S., were nominated as Vice-Presidents. Mr. Julian L. Baker was specially thanked for the valuable services he had rendered to the Society during the years he had been on the Council. Mr. E. V. Evans was re-elected Hon. Treasurer, and Sir Wm. J. Pope, K.B.E., F.R.S., Hon. Foreign Secretary for 1924-25.

It was reported that Dr. Bjarne Johnsen will attend the annual meeting of the Society in Liverpool as an official delegate of the American Section.

Dr. E. F. Armstrong, F.R.S., was nominated a representative of the Society to attend the Centenary Celebrations of the Franklin Institute to be held in Philadelphia, Pa., on September 17, 1924. It was also agreed to ask the Chairman of the American Section to act as another representative of the Society.

It was agreed on the application of Sir I. Gollancz, on behalf of the British Academy Committee, to make good as far as possible any loss that the Tokyo Imperial University Library sustained in the recent earthquake in respect of the Society's publications.

The next meeting will be held on Friday, May 9, 1924, at 2.30 p.m.

MANCHESTER SECTION

The annual meeting was held on April 4, Dr. H. Levinstein presiding. The whole of the committee and officers of the Section were re-elected, there being no occasion for a ballot.

The honorary secretary (Mr. L. Guy Radcliffe) read his report of the transactions of the Section for 1923-1924. He said that the numerical strength of the Section was 506, as against 510 at this time last year. The number of papers arranged for, or read at the eight meetings of the session, was twelve and a joint meeting had been held with the Institute of Chemistry, the Society of Dyers and Colourists, and the Manchester Literary and Philosophical Society. On December 7 there was an innovation in the shape of a joint meeting between the Manchester Section and the Institution of the Rubber Industry, whilst on February 22 there was a joint meeting with the Liverpool Section. On March 7 the Section was fortunate in receiving the promised visit of Prof. F. Gowland Hopkins, who delivered a most delightful and philosophic address to a large and appreciative audience. At the time of presenting this report two meetings remained to be held, and for the annual meeting there was the paper from Prof. F. L. Pyman, whilst, at the last meeting in May, Dr. Arnold Renshaw had promised to read a paper on "Insulin," and there will probably be two short communications from Mr. J. Miller on "A Recent Bleaching Agent for Flour" and "The Detection of Persulphate in Flour." In concluding the report, reference was made to the death of Mr. William Thompson, a former chairman of the Section, and one whose interest in the Society commenced with the birth of the Society and ceased only with his death. His loss was much felt.

Prof. Pyman proposed and Mr. John Allan seconded, the adoption of the report, and the motion was carried unanimously. A very hearty vote of thanks was also accorded the hon. sec. for his services to the Section during the past year. The usual monthly meeting was then held.

Prof. F. L. Pyman, D.Sc., F.R.S., in reading his paper on "The Tautomerism of Amidines," stated that von Pechman found that only one amidine of the general formula

$$R.C.\begin{cases}NX\\NHY\end{cases} \quad \text{or} \quad R.C.\begin{cases}NHX\\NY\end{cases}$$

could be prepared, and that the behaviour of such compounds on alkylation with alkyl salts depended upon the relative characters of X and Y. Where these were similar, *e.g.*, phenyl and tolyl, he obtained on alkylation a mixture of the isomeric alkyl derivatives, but where they differed considerably in character (*e.g.*, phenyl and methyl) he was only able to isolate a single alkyl derivative. In the course of the present series of investigations, it had been shown that there was no qualitative difference between the two cases where X and Y were similar and where they differed in character. In both cases a mixture of the two possible isomeric alkyl derivatives resulted, the relative yields of the two being largely influenced by the relative characters of X and Y. In the earlier papers (*Trans. Chem. Soc.*, 1923, vol. 123, pp. 367, 3359) the behaviour of open-chain amidines was examined, and the present communication (with C. E. Hazeldine and the late John Winchester), recorded the results of treating 4 (or 5) nitroglyoxaline and 4 (or 5) phenylglyoxaline with dimethyl sulphate. It was found that the alkylation of 4 (or 5) nitroglyoxaline in this way gave 5-nitro-1-methylglyoxaline as the main product of the reaction, with mere traces of the isomeric 4-nitro-1-methylglyoxaline, and that all of a number of compounds containing the nitro group in the 4 (or 5) positions, with various other groups in the 5 (or 4) positions, behaved similarly, the main product being always the isomerdine with NO_2 : Me- 5:1. According to unpublished experiments (with I. E. Balaban) the bromine atom had an influence similar to but not so powerful as that of the nitro-group, whilst the known results of alkylating xanthines showed that the carbonyl group was similarly 5 : 1-derivative. The influence of the phenyl group, however, was different, for the alkylation of 4 (or 5)-phenylglyoxaline under similar conditions gave, as the main product of the reaction, 4-phenyl-1-methylglyoxaline together with a small quantity of 5-phenyl-1-methylglyoxaline. The methods of determining the orientation of the methylated nitro- and phenylglyoxalines were described.

SOCIETY OF PUBLIC ANALYSTS

A meeting was held on April 2, Mr. G. Rudd Thompson in the chair and four papers were read.

A Report on the World's Dairy Congress held at Washington, U.S.A., was given by J. Golding, D.S.O., who also described visits to laboratories, Universities, etc., in New York, Washington, Ithaca, Guelph, etc.

Messrs. L. H. Lampitt, D.Sc., E. B. Hughes, B.Sc., and M. Bogod, B.Sc., read a paper on "The Routine Examination of Dairy Products with Special Reference to the Mojonnier Tester" for the determination of total solids of milk. The tester consists of a hot plate on which the milk is evaporated in an aluminium dish, and an electrically heated and thermostatically controlled vacuum oven in which drying is completed, the dish being cooled off in a water-cooled desiccator. The time for a complete determination of total solids in milk is 21 minutes. The Mojonnier method for the determination of fat is a modified Röse-Gottlieb method. The extraction is carried out in a specially shaped flask, which can be shaken after adding each reagent, and then centrifuged.

The ethereal layer is decanted into an aluminium dish, evaporated on a hot plate, dried in a vacuum oven, and cooled in the desiccator. The time for a complete determination of fat is 30 minutes, or for total solids and fat together 38 minutes. Typical results were shown for these determinations on various milk products. An application of the Gerber method to the determination of fat in milk powders was advocated.

"Experiments on the Absorption of Copper following the Consumption of Vegetables containing Copper Sulphate," were described in a paper by Prof. J. C. Drummond, D.Sc., Miss M. G. Palmer, B.Sc., Miss D. E. Wright, B.Sc. Metabolism experiments have been made on rats maintained on diets containing a high proportion of peas containing added copper. As recorded by previous observers, most of this copper is not absorbed but is excreted by the alimentary tract. Definite evidence was obtained that some small proportion of the copper may be absorbed into the blood. This absorbed copper may be in part retained for a time by the liver, and is excreted by the kidneys. Rats maintained for two to three months on diets containing a high proportion of copper-peas showed normal growth and health. Close examination of the tissues at the end of the experiment showed no abnormality which could be attributed to the copper absorbed from the food.

A paper on "An Attempt to extend Mitchell's Colorimetric Method to the Catechol Tannins," was presented by Phyllis H. Price, B.Sc. (work done under the Analytical Research Scheme). Mitchell's ferrous tartrate reagent can be used for the colorimetric comparison of (1) catechol with catechol; (2) protocatechuic acid with protocatechuic acid; and (3) catechin with catechin, but the method does not give satisfactory results for the comparison of these substances with one another. The ration between the colorimetric results is not a molecular one, as observed by Mitchell for pyrogallol and gallic acid, where the carboxyl group acts as a diluent. Catechol tannins, unlike pyrogallol tannins, are precipitated by the combined action of the reagent and quinine hydrochloride or cinchonine sulphate, and this behaviour prohibits the application of the method to catechol tannins. A series of experiments has shown that in order to give the violet coloration with the reagent a substance must contain two hydroxyl groups in the ortho position.

CORRESPONDENCE

INTERNATIONAL SCIENTIFIC RELATIONS

Sir,—I have read the letter of Dr. Fritsche and your comments with very great interest. You may be surprised to know that I do not consider the letter an insuperable obstacle to internationa scientific relations. Dr. Fritsche gives a frank honest statement of the German point of view about questions on which Germans and the Allies cannot be expected to reach common ground for a generation at least—if we continue the present non-intercourse, it may be much longer than that. For a long time Frenchmen and Belgians will continue to believe that German "frightfulness" in the occupied regions was excessive—they saw it with their own eyes while most Germans knew of it only through censored reports. Germans will continue to believe that the conduct of their soldiers was justified by occasional acts of guerilla warfare by the Belgians and as a precautionary measure. The Allies will continue to believe that the war was one of aggression on the part of Germany—Germans will continue to believe that the determination of England to maintain her commercial and naval supremacy and the desire of France for "Revanche" and for the recovery of Alsace and Lorraine were the chief causes of the war —also that the agreements between England, France and Belgium for the defence of the last were a violation of neutrality and a partial justification for the German invasion.

When a war is once started it is easy to rally any people to the patriotic support of their country, and the rank and file of any people will believe that their country is right and the other wrong and *they will continue to believe this after the close of the war.* We cannot hope to change this fundamental fact.

In spite of the above conditions, which we must clearly recognise, I believe that the better class of *both Frenchmen and Germans* desire a permanent peace and that a "rapprochement" is possible. It is not very safe to prophesy, but I believe that the report of the "Experts" will be accepted by France and Germany. On the side of France it will give her the support of the Allies once more and will give her a larger sum in "Reparations" than she can hope to get in any other way. Without its acceptance it would probably be impossible to prevent the franc from going the way of the mark. It was dangerously near to doing that less than a month ago. In Germany, the refusal to accept will prevent any international loans and must soon lead to a financial chaos more disastrous than that through which she has passed.

The acceptance of the report must soon bring a *permanent* settlement of the "Reparations" question. Poincaré cannot continue to hold an indefinite sum hanging over Germany. Personally, I believe that the sum necessary to restore the "losses to the civilian populations," not including pensions or the costs of the armies of occupation, is about the limit of what the Allies can hope to get. Practically, if the amount could be put squarely on that basis, Germany would be compelled to acknowledge that that is in strict, or even in generous accord with the

terms to which she agreed after they were announced to her by President Wilson on November 5, 1918, and it should be possible to carry on a campaign on that basis *both in Germany and France.*

If this practical "rapprochement" is realised, as I hope it may be, I think that the intellectual leaders of England, France and Germany should lead in the movement for peace and should meet again on the basis of common intellectual and scientific interests, agreeing to avoid the discussion of political questions about which there is a difference of opinion. If we wait for a radical change of opinion *on either side,* we shall hinder rather than hasten that softening of differences which we desire. Scientific men can never be coerced to a change of heart in that way.—I am, Sir, etc.,

W. A. NOYES

Paris
April 8, 1924

QUALIFIED OR UNQUALIFIED?

Sir,—I have been both interested in and amused at the various expressions of opinion regarding the chemist and the Institute of Chemistry.

Some opinions have been sane and thoughtful, others, particularly that of Mr. Claremont, have been ridiculous. How else can one describe such a statement that only members of the Institute are qualified chemists?

Suppose such an attitude be followed to its logical conclusion, what may happen? Obviously if chemists who are not members of the Institute unite to form an opposing society, it would be quite in order for them to say only members of their own society were qualified chemists. Similarly people may form themselves into a society and say black is white!

I quite agree with Mr. Claremont that chemists should be properly qualified, but I do not agree with him or the Institute that the only way of qualifying is to attend a college recognised by the Institute.

Presumably the Institute would not consider me a qualified chemist, and consequently would like to oust me from my post, although I attended a technical school for several years and passed a considerable number of examinations in chemistry and allied subjects.

Unfortunately at the time I did not know that hydrogen, for example, was not hydrogen if prepared at an unrecognised college!

If the Institute would open its doors to the qualified chemist without asking how he became qualified, it would go much further towards attaining its objects in a year or two than it has previously during the whole of its existence.

But, no! a man may arrive at Minerva's Temple, but if the Institute is the commissionaire at the time, he will not be admitted to her presence unless he arrives in a Rolls-Royce, and yet it is a universal practice to honour a man who succeeds in the face of difficulties.

The fact is, the Institute is a very exclusive trade union, but differs from other trade unions in that it prefers to spurn a man rather than extend a hand of comradeship.

Between the Institute, on the one hand, and the employers, who to keep wages down fill their laboratories with about 90% of apprentices (if I may call them such), on the other, the position of the chemist —qualified or unqualified—is not an enviable one. —I am, Sir, etc.,

"IRON"

A DESIGNATION FOR MEMBERS OF THE CHEMICAL PROFESSION

Sir,—Mr. C. L. Claremont's letter on the Profession of Chemistry in the issue of March 7, revives a discussion which flourished in your columns last year and terminated to my regret without any reference to a proposal made (though as yet not adopted) in Canada, which would avoid the issue with the pharmaceutical profession. Is it not futile to demand that the members of that profession abandon a title, which as Mr. Claremont points out, is popularly associated with their calling and to which they have historical and legal claims? To students of chemistry the coining of words is a familiar practice. Why not coin one to designate the man qualified to practise the profession of chemistry whether as an investigator, teacher, analyst, consultant or manufacturer? The term suggested in Canada (by Mr. J. A. Macdonald Dawson of Vancouver, B.C.) is "Chemor." What objection can be taken to it?—I am, Sir, etc.,

J. F. SNELL
Professor of Chemistry

Macdonald College, Que.
March 28, 1924

THE EPILATION OF SKINS

Sir,—I have been taken to task for not answering Mr. Wood's hint about the possibility of the inhibition action of the salt in my guinea-pig experiment. Salt cannot inhibit an enzyme that is no longer there, besides, normal saline solution contains the same strength of salt as normal blood which certainly does not inhibit its own enzymes.—I am, Sir, etc.,

H. C. ROSS

113, Mount Pleasant
Liverpool

AN EXHIBITION OF CHEMICAL PRODUCTS

Sir,—It has doubtless been suggested before, though I do not remember having seen it, that one way of popularising chemistry and bringing to the notice of the public some concrete knowledge thereof, would be to have a permanent exhibition of chemical products, more or less on the lines of the Mineralogical Gallery in the British Museum of Natural History. There are very many substances, both organic and inorganic, which would form most attractive and interesting exhibits—finely crystallised masses of various salts, dyestuffs, specimens of trinitrotoluene and other explosives (in suitable quantities!) of the various metals, etc., etc. I remember such exhibits on a comparatively small scale at some of the Exhibitions in past years, and the Chemical Exhibits at Wembley this year (or some of them) might well form a nucleus for such a gallery.

Accommodation would doubtless be the chief difficulty; logically such exhibits should presumably find a home at the Victoria and Albert Museum, though there is, I fear, little chance of space being available there. Perhaps, however, room could be provided, at any rate quasi-permanently, at Wembley after the present Exhibition is over?

Later the more strictly scientific side of the proposal could be extended with the ultimate aim of having a complete collection of all the innumerable substances known to chemistry, so that in time it should become customary for the accounts of the preparation of new bodies presented to the Chemical or other Society to be accompanied by samples thereof for the National Collection, in the same way as a copy of every book published is deposited in the British Museum Library.—I am, Sir, etc.,

C. A. Silberrad

A CORRECTION

We regret that an error was made in publishing the letter from Prof. W. Bone, F.R.S., in our last week's issue. The letter was intended solely for the Editor's private information and not for publication. In the chance that a misunderstanding might arise, we are glad to publish this note.

PERSONAL AND OTHER NOTES

Chemistry House

At a meeting of certain Members of the Federal Council, and of the Chemical Industry Club Committee, held at the Club, on Friday, March 14, 1924, the following Resolution was unanimously agreed to:—

We are of opinion that the best interests of academic, technical and manufacturing chemical science will be ultimately best served by the immediate establishment of a Chemistry House, on a scale involving an outlay of, say, £30,000. We are of opinion that the scheme just outlined should be regarded merely as a basis of a larger scheme for providing adequate accommodation for all the organisations representing the corporate interests of academic, technical and manufacturing chemistry.

At the meeting of the Chemical Industry Club, held on April 14, it was resolved unanimously:—

1. That this meeting of the Members of the Chemical Industry Club, having heard the action taken by the Executive Committee on the subject of the establishment of Chemistry House to date, approves such action.

2. The Chemical Industry Club will support any sound scheme for the establishment of Chemistry House, whether this necessitates the merging of the Club in the scheme or not, but is strongly of opinion that such scheme should be approved by the Members of the constituent and associate bodies forming the Federal Council.

FORTHCOMING EVENTS

Apr. 22 to 24. International Cement Congress, Olympia, London, under the ægis of the Institution of Structural Engineers.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech.	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¾d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide	Expected to advance in sympathy with the crude metal.
Golden	5¼d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide	4s. per lb.
Carbon Bisulphide	£24—£26 10s. per ton according to quantity.

Carbon Black ..	.. Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.
Carbon Tetrachloride	.. £56 per ton, drums free.
Chromium Oxide	.. 1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.
Lamp Black ..	.. 40s. per cwt., barrels free.
Lead Hyposulphite	.. 7½d. per lb.
Lithopone ..	.. £22 10s. per ton.
Mineral Rubber "Rubpron"	.. £15 10s. per ton f.o.r. London.
Sulphur	.. £10—£12 per ton, according to quality.
Thiocarbanilide ..	.. 2s. 9d. per lb.
Vermilion, pale or deep	.. 3s. 4d.—3s. 6d. per lb.
Zinc Sulphide ..	.. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade, but these are the only products in this section which show any activity.

Acetate of Lime—	
Brown	.. £14 10s. per ton d/d. Demand active.
Grey	.. £21 per ton.
Liquor	.. 9d. per gall. 32° Tw.
Charcoal	.. £7 5s.—£9 10s. per ton, according to grade and locality. Market steady.
Iron Liquor ..	.. 1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor ..	.. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote ..	.. 2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible ..	.. 5s. per gall. 60% O.P. Dull market.
Solvent ..	.. 5s. per gall. 40% O.P. Dull market.
Wood Tar ..	.. £5—£6 per ton according to grade. Demand not very brisk. Ample supplies.
Brown Sugar of Lead	.. £47 per ton. Demand active.

TAR PRODUCTS

Acid Carbolic—	
Crystals ..	.. 7¾d. per lb. Only limited inquiry.
Crude 60's ..	.. 2s.—2s. 3d. per gall. Market not so good.
Acid Cresylic, 97/99	.. 1s. 11d.—2s. 1d. per gall. Demand still good. Market firm.
Pale 95% ..	.. 1s. 10d.—2s. per gall. Steady demand.
Dark	.. 1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	.. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained ..	.. 10d.—11d. per gall. Very quiet.
Unstrained ..	.. 8½d.—9d. per gall.
Benzole—	
Crude 65's ..	.. 10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	.. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure ..	.. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% ..	.. 1s. 4½d.—1s. 7d. per gall.
Pure ..	.. 1s. 8d.—1s. 11d. per gall.
Xylol coml. ..	.. 2s. 3d. per gall.
Pure ..	.. 3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	.. 10d. per gall. Few inquiries.
Middle Oil .. / Heavy .. .. / Standard Specification	7½d.—8d. per gall. according to grade and district. Market again weaker.
Naphtha—	
Crude	.. 8d.—9d. per gall. Better demand. Prices show upward tendency.
Solvent 90/160	.. 1s. 2d.—1s. 5d. Better demand. Prices show upward tendency.
Solvent 90/190	.. 1s. 2d.—1s. 3d. Better demand. Prices show upward tendency.
Naphthalene Crude—	
Drained Creosote Salts	£6—£7 10s. Demand not so good.
Whizzed or hot pressed	£9 10s.—£12 per ton. Not much inquiry.
Naphthalene—	
Crystals and Flaked	.. £17—£18 per ton.
Pitch, medium soft	.. 52s. 6d.—57s. 6d. per ton. Market steadier.
Pyridine—90/140	.. 22s. per gall. Demand well maintained. Price again advanced.
Heavy	.. 11s.—12s. Occasional inquiries: little business.

INTERMEDIATES AND DYES

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	.. 1s. 6d. per lb.
Acid H.	.. 4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic	.. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 9d. per lb. 100% basis d/d.
Acid Salicylic, tech.	.. 1s. 4d. per lb. Steady demand.
Acid Sulphanilic	.. 10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	.. 1s. per lb. d/d.
Aniline Oil ..	.. 7¾d.—8½d. per lb. naked at works.
Aniline Salts ..	.. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base ..	.. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	.. 1s. 3d. per lb.
p-Chlorphenol ..	.. 4s. 3d. per lb. d/d.
p-Chloraniline ..	.. 3s. per lb. 100% basis.
o-Cresol 19/31° C.	.. 4¾d.—5¼d. per lb. Demand moderate.
m-Cresol 98/100%	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	.. 2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline ..	.. 3s. per lb.
Dichloraniline S. Acid	.. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol ..	.. £75 per ton.
Diethylaniline ..	.. 5s. per lb. d/d., packages extra, returnable.
Dimethyaniline ..	.. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene ..	.. 9d. per lb. naked at works.
Dinitrochlorbenzol	.. £84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluence—48/50°C.	8d.—9d. per lb. naked at works.
66/68°C.	1s. 2d. per lb. naked at works.
Diphenylamine ..	.. 3s. 2d. per lb. d/d.
Monochlorbenzol ..	.. £63 per ton.
α Naphthol ..	.. 2s. 5d. per lb. d/d.
β Naphthol ..	.. 1s. 1d. per lb. d/d.
α-Naphthylamine	.. 1s. 4½d. per lb. d/d.
β-Naphthylamine	.. 4s. per lb. d/d.
m-Nitraniline ..	.. 5s. 3d. per lb. d/d.
p-Nitraniline ..	.. 2s. 4d. per lb. d/d.
Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. per lb. 100% basis d/d.
Nitronaphthalene	.. 11¾d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.

m-Phenylene Diamine	4s. 2d. per lb. d/d.
p-Phenylene Diamine	10s. 4d. per lb. 100% basis d/d.
R. Salt	2s. 9d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 6d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 10d.—4s. 3d. per lb. d/d.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The market is lifeless, values remaining at a low level.

Acid, Acetic 80% B.P.	£48 per ton. Market easier.
Acid, Acetyl Salicylic	3s. 5d.—3s. 9d. per lb. Easier.
Acid, Benzoic	Commercial acid 2s. 6d. per lb. B.P. quality is being sold in small lots at 4s. lb.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst.	6s. per lb., for 28 lb. lots.
Acid, Salicylic	Prices quoted from 2s. 3d. per lb. down to 1s. 9d. for ton lots. Market rather weak.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 6d. per lb. for quantity. Very weak.
Amidopyrin	13s. 6d. per lb.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. 6d. per lb. Weak market.
Benzonaphthol	6s. 3d. per lb. Firmer.
Bismuth Salts	A steady market. Prices according to quantity :
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Market very firm and advancing. Heavy increase in price of bromine.
Potassium	9½d.—10½d. per lb.
Sodium	9½d.—10½d. „
Ammonium	10½d.—1s. „
Calcium Lactate	Prices vary over a wide range. Good English make can be had from 1s. 7d. to 2s. 3d. per lb.
Chloral Hydrate	3s. 9d. per lb.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	6s. per lb. Little demand.
Guaiacol Carbonate	12s. per lb. for cwt. lots. A cheaper market.
Hexamine	3s. 6d.—3s. 9d. per lb. for foreign makes. Weaker. Without much inquiry. Large stocks.
Homatropine Hydrobromide	30s. per oz.
Hydroquinone	4s. 3d. per lb. Foreign make.
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	70s. Strong upward movement due to disappointing Japanese crop.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Very much firmer in view of the rise in the price of quicksilver. Prices have been advanced by 6d. per lb.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. „
White precip.	4s. 7d.—4s. 8d. „
Calomel	3s. 11d.—4s. „
Methyl Salicylate	2s. 3d.—2s. 9d. per lb. for carboys.
Methyl Sulphonal	24s. per lb. neglected.
Paraformaldehyde	3s. 6d. per lb., without much inquiry.
Paraldehyde	1s. 4d.—1s. 7d. per lb. in free bottles and cases.
Phenacetin	6s. 3d.—6s. 9d. per lb.
Phenazone	8s. per lb. for cwt. lots. Spot prices much lower than forward offers. Firmer tendency.
Phenolphthalein	7s.—7s. 6d. per lb. Firm.
Potass. Bitartrate—99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate—	
B.P. Crystal	8¾d.—9d. per lb. carriage paid. English make.
Commercial	8d.—8½d. per lb. carriage paid. English make.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 6d. per lb.
Salol	4s. per lb.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	3s. 3d. per lb. In more plentiful supply.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite—	
Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.
Sod. Salicylate	Market weak. Powder 2s. 4d.—2s. 9d. per lb. Crystal at 2s. 6d.—2s. 10d. per lb. Flake 2s. 10d.—3s. 4d. per lb.

Sod. Sulphide—	
Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	.. 18s. 6d. per lb.
Tartar Emetic ..	.. 1s. 4d. per lb.
Thymol	.. 13s. 6d.—15s. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.	
Aubepine	.. 13s. 6d. ,,	
Amyl Acetate ..	.. 2s. 9d. ,,	
Amyl Butyrate ..	.. 7s. 3d. ,,	
Amyl Salicylate ..	.. 3s. 3d. ,,	
Anethol (M.P. 21/22° C.)	4s. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. ,,	
Benzyl Alcohol free from Chlorine ..	.. 3s. 3d. ,,	
Benzaldehyde free from Chlorine ..	.. 3s. 6d. ,,	
Benzyl Benzoate	.. 3s. 6d. ,,	
Cinnamic Aldehyde Natural	.. 15s. 6d. ,,	
Coumarin ..	.. 20s. ,,	
Citronellol ..	.. 16s. ,,	
Citral	.. 10s. ,,	
Ethyl Cinnamate	.. 15s. ,,	
Ethyl Phthalate ..	.. 3s. 9d. ,,	
Eugenol	.. 11s. ,,	
Geraniol (Palmarosa)	.. 35s. ,,	
Geraniol	.. 11s.—18s. 6d. per lb.	
Heliotropine ..	.. 8s. 3d. per lb.	
Iso Eugenol ..	.. 15s. 9d. ,,	
Linalol ex Bois de Rose ..	32s. 6d. ,,	Very much dearer.
Linalyl Acetate ..	.. 32s. 6d. ,,	Very much dearer.
Methyl Anthranilate	.. 9s. 6d. ,,	
Methyl Benzoate	.. 6s. ,,	
Musk Ambrette ..	.. 52s. 6d. ,,	
Musk Xylol ..	.. 19s. ,,	
Nerolin	.. 4s. ,,	
Phenyl Ethyl Acetate ..	12s. 6d. ,,	
Phenyl Ethyl Alcohol ..	16s. ,,	
Rhodinol	.. 57s. 6d. ,,	
Safrol	.. 1s. 10d. ,,	
Terpineol	.. 2s. 9d. ,,	
Vanillin	.. 25s. 3d.—26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 15s. 6d. per lb.
Anise Oil	.. 3s. per lb. Firmer market forward.
Bergamot Oil ..	.. 18s. 6d. per lb.
Bourbon Geranium Oil	.. 35s. ,,
Camphor Oil ..	.. 75s. per cwt.
Cananga Oil, Java	.. 9s. 9d. per lb.
Cinnamon Oil, Leaf	.. 6½d. per oz.
Cassia Oil, 80/85%	.. 9s. 3d. per lb.
Citronella Oil—	
Java 85/90% ..	.. 5s. 3d. ,,
Ceylon	.. 3s. 9d. ,,
Clove Oil	.. 8s. 4½d. ,,
Eucalyptus Oil 70/75% ..	2s. 3d. per lb.
Lavender Oil—	
French 38/40% Esters	26s. per lb.
Lemon Oil	.. 3s 4d. ,,
Lemongrass Oil ..	.. 2¾d. per oz.
Orange Oil, Sweet	.. 13s. per lb.
Otto of Rose Oil—	
Bulgarian ..	.. 27s. 6d. per oz.
Anatolian ..	.. 23s. 0d. per oz.
Palma Rosa Oil ..	.. 19s. per lb. Very short supply.
Peppermint Oil—	
Wayne County	.. 21s. 9d. per lb. Again advanced.
Japanese ..	.. 20s. per lb. but very little being offered.
Petitgrain Oil ..	.. 10s. per lb.
Sandal Wood Oil—	
Mysore	.. 25s. per lb.
Australian ..	.. 21s. per lb.

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W.1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—*British India*: Aluminium ingots (The Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E.1). *Canada*: Cast iron pipes (13457/E.D./E.C./2).); Zinc dross and zinc ashes (Canadian Government Trade Commissioner's Office, 73, Basinghall Street, London, E.C. 2.); *Chile*: Copper, cast iron, insulators (9617/F.L./G.C./2.); *Cuba*: Hardware, glassware, silverware, (411); *Egypt*: Tin solder (Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, London, S.W. 1.); Ref. Muh. 1924/19/5.; *France*: Maritime materials (403); Copra, ground nuts, copper sulphate, sugar, (405); *Italy*: Leather (407); *Peru*: Glassware, surgical instruments, chemicals (412).

PUBLICATIONS RECEIVED

PUBLICATIONS OF THE IMPERIAL MINERAL RESOURCES BUREAU. *The Mineral Industry of the British Empire and Foreign Countries. Statistics* 1919—1921. *H.M. Stationery Office*, 1924. *Price* 1s. 6d.:—
BORATES. *Pp.* iv+22. *Price* 1s. 3d.
MANGANESE. *Pp.* iv+23.
NITRATES. *Pp.* iv+37. *Price* 2s.
SULPHUR. *Pp.* iv+21.
FELSPAR. *Pp.* iv+7. *Price* 6d.
PLATINUM AND ALLIED METALS. *Pp.* iv+20. *Price* 1s. 3d.

FIFTH ANNUAL REPORT OF THE GOVERNORS OF THE IMPERIAL MINERAL RESOURCES BUREAU. *Pp.* 24. 2, *Queen Anne's Gate Buildings*, 1924.

DIE TECHNISCHE CHLORALKALI-ELEKTROLYSE. *By* PROF. J. BILLITER. *Fortschritte der Chem. Technologie in Einzeldarstellungen, edited by* PROF. B. RASSOW. *Part II. Pp.* viii+79. *Dresden: Theodor Steinkopff*, 1924. *Price* $0·60.

DIE VERFEUERUNG DER MINERALKOHLEN UND DIE AUFBEREITUNG DER FEUERUNGSRÜCKSTÄNDE. *By* PROF. E. DONATH. *Pp.* 108. *Dresden: Theodor Steinkopff. Price* $0·85.

JOURNAL *of* THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

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EDITORIAL

THE letter from Prof. Noyes which we published in last week's issue carefully avoids discussion of one or two interesting ethical questions. His letter is on the whole a plea for chemists of all nations to forget the past and live in the future in amity with each other. If the Germans believe that this nation and three or four others combined in the summer of 1914 to crush an innocent Germany is it right that they should forget or pretend to forget this circumstance? Would it be right for the Belgians to wipe the slate in so far as the German invasion of Belgium is concerned? Could such an idea be anything except a piece of hypocrisy? What is the proper and high-minded attitude for Belgians, whether chemists or not, to adopt towards the Germans who claim that their treatment of Belgium was well deserved? Perhaps it is suggested that the ideal course is for the Belgians to say to the Germans "What we have heard about Dinant and Louvain and some other places is doubtless much exaggerated; your invasion of our country was more an error of judgment than a crime; send two or three of your distinguished chemists to lecture to us in Brussels as a token of our goodwill." We are not experts on ethics either national or international, and we are not clear whether if Belgium or France take up an attitude of refusal to be friendly with Germans who justify their conduct, we ought to blame them or applaud them. The point is not a mere academic one, it is of some consequence for the future. If some day, twenty or fifty years hence, the United States of America, or France, or Great Britain copies, with the improvements which that interval of time suggests, the conduct of Germany during the late war, is it better that the other nations of the world should on the conclusion of peace invite the belligerents to shake hands all round or should they show their disapprobation in any way?

* * *

On a pure point of morality if country A guarantees the integrity of country B and afterwards invades country B, what attitude should the inhabitants of country B take up when country A has been pushed out? The Germans, it seems, justify their actions in Belgium and would repeat them in similar circumstances. If the Belgians now offer to the Germans the right hand of good fellowship are we to conclude that they are men of noble dispositions or that they would be fit inmates of an asylum? We have met with people who consider the German treatment of Belgium to be a shocking crime unworthy of any civilised nation. We do not know whether Prof. Noyes thinks otherwise, but what advice does he offer to those who hold such an opinion? Are they to pretend they are mistaken? Are they to try and forget the evidence, which, when it was fresh in their minds, drove them to such an opinion? Are they to assume in spite of it that those who a few years ago behaved in that manner to Belgium are now milder in manners and gentler in their ways? The German men of science, according to Dr. Fritzsche, are satisfied that the Germans were then mild and gentle enough. We suppose our own opinions, those of us who were grown up in 1914 and capable of understanding what was done, are of no account. If we still feel any indignation it should be with Italy and the United States, we imagine, for obstructing the Germans in their mildness and gentleness. Before we lose our heads in sophistry and illusion let us look at this extreme case in cold blood and consider what is just and not what is expedient. Let us admit this is an extreme case; let us admit that the German accounts were, as Prof. Noyes puts it,

highly censored; the facts remain, *magna est veritas*; the Belgians know what happened, we in this country have a pretty shrewd idea. Is it wise or just or desirable that we who know less than they should say to the Belgians, "Forget the past"? Why should they forget it? You might as well ask a chemist to forget that picric acid is explosive or that sulphuric acid will dissolve zinc. We would like to ask Prof. Noyes whether he thinks he has enough evidence to justify him in having any definite opinion about Germany's treatment of Belgium. We will not ask him what his opinion is. If he has no definite opinion perhaps he might investigate such evidence as there is and find out as a scientific man what the essential truth is. If he has a definite opinion we feel sure that the opinion of the Belgians, whether it agrees with Prof. Noyes' or not, will be much more definite. We think that Prof. Noyes is doing a good work in trying to promote a better feeling between chemists of all nations; we wish him every success, and we think that any future good feeling will be founded on a knowledge of the truth and not on a pretended ignorance of essential facts. Let us build on realities whether we are building friendship or knowledge. Is the German treatment of Belgium merely a political question about which there is a difference of opinion? Is there no question of morality, of justice, of humanity? Or is the whole difference of opinion comparable with a divergence as to whether ammonium hydroxide does or does not exist in solution? Let us stick to realities; we know all the essential facts about the invasion and occupation of Belgium by the Germans—there is no real dispute about the essentials, the Governments of Belgium, Germany and some other countries knew the truth and published a great deal of it. The rulers of Germany know as well as we do that on the whole it was a shocking business. The German Chancellor himself and many others knew it was in 1914; so long as the German men of science approve of the invasion and occupation so long will it be ineffectual for any one to suggest to the Belgian chemists that they shall sit down peacefully to lunch with the German chemists. So far as the Belgians are concerned let us wait until they have rather more confidence than they now have in the friendly intentions of the Germans. When the Belgians are ready to forgive let us rejoice; let us not urge or advise them to reach this state of mind.

* * *

We publish in this issue a review by E. F. A., on Osborne's book on "The Vegetable Proteins." Knowledge of the compounds contained in plants and of the chemical processes which go on in plants has increased enormously during recent years. Many of us can recollect the time when the botanist regarded chlorophyll, starch and cellulose as compounds of a degree of complexity far beyond the reach of the human mind. At that time but little was known of the chemistry of plant life beyond the fact that plants absorbed carbon dioxide and evolved oxygen. Bit by bit facts have been accumulated, new compounds isolated and their structures determined. We have now an accurate knowledge of the many terpenes and camphors produced by plants, of many of their scents and colouring matters. The various kinds of chlorophyll have been separated and distinguished, the occurrence of hydrocarbons such as pentane and carotin has been studied with care. Starch, inulin, cellulose and ligno-celluloses are no longer mere names. The alkaloids have been synthetically prepared or so closely investigated that their constitution is no longer a matter of speculation. Enzymes have furnished a copious literature and those monographs on Biochemistry which deal with plant life contain a mass of information of considerable scientific value. The sugars and other carbohydrates have been studied so much that their chemistry may now be considered as almost worked out. How agreeable it would be to have an account of botanical chemistry written in such a way that a retired solicitor or a white-lead manufacturer, whose curiosity is not entirely extinguished, could sit down in his garden under his mulberry tree and read it, every now and then getting up to admire the *Primula farinosa* which this imaginary individual has reared with such care and comparing its waxy covering with the inadequate description of it given in print!

* * *

We are informed that the American Chemical Society has arranged with the National Research Council for the publication by the Williams and Wilkins Company of Baltimore, of a new venture to be called *Chemical Reviews*, consisting of a yearly volume of about five hundred pages to be issued in four numbers in January, April, July and October in each year. The Editor-in-chief is Professor W. A. Noyes, and arrangements have been made with the Chemical Society here to give Fellows the advantage of having the American Chemical Society journals and *Chemical Reviews* at the same price as the Members of the American Chemical Society. This very friendly arrangement will be much appreciated. The price of *Chemical Reviews* is four dollars a year to such favoured persons and the list of contributions to the first two numbers suggests that the new journal will be an attractive one. The first number will contain papers by T. W. Richards on "Atomic Weights and Isotopes," by J. C. Irvine on "The Constitution of Polysaccharides," by F. G. Donnan on "The Theory of Membrane Equilibria," by M. Gomberg on "Organic Radicals." The second number will contain papers by G. N. Lewis on "The Quantum Theory of Chemical Affinity," by A. F. Holleman on "Some Factors Influencing Substitution in the Benzene Ring," by T. Svedberg on "Some Recent Advances in the Field of Colloids," by G. Urbain on "Twenty-five Years of Research on the Yttrium Earths," and by A. A. Noyes on "The Systematic Detection of the Rarer Chemical Elements." *Chemical Reviews* will not be confined to articles on purely theoretical topics but will also accept articles of suitable nature on industrial topics. We hope to deal with this subject at a later date when we have fuller information.

British Empire Exhibition

Wembley, April—October, 1924

The British Empire Exhibition at Wembley is already very good and by the time these notes appear in print it will be even better. It has been so much advertised and so much discussed, in Parliament, in the Association of British Chemical Manufacturers, in the Society of Chemical Industry, in this *Journal* and in the daily newspapers that already many of us are a little prejudiced against it. But let us consider the matter in a really scientific spirit. The Exhibition is to illustrate the British Empire, perhaps no unworthy or inadequate topic; it will give us oracular demonstration, as Mr. Caleb Trotter called it, of India, Ceylon, Burma, Malaya, Hong-Kong and other places with architecture distinctive of each country and something to illustrate to us the natural and artificial products appertaining thereto. The buildings in the Exhibition representing the countries we have mentioned are alone well worth a journey from Manchester, Glasgow or Leeds to Wembley. To begin with these buildings are of unusual styles and are beautiful. The architects who have designed them had good taste; the craftsmen who assisted in their construction were skilled in their crafts, the artists who have adorned these buildings with friezes and frescoes have given the visitors real pleasure. There is a high standard about all these buildings, they do not look like Exhibition structures, they look like the real things and no doubt but for the expense they would have been. That ingenious philosopher, Dr. G. Blas, said "real virtue is a very expensive article; plated goods look just as well and are within the reach of all purchasers."

There is no doubt that the British Empire Exhibition has every right to be as imposing a landmark as was the 1851 Exhibition. Whether it will be is another question; the skirts of happy chance and the law of probabilities discussed gravely in a recent article in these pages affect this problem. But as the 1851 Exhibition will for ever, as "Q" put it, be associated with popular science, crochet antimacassars, corkscrew curls and prunella boots, so the Exhibition of 1924 will be typical of art, ideas, fashions and hopes which subsequent generations will scoff at. What will our grandchildren think of the Glasgow girls with their knee-breeches, bobbed hair and gaspers, who from coigns of vantage have left monuments of Georgian Art? What will they think of present day politics, present day literature and present day journalism? How few of us journalists have enough talents to keep our literary reputations alive so long as we ourselves live!

Wembley is obviously great enough and good enough to mark an epoch and this must be the excuse for trying to convey to the readers of this article the sort of impression made by a visit to the Exhibition. After seeing half-a-dozen typical buildings you realise that Wembley is far, far better than you had any right to expect and then you will wander, finding everywhere fresh objects of interest. Such sights again cannot be found, in any place on English ground, be it at wake or fair. Although the ground is English there is an obvious Scots accent attached to many of those who have been engaged in the construction of this Exhibition. It might be worth while some day to give Sir Robert M'Alpine a free hand to rebuild Airdrie and other towns in the purlieus of Glasgow! We cannot keep closely to our topic nor do we think any visitor who possesses a soul will steer a straight course when he sets foot in the Exhibition. Surely the walled city of the Gold Coast will drag him from his path or Australia or New Zealand or Canada or Newfoundland. The brooks and streams, the lakes, the gardens, the colonnades, the Stadium, the ever-moving railway, the water-chutes and other amusements will be as Sirens attracting all except a small remnant; duty will bind a certain number of qualified chemists with chains and unqualified with links of iron. There are upwards of fifty restaurants and cafés, bands giving music of all degrees from the austere tom-tom or the soulful ram's horn to the most exponential of Bach's fugues and the super dominant seventh characteristic of our very latest composers.

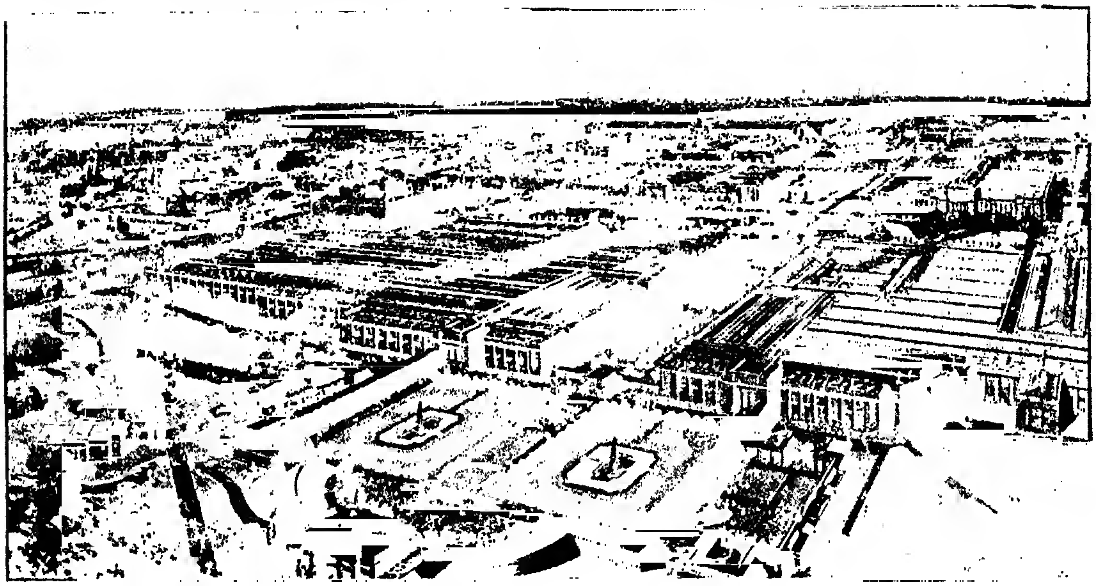
It may be assumed that everyone of sound mind has some interest in science, industry, art, music, sport, history and geography. Here is something for everyone and we think that the huge Engineering Palace and the huge Palace of Industry, in which latter are the chemical exhibits, will provide interesting matter for many of the visitors. Chemists should make a point of seeing this exhibition as

frequently as possible; they will be reminded of many half-forgotten facts of chemical history, they will be vividly impressed—if they are not already of a sufficiently guid conceit—by the way in which chemistry is being utilised in industries which formerly dispensed with it.

So vast an Exhibition demands a good deal of time; it is better to go for two or three hours than not to go at all, but probably those who go a dozen or a score of times will find they have still many new things to distract them. You are surprised by some building, half hidden, or unnoticed and you find it is a singularly interesting symbol of Aden or Fiji or East Africa or Jamaica or the Falkland Islands until finally you are profoundly impressed by the extent and the variety of your Empire. Mere maps, Whitaker's almanacks, statistical reports and the works of Flavius Josephus that learned Jew—will never drive this home. Of course we all know about the Malay Straits—or is it States?—and of false sizes and in false bearings, is more dangerous than utter darkness. The Wembley Exhibition gives us a reliable standard. If it includes Malta and Ireland these still form part of the Empire. We hunted all over for Minorca, Boothia Felix, and the Ionian Islands which we were doubtful about and found none of them. If the next time we are equally unsuccessful we shall conclude that Napoleon or Washington deprived us of these. A collection of postage stamps is not an infallible guide but the Empire Exhibition is. By the way, why was Boothia called Felix? Felix calls up some recollection, we know not what, some phrase we have recently come across.

The Palace of Industry: The Chemical Section

Keeping on walking and turning to the right we now enter the Palace of Industry which includes the Chemical Section organised by the Association of British Chemical Manufacturers. A large committee



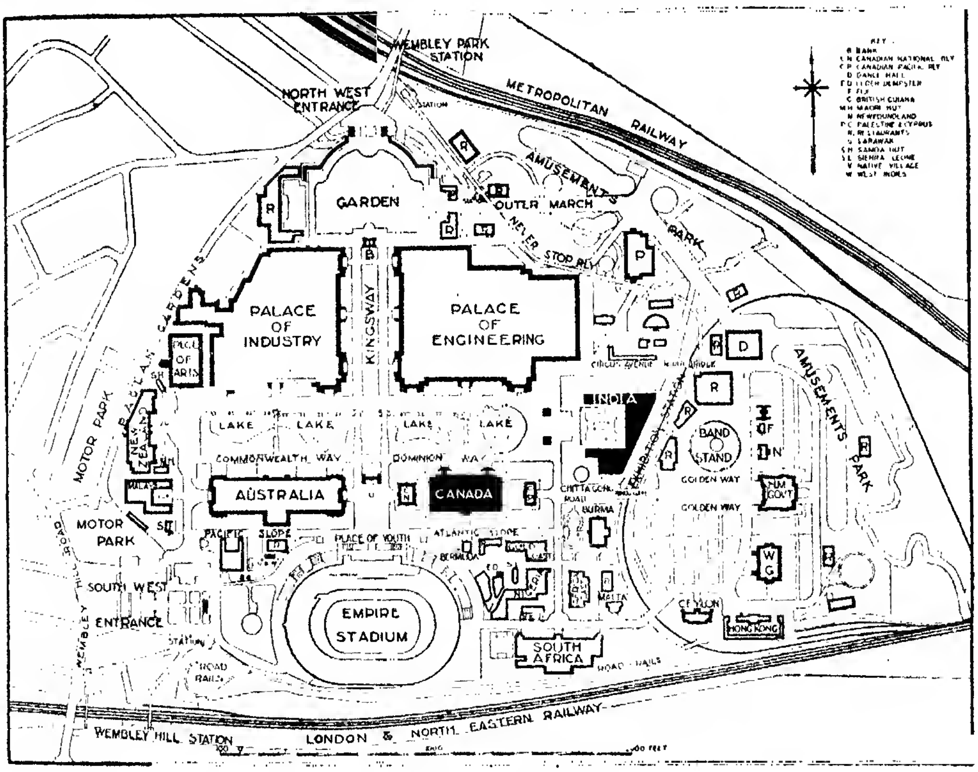
Stamford Raffles, but it is such a long way off, and a long time ago, and perhaps it isn't true. And then we find a building with a dome and minarets of truly Oriental flavour, filled with products from the spicy islands, and we seem to be in touch with something real at last. We would be prepared to testify about it in a court of law or even to wager a brother chemist the price of a dr***. It has always been a mystery to us how people can imagine they believe half the things they think they do believe. The legendary imperceptibly pass into the historical; Armstrong's views on ions and ikons are Findlay's views, but seen through a different medium. Armstrong no doubt thinks of the ionic medium, as Macaulay put it, just as that transparent haze, through which the sailor sees capes and mountains was concerned in the organisation of this Section. It consisted of Mr. W. J. U. Woolcock, the Chairman, Sir Max Muspratt, Bart., and Mr. R. G. Perry for the Association of British Chemical Manufacturers, Mr. Chester Fox for the United Kingdom Soap Makers' Association, Dr. E. F. Armstrong, Mr. E. V. Evans and Mr. J. L. Baker for the Society of Chemical Industry, Mr. R. Gosnell and Mr. H. Barrett for the Perfumery Committee, Mr. E. Hickson and Mr. J. B. Atkinson for the Society of Dyers and Colourists, Mr. C. A. Hill and Mr. Wippell Gadd for the Drug Club, Mr. E. O. Hughes and Mr. P. G. Somerville for the National Benzol Co., Ltd., Mr. F. Kingzett and Mr. Godber for the British Disinfectant Manufacturers' Association, Commander R. E. Stokes-Rees for the Institution of Petroleum Technologists,

Dr. J. T. Hewitt and Professor J. F. Thorpe for the Chemical Society, Mr. R. Pilcher for the Institute of Chemistry, Dr. S. Miall for the Federal Council, Mr. T. H. J. Carroll and Mr. F. C. O. Speyer for the British Sulphate of Ammonia Federation, Mr. L. M. G. Fraser for the British Chemical Plant Manufacturers' Association, Mr. N. Garrod Thomas for the National Sulphuric Acid Association, Mr. E. T. Nethercoat and Mr. T. Marns for the Pharmaceutical Society, Mr. S. Sadler for the Association of Tar Distillers, and Professor Hinchley for the Institution of Chemical Engineers.

This Committee held several meetings in 1922, 1923 and 1924 and the advice of its members was doubtless of great value to the Exhibition authorities,

The Scientific Exhibit

One of the most original features of the Chemical Section is the scientific exhibit intended to illustrate the work of the present generation of British chemists. This has been organised by a sub-committee of the large A.B.C.M. committee previously mentioned. The sub-committee which had as its chairman Dr. Herbert Levinstein, was assisted by many of the most noteworthy of our chemists and kept closely in touch with the committee of the Royal Society so as to avoid unnecessary overlapping. Dr. Levinstein devoted himself to this agreeable task and secured help from all those universities and other places where chemical research is carried on. He has taken immense interest in this exhibit and the



Plan of Exhibition

but the driving force was that of the chairman, Mr. Woolcock, and he did the lion's share of the work; and a very considerable and notable piece of work it was. Mr. Woolcock was suave, tactful or threatening as occasion required; he has a *curiosa felicitas* of his own, a disingenuous and courteous bluntness which is difficult to resist. By judicious cajolery, flattery, determination and attention to detail he got the business through and the chemical section was always as far ahead as any other. Everyone who visits the Chemical Section should feel a little grateful to him.

result fully justifies the time spent on it by him and his co-workers.

In the centre of the Scientific Exhibit is the Fiery Fountain, an attractive scientific toy which will probably interest the general public more than the other exhibits of more scientific importance displayed in this section.

Issuing from a rock is a stream of water flowing in a graceful curve on to a glass flower and thence overflowing into a mossy pool. As the stream of water touches the flower it appears to catch fire and the flower is brightly illuminated by fiery water.

As you look, the colour changes from fiery white to fiery red, from fiery red to the vivid green like that shown by a Verey light, but the water flows over the flower entirely colourless. As it falls on to the tank below it again shows a brilliant iridescence.

Many pretty experiments have been shown with phosphorescent and fluorescent substances. Most of these depend for their full effect on a darkened room. Here we have daylight and no doubt many besides the general public will be puzzled to know how this pretty and attractive effect is obtained.

The exhibit has been prepared by the Manchester College of Technology. Many experiments have been made to bring this device to perfection and Principal Mouat Jones and Mr. Hodgson are to be congratulated on providing a very successful and ingenious attraction.

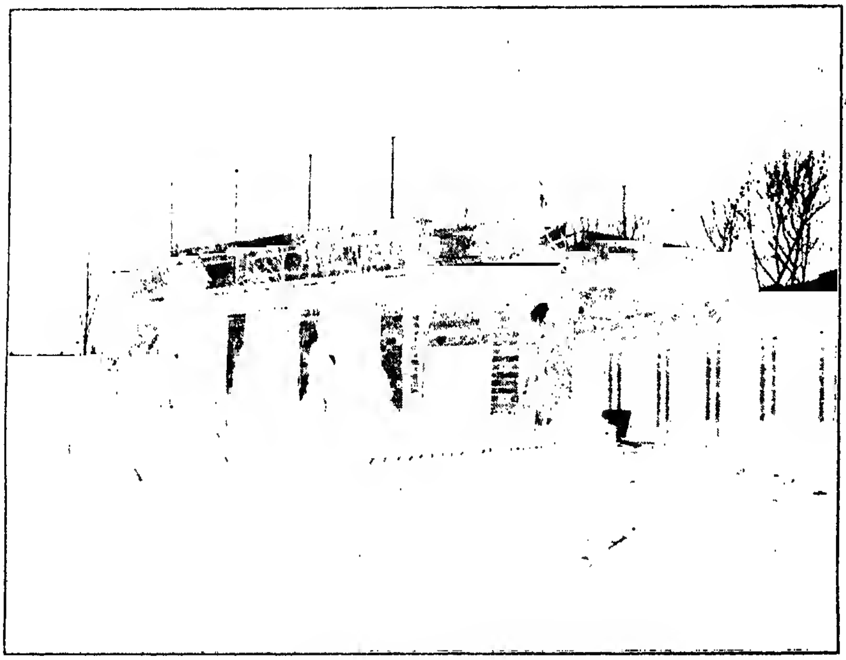
The Alkaloid Section, organised by Dr. T. A. Henry and Professor F. L. Pyman, consists of a large number of little bottles containing crystals and powders of all kinds and colours and interspersed among the bottles are cards with chemical hieroglyphics inscribed on them.

The diagrams with their mysterious hieroglyphics shown in these cases tell the story of how much has been achieved for each alkaloid dealt with. Thus, one of them shows how it is possible to start with a component of nutmeg oil and passing from it through a whole series of compounds to arrive at alkaloids such as cotarnine and hydrastinine, which have important medical applications as styptics and from these in turn even more complicated alkaloids have been produced.

Apart from these medical and chemical aspects of alkaloids, they are not without interest in other directions. Thus the exhibit includes a comprehensive series of the highly poisonous alkaloids obtained from the aconites of Japan, India and England. Aconite roots have been used as arrow poisons as well as in medicine, and they owe their use in these directions to the toxic alkaloids they contain.

Finally it may be of interest to add that the specimens shown represent work done wholly in Great Britain, that practically every type of alkaloid is included—a sure sign of the importance of the British contribution to knowledge on this subject—that every important British authority on alkaloids has contributed to the exhibit, and that no such collection has ever been got together before.

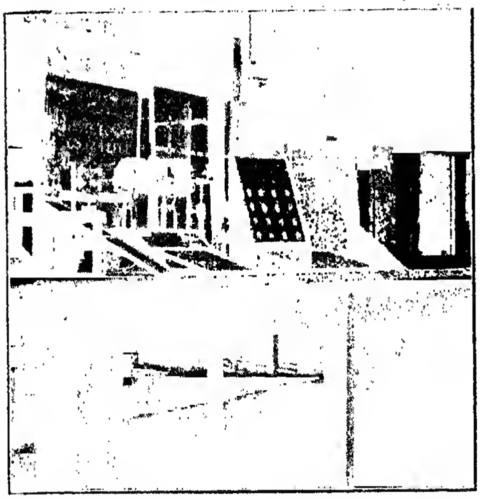
The exhibit of Inorganic and Physical Chemistry was arranged by Prof. F. G. Donnan and is very comprehensive. It includes apparatus for determining the rate of solution of gases by water, lent by Prof. Adeney. Prof. Allmand shows photochemical cells, electrolytic manganese and other objects of interest; Prof. Bassett shows models and specimens to illustrate the phase rule. Dr. Egerton shows specimens of distilled metals and notes of various vapour pressures. Dr. Friend has an exhibit showing the corrosion of metals and the various pigments which are used to prevent corrosion. The Royal Institution shows some of the Historical



The Main Entrance to the Grounds

Collection of Apparatus of the late Prof. Sir James Dewar, and there are several other exhibits of apparatus used by physical chemists.

Prof. McBain has done much original work on colloids and the committee gladly availed itself of his help in organising the exhibit of colloid chemistry. Dr. Hele Shaw's Stream Line Filter shows how colloids may be filtered. Banded precipitates are shown by Dr. Bradford and Mr. Emil Hatschek. Many chemists who know these only



In the Scientific Exhibit

from illustrations in books will be glad to see actual specimens. Prof. McBain himself has an exhibit of soap solutions and other exhibitors show colloidal rubber, clay and carbon. Prof. Hardy's work on the distribution of water in a gel is also shown.

There are exhibits showing the progress in explosives during the years 1900–1924 collected by Sir Robert Robertson and lent by the Board of Trade, the Imperial War Museum, the Science Museum, the Research Department of Woolwich, Messrs. Nobel's Explosives and others. Some of the exhibits refer to an earlier period, for instance, the first practical smokeless powder made so long ago as 1882 by Mr. Walter F. Reid, a former President of the Society of Chemical Industry. There are models of plant for the manufacture of guncotton and nitroglycerine and for the recovery of acetone on the lines worked out by Nathan, Thomson, Rintoul and Sir Robert Robertson himself. There are devices for detecting the gradual decomposition of nitroglycerine, the calorimetric apparatus of McNab and Leighton for determining heat values of gases and sundry information about the new explosives developed during the war and models of plant for their manufacture.

Crystal structure as we now understand it, owes much to the labours of the Braggs. Prof. W. L. Bragg shows a considerable number of models of crystals made to a scale of one hundred million to one.

There are exhibits arranged by Prof. Smithells to show the structure of coal, the nature of flame and the removal of sulphur compounds from coal gas.

The Cavendish Laboratory of Cambridge shows a number of interesting things, diagrams explaining much of the work of Rutherford, Geiger, Andrade and Moseley: photographs of mass spectra by Aston, and of α-particles by Wilson. The importance of this work and the valuable contribution to knowledge made by the Cambridge school, are well-known to most of our readers. This exhibit has been organised by Sir Ernest Rutherford.

Dr. Ormandy has arranged a number of exhibits of various plastic materials, the conversion of cellulose into sugar: phenol and cresol condensates prepared by Synthite, Ltd. and the Damard Lacquer Co., also casein products prepared by the Erinoid Company.

The metallurgical exhibit is not a large one, having regard to the great mass of recent work on the structure of metals, but it is not easy to show in such an exhibition the microscopic structure of steels and alloys. The microscope is becoming of considerable importance in many industries, and the industrial section of the Royal Microscopical Society will convince anyone who is fortunate enough to attend its meetings how many problems the microscope is helping to solve. Prof. F. C. Thompson has taken charge of this exhibit, which includes some interesting exhibits of the crystallisation of metals.

Colouring matters always form an attractive display; the scientific work done here in this branch

In the Scientific Exhibit

of chemistry is not so easy for him who runs to read as is a mass of brightly-dyed fabrics. Prof. Hewitt has, however, collected some interesting things, some original dyes prepared by Sir William Perkin, sixty or seventy years ago, natural dyestuffs prepared by Prof. A. G. Perkin, the plant pigments, anthocyanidins extracted by Dr. Everest and the pyrylium salts made by Prof. Hewitt. There are also dyestuffs shown by Prof. Heilbron, Dr. Silberrad, the British Dyestuffs Corporation, and L. B. Holliday and Co.

The English and Scotch chemists have carried out some important investigations on the structure of terpenes. Hard thinking and logical reasoning on these subjects do not necessarily impress the imaginations of some thousands of visitors who have never heard of a benzene ring. The terpene specimens provided by Prof. W. H. Perkin and Prof. G. G. Henderson will nevertheless be of interest to all who have studied organic chemistry.

Catalysis is of great importance industrially, and the theory of it is both difficult and interesting. Dr. Hilditch has gathered together some good models and units of plant employed by the United Alkali Company, and some oils hardened by catalytic processes, prepared by Messrs. Crosfields, Ltd. The words catalysis and analysis have always appealed to chemists; in Greek it would seem that they mean, respectively, breaking down and breaking up, though catalysis is the exact equivalent of the phrase, breaking up, as applied to a school. The idea of catalysis is very closely akin to the idea of rest after labour, a sojourn in a country inn at Lyme Regis, after a busy term at Sheffield. This is catalysis as the old Greeks would have understood it. Some favoured visitors may have the opportunity at the Exhibition of seeing catalysis as applied to editors.

We have not forgotten the exhibit of chemical engineering arranged by Prof. Hinchley, but as we intend to have a special article dealing with chemical engineering at the Exhibition, a fortnight or three weeks hence we will not deal with this now, except to mention that it is worthy of a visit.

This scientific exhibit and the book written as a supplement to it to record the recent advances in chemical knowledge in this country, bring home to us the flourishing state of chemistry. So far as the Structure of the Atom is concerned we may well be proud of the British share. This particular subject will fill us with pride until some daring speculator shall advance new and better hypotheses.

Man does with dangerous curiosity,
These unfathom'd wonders try:
With fancied rules and arbitrary laws,
Matter and motion he restrains:
And studied lines and fictions circles draws:
Then with imagined sovereignty,
Lord of his new hypothesis he reigns.
He reigns: how long? till some usurper rise;
And he, too, mighty thoughtful, mighty wise,
Studies new lines, and other circles feigns.

These verses are almost as true to-day as they were when they were written, nearly two hundred and forty years ago.

This Exhibition has taken two years to organise, and has cost twenty million pounds sterling to build. It always seems more impressive to put in the word sterling; its significance is nevertheless comparable to the mere expletive. And at the finish there is a rush and a scramble to get things done in time, late and early hours spent in hurried work. The book we have spoken of, a record of modern British chemistry, prepared by the greatest living experts in their own departments, is an instance of this. Dr. E. F. Armstrong, who has edited this and written an excellent introduction to it, has had to issue frantic appeals at the eleventh hour to authors, printers, publishers *et hoc genus omne* to get the compilation ready in time. He has done it and done it well, but probably he has had to sit up so late that hardly here and there a hackney coach, appearing, showed the ruddy morn's approach.

Even the editorial staff wish that Special Numbers did not coincide so nearly with Easter holidays, making an undue rush to print two numbers in one week, and they regret the light-hearted way in which, four or five months ago, they undertook the issue of a set of elementary pamphlets, intended to show how chemistry pervades the whole of human life, beginning with the laws which keep the planets in their radiant courses, and ending with some precept deep for dressing eels or shoeing horses, ranging in fact from stellar chemistry and biochemistry to metallurgy. But the one man whose task we have not coveted and whose responsibility we have not envied is Mr. Woolcock.

The Chemical Exhibit

Heavy Chemicals

No exhibition, including the chemical industry, would ever be complete without the participation of those two giants in the chemical trade, Brunner, Mond and Co., and the United Alkali Co. So much could be said about either of them that it is difficult to know where to begin. Brunner, Mond and Co. not only exhibit a full range of their own products at their stand, but provide space for their subsidiary companies. A special feature is the demonstration of P. 84 silicate of soda for hardening concrete, and samples of other grades of silicate of soda suitable for other purposes are also to be seen. All sorts of products ranging from soda ash to caustic soda, ammonium chloride to calcium chloride are there, to remind the onlooker of the importance of the alkali industry whether to other industries or to the home. Attention should be called to the exhibit of crystal calcium chloride, which contains up to 75 per cent. of the salt and is of pharmacopœal purity in regard to its content of arsenic.

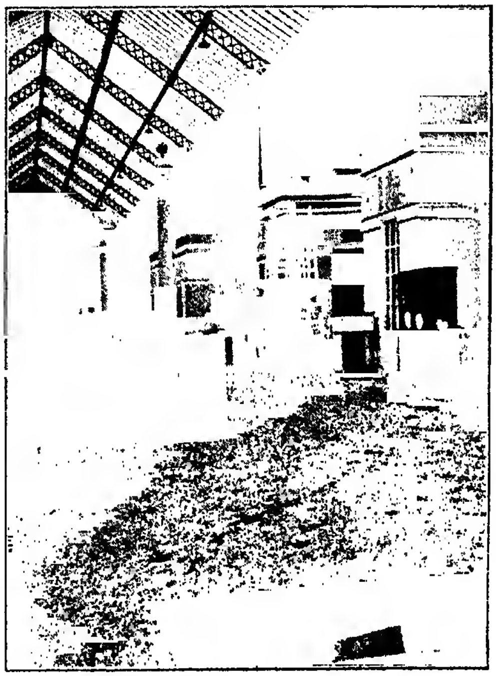
Of the subsidiary companies, the Castner-Kellner Alkali Co., Ltd., provides exhibits which show the extraordinary range of uses to which its products are applied and remind one that its works, engaged in the manufacture of sodium and chlorine products, ranging from metallic sodium to hydrochloric acid, are remarkable for their scientific planning and equipment. Those interested in the soap, dyestuff, paint, oil extraction, rubber or laundry industries, will find a visit to this stand well worth while. An electrolytic process of a different type is also utilised by Electro-Bleach and By-Products, Ltd., to manufacture chlorine, soda, bleaching powder, sesquicarbonate of soda and salt. An interesting by-product of the manufacture of caustic soda by treating sodium carbonate solution with lime is carbonate of lime, which, produced in a very fine state of division, is eminently suitable for agricultural use and for "stone-dusting" mines. Many high-grade chemicals are shown by Chance and Hunt, Ltd., a firm which supplies ammonium carbonate

(for the baking trades), caustic soda, sulphuric and hydrochloric acids, ammonia, sodium sulphide of various grades, saltcake for glass and paper making and iron-oxide pigments. This firm neglects no opportunity to improve its products or processes and is willing to investigate problems connected with the use of its products. The Calder-Fox scrubber patented by the company is a successful method for removing acid mist in the exit gases from sulphuric acid concentration plants, and information about it is willingly given to intending users. Lime in one form or another fills a multitude of users, amply illustrated by the Buxton Lime Firms Co., whose output exceeds a million tons a year. The physical and chemical properties of lime are too often neglected, but the products of the company possess characteristics that comply with needs ranging from agriculture to concrete making, water softening and various chemical processes. Synthetic Ammonia and Nitrates, Ltd., whose works for the fixation of atmospheric nitrogen at Stockton-on-Tees are now completed, exhibits samples of ammonia and sulphate of ammonia that remind one that, although the plant can produce nitrogenous fertilisers in quantity, it could, in time of war, supply huge quantities of nitrates, thus rendering the country independent of foreign supplies.

No introduction is needed by the United Alkali Co., which, though a descendant of the pioneers of the British chemical industry, is as new in its processes as it is old in years. Although samples of the company's products are shown in various portions of the stand, the main object of the exhibit is to show, by photographs and other means, how widely those products are utilised in the various industries of the country, whether the manufactures be paper, glass, textiles, dyeing, printed calico, galvanised iron, foodstuffs, leather, or even ice. Thus the bleacher and the mineral-water maker, the match maker, and wire maker, the cotton printer and the water engineer are all beholden in some way to the United Alkali Co. The chief manufactures at the company's various works are, of course, sulphuric acid, caustic soda, soda ash, and chloride of lime, all products essential to industry, but it should also be pointed out that the company is the largest manufacturer in Great Britain of that most important fertiliser, superphosphate, and that others of its products such as salt, soda crystals, and cleansing materials are as indispensable in the home as superphosphate is on the farm. An interesting development of the company's scope is the manufacture of organic chemicals and dyestuff intermediates, of which the national importance is shown in a diagram that should be seen by all those who are interested in the continued growth of the dyestuffs industry in this country.

Another of the firms which extract salt from the mid-Cheshire brine fields is Murgatroyd's Salt Works, Ltd., and their stand is remarkable for the number of grades of salt shown. All grades are there, from coarse salt for curing fish, dairying, cooking and the table, up to fine salt that is analytically pure, and including even salt that will not cake when exposed to damp, the change being produced, not by adding substantial amounts of other chemicals, but by physical treatment. In addition, a coarse, uniform salt is shown that does not "ball"; it is supplied for the manufacture of salt cake and a quality is made free from calcium and magnesium compounds. Here on this stand can thus be seen one chemical which, in various grades, covers the range from fine to heavy chemicals, as well as being an important food adjunct, a supply of 15 lb. per annum being necessary for health for a grown man.

In their exhibit, Messrs. F. W. Berk and Co. chiefly show specimens of their main products, hydrochloric, nitric and sulphuric acids for a variety of uses, as well as samples of other of their well-known products, including lactic acid, hydrogen peroxide, alkaloids, mercurials, sulphur, mercury, potash salts and a large range of crude drugs. This



Part of the Chemical Hall as it was

company specialises in the export trade, being a merchant as well as a manufacturer, and the exhibit also shows the methods of packing materials for export so as to ensure both safety and economy. The company owns works both at Stratford, London, and at Pentrepoth, Swansea, and as the heads of the various departments have been with the firm for periods ranging over forty years, an accumulated experience and a knowledge of requirements are available that are not less valuable to the buyer than the technical qualifications at command.

A useful range of industrial chemicals is exhibited by J. M. Collett and Co., Ltd., of Gloucester, their exhibit including the metabisulphites of potassium and sodium, the sulphites of lime and soda, as well

as sodium bisulphite (anhydrous and liquid) and bisulphite of lime.

On approaching the stand of Joseph Crosfield and Sons, Ltd., one is immediately reminded of soap, of course, but there are other products of this company that are equally noteworthy. Take Crosfield's Pyramid brand glycerine, for instance. This is supplied in qualities suitable for use in the manufacture of many chemicals and industrial products, such as lubricants, leather dressing and polishes, inks, toilet preparations, drugs, and then it finds use in surgery, printing and dyeing. Caustic soda is an important product of this Warrington firm, but there is also silicate of soda—and it is time that the public realised that this protean body has many other uses than that of preserving eggs; it is a universal adhesive as well as a "hardener" for concrete and cunningly changed in form, it becomes Doucil, the new material for softening water and absorbing vapours. Visitors to this stand will not fail to be impressed with the complexity of modern industry, as illustrated by a firm whose products range from soap to cement, and if they realise the quality of the scientific direction that lies behind it, all the better for chemists and chemistry.

The fine colour of the exhibit of sulphate of copper by James H. Dennis and Co., Ltd., cannot fail to catch the eye. The product, of which the firm is the oldest and largest maker in the world, is of 98 to 99 per cent. purity, and has been used to protect the French vines from diseases for over fifty years. It is used for the prevention of plant diseases, as a weed killer, for purifying water, and as an addition to asphalt to make improved road material. Those who have seen the ravages of disease in the vine yards in certain years will understand the importance of this cœrulean chemical.

A large number of industries will find attractions at the stand of B. Laporte, Ltd. There is hydrogen peroxide of all strengths and qualities for bleaching wool, silk, straw plait, gelatin and many other products, and barium salts are present in quantity, such as barium peroxide (which is not only the purest made, but also the only British make), the carbonate for the ceramic, glass and sugar industries, the sulphide for the tanner and the purification of acid, and the sulphate, known in the colour trade as blanc fixe. Sodium salts are there, too, whether the hypochlorite or pyrophosphate, the acid pyrophosphate used in baking, the sulphide, bisulphite, perborate—all of such great industrial utility. Soap, washing powders, blues and other laundry requisites, are also shown, in addition to sundry preparations for various technical and trade purposes.

Nickel and its salts and the Maple brand of copper sulphate predominate, as might be expected, at the stand of the Mond Nickel Co., and will remind the scientific observer of the beauty of the process by which nickel is purified, the impure material becoming the attractive metal that is now so ubiquitous, whether as coinage (and the company has supplied several foreign Governments for this purpose), or as a shining mask for baser metals in a thousand different ways. Next time visitors are "abroad," the sight of the clean, bright coinage in Belgium and other countries will bring up memories of the stand of the Mond Nickel Co. Some of the metals of the platinum group are also produced by this company, so its stand does not lack interest.

Sulphuric acid is so important a chemical, such an index to the general industrial prosperity, that it may be said to carry its own recommendation, and Spencer Chapman and Messel, Ltd., have made it so long and so extensively, that little remark is needed. In an oval glass case stands a central bottle filled with crystals of sulphur trioxide, and surrounding it are specimens of oleum and sulphuric acid. Charts are exhibited showing the various properties of these two products, and the stand should not fail to impress those who can appreciate the vast economic import of the crystals and specimens displayed with such elegant simplicity.

To the uninitiated it may come as a surprise to hear at the stand of the Washington Chemical Co. (with Turner Bros. Asbestos Co., Ltd.) that the works of this company, covering 50 acres, and the largest of its kind in Europe, produces solely magnesia in its various forms. But there it is: magnesia, light, heavy or calcined, is used in making rubber products such as tyres, in making explosives, soap, ink, enamelware, scientific glassware, china, paper and toilet papers, and it is to be found even in fine table salt. Founded in 1840 by Pattinson and Newall, both Fellows of the Royal Society, the company has developed continuously, and whether "Pattinson's" magnesia is used in the pharmacy or in industry, the product is always found to be uniform in colour, texture, composition, and purity.

No-one should miss the wonderful display of crystals of various alums on the stand of Peter Spence and Sons, Ltd., a firm with nearly 80 years' experience behind it. One huge crystal weighing over 200 lb. took four years to grow, and is probably the largest single artificial crystal ever produced. On each side of this exhibit is a large pyramidal column, over 5 ft. high, which is built up of about 140 practically perfect octahedral alum crystals. But there are many other exhibits besides crystals, such as the specimens illustrating various salts of aluminium, and their manifold applications in dyeing, paper making, leather manufacture, fire-proofing, water purification, and the specimens of titanium preparations, *e.g.*, titanous chloride and sulphate used for reducing and stripping, and titanium potassium oxalate, used in dyeing leather. Messrs. Spence also show sulphuric acid, carbonate of lime, silica and various other industrial materials of which they are large producers.

"How was it done?" This question was asked by a visitor on hearing that Messrs. J. and E. Sturge, Ltd., manufactured the required grade of precipitated chalk, not by mixing a lighter with a heavier grade, but by manufacturing direct to the bulk required thus ensuring a uniform product that could be repeated at any time. However it was done, Messrs. Sturge's stand exhibits the results, a remarkable range of graded samples, whose structure is depicted in photomicrographs. Pleasant memories are awakened by the exhibit of products derived from the grape, including the more important tartrates.

There are also products derived from the lemon—citric acid and various salts—in addition to potassium carbonate and bicarbonate, and magnesia. All these materials are subject to rigorous analytical control, and are as free from common impurities, such as lead or arsenic, etc., as is possible. So visitors can sip their lemonade or clean their teeth without the slightest fear of ill-consequences.

A beautiful display, both in form or colour, is given on the stand of J. and J. White, Ltd., the oldest and largest manufacturers of chromium compounds in the world, and a striking feature is the contrast between the dullness of the raw materials and the brilliance of the finished products. The chief products shown are potassium bichromate and sodium bichromate, used chiefly in dyeing and tanning, and tanners will be interested in the removal of the uncertainties due to indefinite strength of chrome tanning liquors by the provision of chrome-tan, of definite strength, sold both as liquor and crystals. Oxide of chromium is shown of great purity, for the manufacture of ferrochrome and non-rusting cutlery, as well as for paint making. There are also chromic acid for use in electric batteries, ammonium bichromate, used in fireworks and photography, and a number of other chrome compounds, which, if not of great commercial value, are of note for their variety of colour. An interesting by-product is dry, neutral sulphate of ammonia, a contrast among so much brilliance.

The stand of Baird and Tatlock (London), Ltd., brings up memories recalling the astounding feats of genii in the Arabian Nights. Was something wanted hurriedly in the laboratory, Baird and Tatlock used to produce it and even now, despite the scepticism engendered by advancing years, one wonders how they did it. No matter what sort of apparatus was wanted, whether a laboratory bench, a Sohxlet, distillation apparatus, a pipette, or a clay triangle, they had it and all sorts of interesting chemicals as well. They earned a debt of gratitude during the war, and it is pleasant to be reminded of it at their stand.

On the right hand side of the stand of W. J. Fraser and Co., Ltd., Dagenham, is a vertical autoclave with mixer, such as is used for producing organic chemicals, and by it is a horizontal steam-jacketed high-pressure dryer fitted with an internal agitator. These and the other exhibits can illustrate but a small part of Messrs. Fraser's production, which includes chemical apparatus of all descriptions, so recourse is had to photographs showing stills, condensers, autoclaves, mixers, heaters, coolers, driers, pans, tanks, conveyors, pumps, and compressors, and even weighing and measuring apparatus. There is also a large model of a Mills-Packard sulphuric acid plant, and the stand should be visited by those who wish to know what a chemical plant manufacturer in this country is doing.

Coal and its Products

At the sign of the Benzene Ring used so cleverly for decorative purposes by the South Metropolitan Gas Co., the tyro will learn more about Metro chemical products derived by distilling coal. Metro sulphate of ammonia, presented in glistening bulk in terrace-garden-like surroundings, shows that its reputation for dryness and neutrality is deserved and the wooden balustrade around it is stained in various shades to show the series of browns obtained by treatment with Metro creosote. Noticeable are the gas-lighting arrangements displayed above samples of solid smokeless fuels held in braziers surmounting four octagonal cabinets, each of which contains Metro products such as dye intermediates, ammonia, coal tar of various grades, pitch and heavy inorganic acid. Other specialities to be seen are road tar to the specification of the Ministry of Transport, a powerful disinfectant fluid, benzol, and pitch. It is a long step from Durham coals to Metro dye

Another Portion of the Chemical Hall

intermediates, but there they can be seen, and though samples of gas will hardly be shown, its qualities are well enough known to the seething populations of South London.

The Gas Light and Coke Co. bears its 111 years of existence lightly, and provides a stand showing not only its well-known products such as tar, ammonia and cyganogen compounds, but also some of its later developments such as betanaphthol and naphthalene, cresol and pale liquid carbolic acid of much higher purity. The company and its products are too familiar to need any introduction and it will suffice to point out that on the stand there is a working model to demonstrate the ease with which the company's neutral sulphate of ammonia can be applied to the soil, a point the importance of which can be fully realised only by those who have had to cope with rotted bags and a clogged fertiliser drill during a short spell of fine weather at sowing time.

The Uses of Tar

The public is beginning to realise that tar has uses other than on roads or sheds. The examples of primary and intermediate products obtained by the distillation of coal tar exhibited by the Midland Tar-Distillers in co-operation with the South Western Tar-Distilleries and Messrs. Burt, Boulton and Haywood Ltd., should give more valuable enlightenment. Samples of products for treating roads, for horticulture, disinfecting, tanning and for medicinal use are on show, and there are interesting models of the Midland Tar Distillers' plant for the continuous distillation of coal tar and of the Burt, Boulton and Haywood creosoting plant. One is glad to see the range of useful and ornamental articles manufactured from phenol by Synthite, Ltd., which is the largest manufacturer of formaldehyde in this country. The process used is, of course, that in which phenol is condensed with formaldehyde to produce plastic materials, which are coloured, shaped and treated so as to produce various articles.

Messrs. Burt, Boulton and Haywood are also exhibiting at another stand, where samples of wood preservatives are accompanied by specimens of timber creosoted over 70 years ago, showing the efficiency of creosote for preserving wood. All types of disinfectants are exhibited, and an interesting new product is colloidal sulphur, which is finding increased use in horticulture and veterinary work. On the same stand, demonstration is given of the Premier Mill, together with finely ground pigments, emulsions, and other products prepared by it.

Jeyes Sanitary Compounds Co., do not desire so much to delight the eye as to impress the mind, as their stand is designed to show the great stability, high germicidal strength and relative non-toxicity of Jeyes Fluid and Cyllin. The apparatus for standardising disinfectants by means of the Rideal-Walker test is demonstrated at the stand, and in addition to several sanitary preparations, an alarming series of bacterial cultures from town air and other sources of infection attracts attention.

An illuminated globe representing the world is found at each corner of the highly original stand of Newton Chambers and Co., Ltd., and Izal Germicide appears to be overflowing from the huge bottle in the centre, supported on a pylon, and running in streams to every corner of the globe. The bottle rests on a glass stand showing silhouettes of the company's collieries and chemical and iron works and the supporting pillar springs from those key-products, coal and iron. Show cases contain an array of other products manufactured by the company, which dates back to 1793.

The Kalbitum Paint Co. show black bituminous paint that is claimed to be an efficient and economical preservative for iron and steel work in many kinds of plant. The paint is applied cold and does not require skilled labour. An attractive blend of colours characterises the stand of the Keystone Varnish Co., which exhibits paints, varnishes and enamels for a wide variety of purposes.

Dyestuffs and Intermediates

A lighthouse, happily surmounted with a block of coal and surrounded by resplendent columns, summons with its flashing lights the curious to a stand that is a fairyland—or is it an Aladdin's cave?—of light and colour. The British Dyestuffs Corporation, Ltd., secure in the glow of colour from cotton and silk, velvet and muslin dyed with its products, has largely dispensed on its main stand with the usual show of samples in bottles, and the result is singularly attractive. Their flashing lighthouse dominates the hall, but without its call there is interest enough. Imagine a large exhibit which demonstrates the various stages of the dyestuffs industry from prehistoric days up to those of Perkin and the present time! There are colours out of date, colours up to date and colours that have apparently just emerged from the factory. The public will begin to understand the real significance of that trite expression, a feast of colour, and incidentally will gain a pleasant—if distant—glow of proprietorship in considering the improved fortunes of this national company. But what a task was that of selecting material for this stand! To choose exhibits from materials that are used in dyeing every kind of textile, in making lakes for paint, varnish, distemper, ink, in dyeing leather, in curing disease, in vulcanising rubber, in colouring photographic films is obviously not easy—there surely must be a B.D.C. colour for every known purpose and some new ones. And if you want your bottles, there on another stand are specimens of fine chemicals, photographic chemicals, medicinal chemicals and many more. And if you want to know anything, a chemist will tell you how the dyes are made and another gentleman will sell you any quantity, swiftly, painlessly, and economically.

The exhibit of the British Alizarine Co. will certainly attract much attention, whether from the point of view of the colour or the quality of the products shown. Here can be seen all sorts of alizarine colours, reds, oranges, pinks, mauves, blues, greens produced on different materials by the various methods set out in the company's pattern cards. A noticeable feature is the large number of shades such as salmons, terra-cottas and other mixed shades obtainable in printing on cotton with Alizarine Orange. Then there are the Anthracene Browns, and a fine series of Alizanthrene Vat Dyes on cotton yarn. There is much attractive material on this stand.

A visit to the Colne Valley in Yorkshire leads to the acquisition of much knowledge. The wise man will in some parts learn how not to be a "furriner" and how to pronounce Slaithwaite as Slowitt, and if he goes to Milnsbridge he will find, in a valley where factories hum amidst stark uprearing rocks the Colne Vale Dye and Chemical Co., Ltd., who, in that greyness, produce aniline dyes to clothe the native in Kamchatka or Benin or to ornament the coster's Sally on Hampstead Heath or someone's Harriet on the Great Orme. Their telegraphic address is Aniline, Huddersfield, and their stand is easily found at Wembley.

The interesting exhibit of the Clayton Aniline Co., Ltd., illustrates the complete range of products manufactured by this firm, samples of about 250 colours and 100 intermediates being shown, in addition to samples demonstrating the working up of raw materials into dyestuffs and the application of dyestuffs in dyeing, painting, printing, leather treatment and other trades.

The policy of Hickson and Partners, Ltd., to make only a few colours but to make these on a large scale will attract visitors to their stand, especially as the firm claims to be the largest maker of Roseine in this country. This dye is, of course, magenta, but as the firm believes in British names for British products, the original name of Roseine, due to Brook, Simpson and Spiller, has been given to it. The stages in which the firm's products are manufactured are shown in an attractive manner, the care taken to keep a high standard of purity being very noticeable, and giving an explanation of the excellence of the effects produced by this firm's dyes, which are finding important outlets at home as well as abroad.

A most original and instructive stand is that of L. B. Holliday and Co., Ltd. Realising the bewilderment that must result to visitors confronted with a large number of dyes accompanied by samples to show the great variety of their applications, the firm has provided a demonstration to prove that British-made dyestuffs are equally fast as the best foreign dyestuffs. The samples exhibited show that the comparison is in no way to the disadvantage of the British product. This exhibit should dispel any lingering notions that British-made dyes are of other than first-class quality.

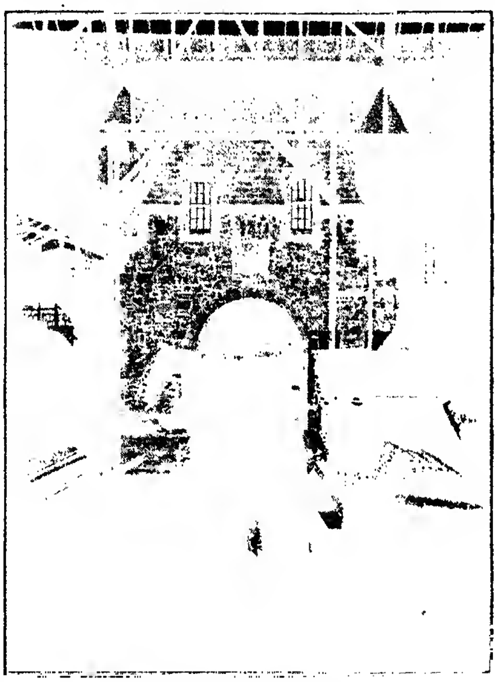
Mention "Nigrosine" or "Induline" and one thinks at once of Williams Bros. and Co., a firm which is the oldest and largest maker of these colours in the country, as well as a large producer of aniline dyes for use in the manufacture of leather, polishes, inks, stains, varnish, soap, candles and many other products. Selections of the firm's manufactures make an attractive display, and those who are dismayed on seeing the appetising custards, egg powders and other foods tinted with the firm's colours can easily be reassured, as all the products supplied for tinting confectionery have long been shown to be harmless.

A fine show of colour greets the eye at the stand of Scottish Dyes, Ltd., a company which specialises in anthraquinone dyes for cotton and silk and acid alizarine dyes for wool. Specimens of intermediates such as anthranilic acid, anthraquinone, methylamine hydrochloride, naphthanthraquinone and phthalic anhydride are to be seen, but pride of place is given to the standard dyes manufactured by this firm, and the range of textiles dyed with these colours worthily uphold the Scottish claim for excellence.

Dyes are also shown by the Ajax Aniline Dye Manufacturing Co., Ltd., suitable for a wide range of materials, including leather, artificial silk, carpet yarns, and the exhibit comprises bottles of dyes and intermediates as well as a slection of dyed samples. Three glass cases containing various chemicals and direct cotton, acid, chrome, union, leather, jute and paper colours are exhibited by J. C. Bottomley and Emerson, Ltd.

Fine Chemicals

The British Drug Houses, Ltd., known familiarly as the B.D.H., must have had a difficult task in deciding what to exhibit at their stand, as their output and range of chemicals and pharmaceutical products is said to be larger than that of any other similar firm in the world. However, the stand is thoroughly representative and visitors can choose between the



In the Palace of Industry
The Distiller's Stand

attractions of the section for medicinal chemicals, or those for laboratory chemicals, for pharmaceutical products, or for pharmaceutical and toilet specialities. The medicinal chemicals include complex synthetic organic compounds as well as active principles of natural origin, but pride of place must be given to insulin, which was actually placed on the market after only three months' preparation and is now being produced in an improved form at the rate of 200,000 doses a week. It will be remembered what good work the B.D.H. have done during and since the war in providing a British source of laboratory chemicals. More than one chemist has given testimony to the value of their catalogue listing over 3500 analytical reagents and laboratory chemicals of guaranteed purity, there being over 3000 research chemicals alone. There are indicators used in determining hydrogen-ion concentration and stains and dyes for microscope work, and many out-of-the-

way chemicals are stocked because, though they may not be often wanted, when they are, they are wanted quickly. Then there are exhibits of pharmaceutical preparations and of proprietary, pharmaceutical and toilet articles, including a "vanishing cream"—but those who want to know how this is made must go to the stand and ask for the Record of the B.D.H. exhibit.

Boots' Pure Drug Co., Ltd. confine their display almost solely to fine chemicals, including alkaloids, anæsthetics, antipyretics, antiseptics, hypnotics, perfume bases, and research chemicals. A chart and samples are shown illustrating the manufacture from coal tar of saccharine, of which the firm is the largest British maker, and similar demonstrations are provided for acriflavine, aspirin, and atropine. Of much interest are the special displays of insulin made by the firm and of Stabilarsan, an improvement upon the old German salvarsan. Models of the works and photographs of plants at Nottingham suggest the extent of the firms' activities, and special literature is being distributed, of special interest to chemists being the catalogue of research chemicals, over a thousand now being available.

One hardly knows where to start in describing some of the stands. Take Burgoyne, Burbidges and Co., for example. The exhibit is mainly devoted to medicinal and pharmaceutical preparations. But who can choose between the charms of chloramine T and nitriles, or camphor monobromide and cinnamates; or express a preference for something out of the complete range of analytical reagents shown as against the series of stains and reagents for bacteriological work? Where ampoules and pills compete with amyl esters and floral and fruit ottos, who shall award the prize! And there is chloral hydrate (of which the firm is the largest maker in England), accompanied by its method of production, plain for all to read. But visitors must see the stand themselves.

At the two stands of W. J. Bush and Co., Ltd., visitors will be able to obtain an insight into an interesting industry. Since the war this firm has specialised on the production of fine chemicals used in making essences, confectionery, mineral water, perfumery and soap, and products are also made for lacquerers and varnish makers. Such products must be of reliable quality, and the list of products made by Messrs. Bush indicates that it is beginning to be realised that excellence is no more difficult to find at home than abroad. At the perfumery stand, at which the products of two subsidiaries are shown, attention is at once drawn to the series of preparations containing the famous Mitcham lavender, still the finest of its kind, and there are many other handsome productions on view as well.

A charming setting is given to Messrs. Howards and Sons exhibit, which is housed in a stand that suggests an eighteenth-century apothecary's shop, the effect being enhanced by the inclusion of several interesting old pharmacy jars among the chemicals shown. In this way a reminder is given that, although the firm dates back to 1797, it is modern in every way, whether in its methods of manufacture or packing, or in its increasing range of manufactures. The exhibits are taken from the products as manufactured, and are arranged in groups of particular interest being the quinine section, which includes specimens showing the increased production of quinine alkaloids due to improved methods of cultivation. Bismuth salts, iodides, mercurials, citrates, camphor, boric acid, Epsom and Glauber's salts, aspirin and many other products are shown, and special attention should be drawn to the separate group showing the stages of evolution of aspirin tablets from coal and that of the new synthetic solvents, such as isopropyl, alcohol, cyclohexanol, etc. that are being produced as work in the laboratory is transferred to large-scale production in the factory.

Chemical reagents are rightly made the centre of the large display of fine chemicals on the stand of Hopkin and Williams, Ltd., as the firm was a pioneer in the Empire of this branch of the fine chemical industry, witness their book on "Analytical Reagents." A very good display is made of thorium salts used in the manufacture of incandescent gas mantles and many will see for the first time the series of uranium compounds and cerium compounds used in the manufacture of pottery and the like, as well as of glass, the cerium compounds being also of interest to the tanning and dyeing industries.

Some triumphs of chemistry are to be seen at the stand of May and Baker, Ltd., whose exhibit covers products both for medicinal and industrial use, ranging from Seidlitz Powder to Novarsenobillon, an arsenobenzol compound used for the treatment of syphilis. For the treatment of this disease there is also Arseno-argenticum (sodium silver arsenobillon), Luatol (sodium potassium bismuthyltartrate), and Rubyl (quinine bismuth iodide). As the firm is the largest British manufacturer of mercurials, there is naturally a fine display, including the chloride, and oxides for anti-fouling paints. Hypnotics and analgæsics, anæsthetics and alkaloids vie in interest with bismuth salts of all kinds, molybdic acid and ammonium molybdate for testing steel, lead arsenate for controlling insect pests, potassium cyanide in various strengths, lithium salts, and guaiacum, jalap and scammony resins. An interesting exhibit.

Thomas Tyrer and Co., Ltd., naturally specialise on their stand in a representative selection of the well-known "Sterling" brand of pure and technical chemicals. Bismuth salts, bromides, ethers, iodides, mercurials, phosphates and phosphoric acid, preservatives, siccatives, antifouling compositions and many more besides, are produced for industry, and there are other fine chemicals for analysis, assaying, pharmacy, photography, vulcanising and a large number of industries. It is of interest to note, as an indication of the firm's progressive character, that it is prepared to consider proposals for the initiation of new manufactures, and yet the list of "Sterling" brand chemicals covers 28 closely printed pages!

The exhibits of Duncan, Flockhart and Co. are classified under anaæsthetics, organotherapy, and vaccines and protein therapy, which include many fascinating products of modern science. The white label chloroform—the original chloroform—ether, ethyl chloride represent the anæsthetics; adrenalin, pituitary fluid, thyroid gland represent organotherapy, and the vaccines, tuberculins and the peptone treat-

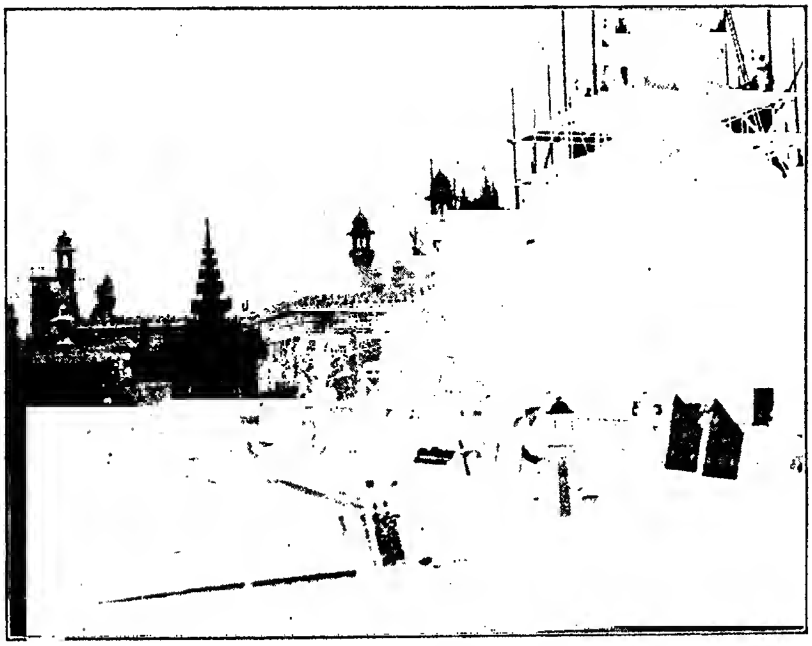
ment, innocent enough in appearance, mean the relief of so much human misery, but one wonders if the part played by the chemists who have made their production possible is yet generally realised by the public. Progress is being made, however.

Those suffering from "nerves" should not fail to acquire comfort from the delightful array of sedatives exhibited by Whiffen and Sons, Ltd. Atropine, hyoscine and hyoscyamine, bromides of many kinds, and caffeine, are there to sooth the troubled breast, transparent camphor lies in wait for minor ills, and iodides, produced by this firm for over 50 years, offer the alarming possibility of the mass treatment of goitre through the local water board. That interesting salt, tartrate of nicotine, flaunts beside the salicylate, and common nicotine and iodine, iodoform, essential oils, salicin and various quinine salts each add their note, culminating in an ominous bulk display of strychnine. As a contrast there is vermilion in shades from pale orange to deep red, a product made by one branch of the firm for over two centuries.

Characteristic stands are those of Burroughs, Wellcome and Co., Ltd., who have an attractive display of their well-known products, whether of the "Tabloid" brand of photographic chemicals or of medicinal and toilet specialities. Everything done by this firm is marked by precision and thoroughness, qualities which are reflected in their many and varied exhibits.

Johnson and Sons, Manufacturing Chemists, Ltd., exhibit their "Scales" brand of photographic preparations, some of which were developed during the war to replace products previously obtainable only from Germany. Many other chemicals are exhibited, of course, and the stand will well repay a visit.

Everyone will wish to see the large revolving centrepiece containing photographs of Port Sunlight at the stand of Lever Bros., and if information is wanted, experts are there to advise on the use of numerous soaps and cleansing agents, whilst interesting information can also be obtained in booklets to be read at home. Sunlight, Lifebuoy, Lux and Vim— the names explain themselves, and if Twink is possibly new, the wide range of Twink colours for all textiles is illustrated by a novel device. On the same stand Messrs. R. S. Hudson's exhibit their well-known soap and other products.



India and Burma

One cannot escape the exhibits of soap, and the Erasmic Co.'s stand makes one feel how much one's ablutional and tonsorial habits have fallen short of the ideal. Those who visit this and some other stands will come away heavily laden, if lighter in other ways. At another stand, that of D. and W. Gibbs, most of the space is given up to the manufacture (excluding boiling) of toilet soap, using actual works machinery run by a full staff. Then another stand consists solely of the Ofome cleanser, which is designed to combine the properties of soft soap, household soap, cleaning powders and benzine, and so to reduce the cost and labour of cleaning. The stand of J. J. Rigby shows many soaps—a soft soap for waste spinners, a pure vegetable oil soap for

textile works and a variety of household soaps for various purposes. On the stand of Joseph Watson and Sons are to be seen the well-known Matchless Cleanser, Nubolic disinfectant soap, various toilet soaps and washing powders, and a display of technical oils and feeding cakes produced at the firm's seed-crushing mills.

Amongst other firms that are exhibiting mention must be made of J. and E. Atkinson, Ltd., who show Eau de Cologne representing a century's experience in manufacture, soap, perfumes, and various aids to beauty.

The Section devoted to Pottery and Glass provides some very fine exhibits of ceramic wares and glass products. Amongst the last-named exhibits, Messrs. Chance Brothers and Co., Ltd., are showing a set of heat-resisting laboratory glassware and a range of samples of scientific glasses, such as optical and spectacle glass and heat-resisting ware, in addition to all types and descriptions of window-glass.

Bottles for everyone and for every use are to be seen in the exhibit of the United Glass Bottle Manufacturers, an interesting feature being the crystal show jars in the space occupied by Webb's Crystal Glass Co., Ltd. The combination of brilliance and attractive shape that characterises these jars reflects much credit on the company, whose works, known as the Edinburgh and Leith Flint Glass Works, are well situated for supplies af fuel and raw materials and so can supply in quantity both quickly and economically.

In the Rubber Industries Section, most of the well-known manufacturers are represented. On the stand of the North British Rubber Co., Ltd., is a selection—completeness would be almost impossible—of the company's products. Tyres jostle with belting of every sort and snakes of hose lie slimly coiled, and there are samples of many charming articles made from vulcanite. Mechanical goods of every description are shown, and there are specimens of rubber tiling, matting, mats and "paraflor" floor covering. Near by is housed the Peachey Process Co., Ltd., which is exhibiting the numerous and growing applications of the process from which the company takes its name.

In another part, the Thermal Syndicate is showing an interesting series of Vitreosil products. Vitreosil is, of course, pure silica fused by an electric process, and there seems little limit either to the forms in which it can be made or the uses to which it can be put. Gas globes, lighting bowls and many decorative articles in Vitreosil are to be found anywhere, and there are Vitreosil concentration plants for sulphuric acid, and plants for many chemical manufacturers. For the laboratory there are Vitreosil combustion and pyrometer tubes, tubes for gas analysis and ordinary tubing, plates, boats, evaporating dishes, beakers and many other indispensable articles. It is of interest to note that Vitreosil, free from bubbles and striæ, can now be obtained for optical work.

Nobel Industries, Ltd., occupy a bay that is an exhibition in itself and the huge model landscape that illustrates the usefulness of Nobel products and their influence on every day life will prove a great attraction. In addition to explosives, there are gold and aluminium paint, manufactures of non-ferrous metals, leather cloth, gas mantles, and various engineering products to show the wide range of industry covered by this important company.

The stand of Necol Industrial Collodions, Ltd., forms part of the Nobel Exhibit and furnishes an illuminating comment on the possibilities of collodion lacquers and enamels for use by the leather, furniture, metal and engineering trades. The lacquers are air-drying, water-white liquids and, like the enamels, can be applied by spraying, dipping or brushing. Other exhibits are "Necoloidine," a pure collodion for microscopy and photography, and Necol coloured and frosting lacquer for application to electric lamps.

The visitor who neglects the Section devoted to Food Products and Beverages will be indeed unwise, for there, amidst an array of toothsome biscuits, and with sauces to the right of 'em, and condensed milk to the left of 'em, is the stand of Baker, Perkins, Ltd. Those who are aware that Messrs. Baker, Perkins make machinery for the manufacture of soap and paint must not draw any hasty conclusions, for a visit to the firm's works at Peterborough would reveal drying plant, sifters, grinders, mixers, mills of all kinds, and many varieties of chemical plant either in the making or about to be dispatched. Let the doubter, with memories of certain meals, pass on, reflecting on the mysteries of Providence.

In the Scientific Instruments Section there are exhibits of all kinds of instruments, amongst which mention may be made of the balances shown by those well-known makers L. Oertling, Ltd., whose exhibit includes balances and weights, both chemical, assay and bullion, as well as hydrometers, petroleometers, saccharometers and other indispensable instruments. There is also the ingenious Otis King calculator. This calculator, shown by Messrs. Carbic, Ltd., is made in two models, one which solves any question of compound multiplication and division or problems involving both, whilst the other will solve all mathematical problems that can be solved by an ordinary slide rule and is equivalent to a slide-rule 66 in. long, but is more accurate. The instrument is simple in operation and can be carried in the pocket, as it is practically indestructible and weighs only four ounces. Full particulars are given in leaflets, to be obtained at the stand.

One approaches the different stands with varying feelings, but that of Johnson, Matthey and Co., Ltd., cannot but induce a deep sentiment of respect. Are they not the lordly people who abound in gold and silver and precious metals, while we possess neither aniseed nor cummin. Do not they work up glittering masses of platinum or gold or silver into apparatus that will reveal—let us hope accurately—all kinds of dark secrets in the laboratory or produce the most entrancing perfumes. And is it not this firm that, in a modest notice, offers to supply "Salts and Compounds of the Precious and the Rarer Base Metals," and invites inquiries. Invites inquiries! Memory recalls a small boy who wished to be an engine driver. He had not heard of Johnson Mattheys. It is well to tread lightly: the visitor is in the Jewellery Section.

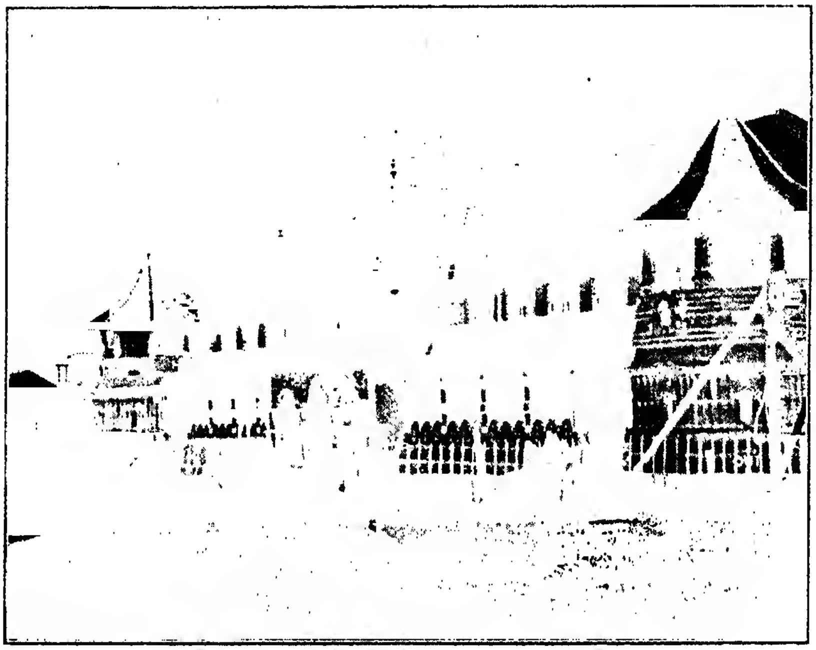
Palace of Engineering

Sheer numbers alone make it impossible even to mention all the firms exhibiting in the Palace of Engineering. An attempt, far too limited by space and time, will be made to draw attention to a few of the exhibits, with the pious hope that it will be possible to do more at a later date. The specialities at the stand of Attwater and Sons can be summarised as "insulating and packing materials" and nearly anything that could be mentioned under these heads will be found there. From india-rubber valves, sheet, washers and pipe, to belting, from mica and vulcanised fibre, to bakelite and ebonite products, all these and more are to be seen in fact or in figure at Messrs. Attwater's stand and many are sure to see them.

Sir W. H. Bailey and Co., Ltd., make a wonderful variety of plant and seem to supply with equal facility anything from a small pump to large and complicated turret clocks, though they modestly describe themselves as pump, valve, testing machinery and recording instrument makers. Some of their products on the stand include pumps, compressors, vacuum pumps for chemical works, valves, guages and recording instruments.

If any information on refrigerating and ice-making plants is required, this can be obtained at the stand of Messrs. J. and E. Hall, Ltd., of Dartford. Cooling is quite a common operation, but it is not always efficiently conducted, and there are many opportunities in the chemical industry for the installation of plant such as that supplied by this Dartford firm. The application of refrigeration is by no means confined to the storage of food materials and large plants by Messrs. Hall are already in use by some large industrial undertakings. To what extent their plant can be used can be guaged by a visit to their stand.

Messrs. David Moseley and Sons, Ltd., are exhibiting with the group organised by the Society of Motor Manufacturers and Traders, so that tyres are predominant. But there is a skeleton sample show of other manufacturers such as hose, all sorts of mechanical goods, and vulcanite tubing. Standard pumps have long been made by this firm in vulcanite and vulcanite pumps of the type made 10 years ago are still working successfully.



Ceylon

Another exhibitor in the Motor and Cycle section is Bell's United Asbestos Co., Ltd., known to readers of this *Journal* as the manufacturers of Poilite and Everite products, such as asbestos cement, sheets, whether flat or corrugated, tiles, coping ridging and other constructional materials. In the production of these materials the company uses solely standard Portland cement of British manufacture supplied by the Cement Marketing Co. The stand of this last company is to be found in the Building Materials section of the Palace of Industry.

One cannot claim any professional interest in diving tanks, but one is being used for demonstrations by Siebe, Gorman and Co., though to readers of this *Journal* they will be known as

manufacturers of air compressors with a wide range of capacity, of gas analysis apparatus, of smoke helmets, and of oxygen breathing apparatus. A trusting person will give demonstrations with a self-contained breathing apparatus in a poison gas chamber every day, and as visitors are sure to want to see this and the diving tank, they will also see the rest of Messrs. Siebe Gorman's unusual exhibit.

The "Geryk" vacuum pump is shown by the Pulsometer Engineering Co., Ltd. The interesting point about these pumps is that they are capable of evaporating at very low temperatures; thus, for instance, aqueous moisture can be evaporated at a temperature as low as 0° F., and as evaporation at low temperatures is at times of cardinal importance in various chemical operations, the exhibit is sure to attract a good deal of attention.

The Semet-Solvay and Piette Coke Oven Co. has provided an exhibit which consists of a half-size model of a "Piette" vertical flue oven in silica construction and a model of a modified type of the same oven that may be heated either by producer, blast-furnace, or coke-oven gas, to meet varying demands for surplus gas. There are also two small models of the Standard Semet-Solvay regenerative oven with a number of photographs and drawings of plants built by the firm and its associates.

A friendly cynic said that the best way to find the Palace of Engineering was to follow the Scotch accent. It is true that there are many Scotch exhibitors, and as they long have had a reputation for sound work, one is not surprised to find this in evidence on the stand of Pott, Cassels and Williamson, of Motherwell. One of their specialities is the manufacture of all sorts, types and sizes of centrifugal drying machines, and if more information is wanted, why not visit the stand?

A heavy responsibility weighs on those who manufacture containers that have to withstand pressure and it is surprising that one so seldom hears of accidents due to steel gas bottles and cylinders, used to store a large number of industrial gases, whether compressed air, oxygen, acetylene, nitrous oxide or other gases. Those who control the destinies of the stand of Stewarts and Lloyds, Ltd., of Glasgow, do not seem in any way nervous and offer one an assortment of tubes and fittings for all purposes whether under pressure or not, or gas cylinders full of dangerous gases with as little concern as they provide steel plates and castings or zinc sheets. One cannot but admire this certainty.

Diogenes lived in a tub, so memories of childhood suggest, but he can't have had one made by Messrs. P. D. Mitchell, Ltd., of Dundee. No doubt this firm could provide a suitable barrel for tired and morose journalists, for, according to a polite gentleman, overflowing with information, they can furnish steel containers, kegs, drums and barrels of every description with wonderful patent weldings. Alas, such are beyond the dreams of journalists. . . . but, in any case, think of the English climate!

The Glenboig Union Fireclay Co., Ltd., show a variety of their fire-clay goods and furnish particulars of their different products with advice on how to choose products for use under particular conditions. This firm has the twin advantages of being of old standing and of having at command the best technical assistance, reasons why their products have gained so many awards at home as well as international exhibitions.

Of course, the Mond Nickel Co., Ltd., has a stand in the Palace of Engineering and like this company's other stand in the Chemical Section, it is well worth a visit, the exhibits being of much interest.

It is evident that electrical power is being increasingly used in industry and it is of interest to call attention to the stand of Messrs. Allen, West and Co., a firm which has specialised on the various types of control gear for every kind of electrical control required in chemical works, dye works, and other factories. Particulars of starters, switch gear, resistances, and controllers made by this firm can be obtained at their stand.

The Cambridge and Paul Scientific Instrument Co., though exhibiting in the electrical section of the Palace of Engineering, has numerous other exhibits on other stands in the same building—the exhibits including thermographs, distance thermometers, thread recorders, pyrometers—whilst in the Palace of Industry, there is a thread recorder measuring furnace temperatures in the scientific exhibit, an automatic temperature control outfit on an electric furnace shown by Baird and Tatlock, index thermometers in the working bakery shown by Baker, Perkins, Ltd., and there are other exhibits in other pavilions.

* * *

Thus concludes this hasty and incomplete account of many exhibits of interest to readers of this *Journal*. Omissions are many, but it is hoped to repair these and other errors by articles that will appear in later issues, describing groups of exhibits in detail.

FLUXES AND SLAGS IN METAL MELTING AND WORKING

A general discussion on this subject is to be held on Monday, April 28, by the Faraday Society and the Institute of Metals with the co-operation of the British Non-Ferrous Metals Research Association and the Institute of British Foundrymen. The meeting will be held from 3 to 7 p.m., with an interval for tea, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 1. A general introduction will be given by Prof. C. H. Desch, and there is a programme of some fourteen papers intended to initiate discussion on the various aspects of the subject. The papers deal primarily with the uses of fluxes and slags in the smelting and refining of the non-ferrous metals, but there will be one section dealing with fluxing problems in arc and oxy-acetylene welding. The subject of slag inclusions will also be dealt with. A copy of the complete programme may be obtained from the Secretary of the Faraday Society, 10 Essex Street, London, W.C. 2.

THE FERMENTATION OF CACAO

By A. W. KNAPP, B.Sc.

(*Continued*)

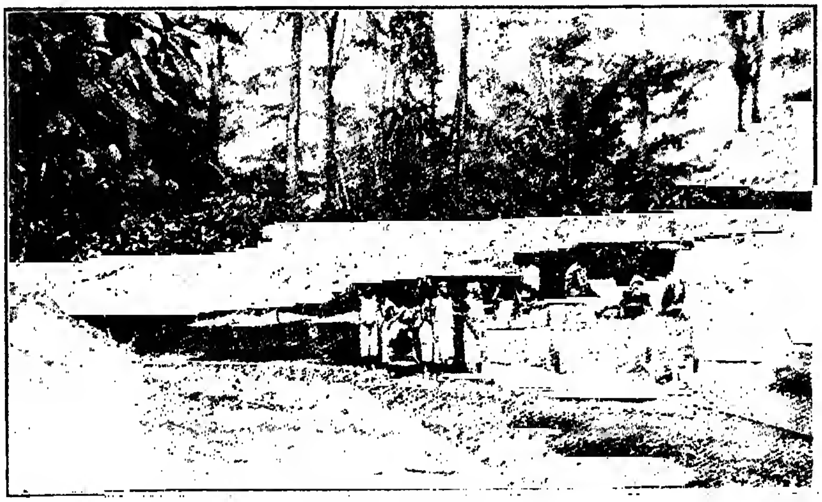
Changes in the Interior of the Bean

Under the skin of the bean there is a soft membrane, the perisperm. The part of this membrane which is on the outside of the cotyledons consists of long polygonal cells up to 60μ in length. The continuation of this membrane between the folds of the cotyledons has a more indefinite structure. On fermentation this membrane gradually loses its structure and in some places disappears entirely. This is in accord with observations of the cacao bean of commerce. Everyone has noted in the rooms in which roasted cacao beans are broken up, that pieces of thin transparent skin, known as "beeswing," float about the room. This is the perisperm, and on examining fermented cacao beans one can usually only discover it at places where it would be at its thickest. Attached to this membrane, on the outside only of the cotyledons, and not in the folds, is the epidermis of the cotyledon, which, in the raw beans, consists of polygonal cells about 20μ in diameter. These cells each contain about nine little angular granules which are about three-quarters the size of the cacao starch, and which stain brown with iodine. These may be aleurone grains. This epidermis appears to be little affected by fermentation.

As the manufacturer only has use for the inside of the bean, and not for the shell, with its small amount of adherent pulp, it is with the changes in the cotyledons that he is mainly concerned.

The cotyledons of the fresh bean as taken from the pod contain about 33 per cent. of water and 37 per cent. of the hard fat, cacao butter. The principal other substances present are starch, albuminoids, tannins, fibre and theobromine.

The microscopical appearance of a section of the fresh Forastero bean is highly characteristic, the most striking feature being that 10–20 per cent. of the cells are full of a violet pigment. The ordinary cells contain starch and fat, but I was unable to find these in the pigment cells; possibly their presence was concealed by the pigment. Where the section has been exposed to the air certain of the cells, which do not contain violet pigment, become brown. If the beans are merely dried, the patches of violet pigment are unchanged, save that driving off the water causes the colour to be deeper and more blue. The curious misty slate colour of a section of an unfermented bean is solely due to the violet dots on a white or brownish background. Examination with a hand lens will readily reveal the pigment.



Transporting cacao-beans from the plantation to the fermentary, San Thomé

Fig. 1

In the fermentation of Forastero cacao as practised in Trinidad, the interior of the bean shows practically no change for the first 48 hours. In a very short time, when the beans have been fermenting about 60 hours, a remarkable change takes place. The isolated pigment patches disappear, and the pigment is evenly diffused throughout the bean. The juice of the cotyledons, formerly neutral, is now acid to litmus, and this acidity changes the violet pigment from blue-violet to red-violet. Even the white germ becomes tinted red-violet. At the same time the interstices in the bean become full of a gummy brown, or brownish-purple, liquid. This liquid I found to contain a multitude of orange-coloured spheres, much smaller than starch grains. They look like cacao butter globules, but do not readily dissolve in petrol.

The temperature at which this rapid and striking change takes place is from 44° C. to 47° C. This is the temperature at which the cacao seed is killed,

and at which, therefore, it becomes possible for the various substances in the bean to come in contact and react. By this time the pulp is acid with acetic acid, and as the skin during fermentation becomes permeable it is reasonable to assume that this acid passes into the bean, and assists in the chemical changes. I have never seen micro-organisms inside the bean. There remains to consider if enzymes assist in the reactions.

The Presence of Enzymes

The following enzymes were found by Brill[7] in cacao beans and pulp :

Enzymes in Cacao Beans

	Pulp	Beans (fresh)	Beans (fermented)
Casease ..	+ ..	+ ..	+
Oxidase ..	++ ..	++ ..	+
Raffinase ..	+++ ..	[illegible] ..	++
Protease ..	+ ..	..	+
Invertase ..	++ ..	– ..	+
Diastase ..	..	..	++

Besides the above, Brill[8] also found an emulsin-like enzyme in the fresh bean (thus corroborating J. Sack.)[9] He showed that lipase, albuminase, inulase, maltase and reductase were always absent. It is curious that he does not mention peroxidase. In testing the dried beans at Bournville we have not found oxydase ; possibly it is destroyed by the temperature of drying or by the absence of water. We find, however, that dried, unfermented beans from Trinidad and Accra contain peroxidase, unless they have been steamed. It would appear that the protease and invertase in the bean come from the pulp. Diastase is developed in the bean during fermentation, and probably aids the production of the dextrin-like liquid in the bean. It should be noted that in correct fermentation of cacao there is not the slightest sign of germination, and that therefore any observed changes are not due to germination but to the action of the enzymes which is made possible by the killing of the seed by heat, possibly assisted by acetic acid. It has sometimes been suggested that the objects of fermentation are to kill the bean and ensure a stable product. But the bean is killed by merely drying in the tropical sunshine, and, contrary to the opinions of many planters and brokers, the unfermented bean, if dry, is perfectly stable, shows not the slightest inclination either to germinate or ferment, and will remain quite unchanged for years.

Oxidation of the Tannins

A very important change which occurs on fermentation and drying is the change of Criollo beans from white to brown, and of Forastero beans from purple to brown or purplish-brown. It is generally agreed that both contain substances generally called "tannins," which, in the presence of an oxidase, go brown. The Criollo beans contain a colourless tannin, and, in my opinion, the Forastero beans contain the same colourless tannin and also the purple pigment, which is a tannin or compound of tannin. With the juice of the fresh undried Forastero bean, whether unfermented or fermented, one obtains a deep blue with ferric sulphate. If oxidation is first allowed to occur, the colour obtained is olive green.

Criollo beans only require two days to ferment. In 24 hours they are several degrees hotter than the Forastero under the same conditions, but as they are frequently only fermented 36 hours, one must conclude that a temperature of 35° C. kills the Criollo bean and liberates the oxidase. Fickendey definitely states, on the contrary, that the devitalising temperature is 5° C. to 10° C. higher than for Forastero. The skin is thinner and therefore probably more easily penetrated by the acid juice of the pulp.

The development of the brown colour is easily seen by cutting through a fresh bean and exposing the cut surface to the air. The change in colour, however, does not readily occur throughout the bean unless it has been killed, whether by high temperatures, as in fermentation, or by freezing (as shown by Fickendey). Further, oxidation by the air cannot occur in a bean containing only 5 per cent. of moisture, although Schulte im Hofe[4] has shown that it occurs in beans containing 15 per cent.

The cacao tannins are soluble in water, but the brown oxidation products are insoluble. It has been suggested that it is the oxidation product of the tannin which gives the characteristic aroma of cocoa and chocolate, but both Sack[9] and Caspari[6] have shown that these coloured bodies are tasteless and without aroma. The action of heat on the oxidised tannins is responsible for the fine chocolate colour of roasted cacao beans, and as the tannins (particularly the purple variety) are unpleasantly astringent in flavour, the greater the oxidation the more the astringency is removed. It would probably be unwise to carry this oxidation process to completion, because the product would then be flat and insipid. The ordinary fermentation and drying appear to allow of sufficient oxidation to give a satisfactory product. The greater the amount of purple tannin the bean contains, the more astringent is the finished product.

Fickendey has shown that carbon dioxide is produced when cacao beans are oxidised. This brings the action in line with the discovery of Bertrand,[13] that the oxidation of tannin and pyrogallol in presence of an oxidase is always attended by liberation of carbon dioxide. It is interesting to compare two of Bertrand's results with that of Fickendey :—

	Oxygen absorbed c.cs.	Carbon dioxide disengaged c.cs.
Bertrand (1) ..	23·3 ..	13·7
(2) ..	29·8 ..	16·4
Fickendey	9·0 ..	4·5

It is a recognised effect of the fermentation of cacao, that the beans become plumper after 5 days fermentation. In my experience such beans are full of liquid and there is no evidence of the presence of any gas. But if oxygen can pass in, then carbon dioxide can readily pass out. Not all botanic varieties "plump up" at the same time. Thus, in one experiment in which Trinidad Criollo and Trinidad Calabacillo were fermented under identical temperature conditions, in five days the Criollo beans were a

much darker brown externally and were as round as eggs, while the Calabacillo were fairly flat.

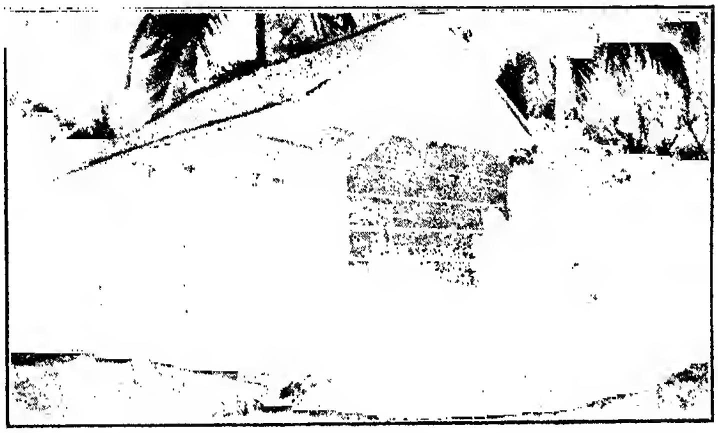
The question of the distribution of the theobromine during fermentation is dealt with in a paper by R. V. Wadsworth and the author.[10]

Drying the Beans

The development of the brown colour continues during the drying. If the beans are heaped on the drying platforms some exothermic action takes place. Thus, after seven days fermentation in a box and one day's exposure to the sun on a tray, some beans were heaped 18 in. high and covered with banana leaves. On the following morning their temperature was 42° C. It is hard to believe that this was due to the continued fermentation of the exhausted pulp, and suggests that the heat was produced by oxidation inside the bean. It is possible that this is a factor in the high temperatures maintained in cacao fermentation.

Fickendey has shown that the oxidase in cacao is destroyed at 75° C. It will be evident, therefore, that it is advisable not to exceed this temperature in the early stages of drying, as may happen when using artificial means. Moulds seldom appear in the fermenting boxes, unless the temperature falls below 34° C., although it is difficult to understand why they do not thrive there. When the beans are put on to the drying platforms mould growth is always liable to occur, and the risk of the cacao becoming mouldy is one of the planter's chief troubles. The help of the bio-chemist is needed here. Hudson[5] recommends that the drying platforms should be covered with sheet copper. This might prevent mould growth, but there would be some risk of the acetic acid in the beans taking up the copper.

Besides the brown colour, a crisp "break" and the presence of air spaces are recognised characters of fermented cacao. There is an appreciable increase in the percentage of mucilage, gum and pectin found in the bean after fermentation, and it may be that the drying of these to brittle solids accounts for the fact that while the unfermented beans when dried have a cheesy consistency, the fermented beans are crisp. The skin of the fermented bean has been expanded, and the cotyledons partially separated by the fermentation, so that on drying the shell remains more or less free and the bean appears open-grained. Although the shell has become permeable to liquids, fermentation actually renders it, on drying, tougher and harder, and less likely to be attacked by insects. The removal of the sugars from the pulp and the saturation of the shell with pectin may account for this.



Small boxes for fermentation of cacao, Trinidad. Note ventilation at top

Fig. 2

Other Methods than Fermentation

Fickendey[12] has suggested that the bean should be killed by freezing, and the pulp removed by washing. In Perrot's[11] opinion fermentation is detrimental, and the beans should be steamed and the pulp removed by dilute alkali. I have tried both these methods on Trinidad cacao, but, apart from the fact that they are more costly than fermentation, they do not produce so good a product. In particular, the characteristic chocolate aroma is lacking in the roasted bean. This raises the question as to whether the pulp is necessary to obtain all the beneficial changes. Below are notes on some experiments I made to determine this :—

Experiments on Skinned Beans

1. *In Dry Air.*—Several pods, unripe, ripe and over-ripe of the Forastero Amelonado type were taken. The beans, deprived of pulp and skin, were maintained at 45° C.—50° C. in a closed space, air being admitted from time to time. After one day the beans became brownish outside, and developed a faint acid and malt-like odour. After two days beans became brown in parts throughout, pigment cells broken down in places, and colour distributed. Acid and malt-like odour. After three days the radicle (or germ) became brown. After three days' drying

the cotyledons were brown, but only changed in parts.

On roasting the beans were only slightly better than unfermented cacao in colour, odour and taste. As these beans tended to dry up during the experiment, and moisture is evidently necessary for fermentation, the following test was tried:—

2. *In Moist Air.*—Similar beans to those above were carefully skinned and maintained at 45°—50° C. in a vessel partially closed with a plug of moistened cotton wool. After two days the beans were darker and browner; the odour was malt-like, and the greater portion of the bean was brown, and most of the pigment evenly distributed. The appearance was that of partially fermented beans, but the odour was different.

3. *Surrounded by Wet Cotton Wool.*—Beans as above after one day, 40°—43° C., and one day, 43°—47° C., began to germinate. (Beans with pulp removed, but skin left on, acted in the same manner.)

4. *Surrounded by Cotton Wool Moistened with 2 per cent. Acetic Acid.*—In one day at 40°—43° C. the beans became very much paler in colour, the whole of the pigment being evenly distributed: the appearance was very like that of ordinary beans after correct fermentation for three days. (Beans with the pulp removed, but with skin left on, acted in the same manner.) These beans on roasting, though excellent in colour, had not the full cocoa aroma and flavour.

The above experiments show that the colour changes usually associated with fermentation can be obtained without the help of the pulp. The product, however, has not the full cocoa aroma. It is evident that the cotyledons themselves contain the oxidase necessary to bring about the colour change from purple to brown. The development of the malt-like odour suggests the presence of diastase. The experiment with acetic acid indicates that the acidity of the pulp plays an important part—it helps to kill the bean, rapidly penetrates the skin of the bean, and aids in the distribution of the colour throughout the cotyledons. The acid changes the colour from blue-purple to red-purple.

The Odour

It should be first mentioned that the characteristic odour of chocolate is not present in the raw bean, but is only produced on roasting. It is absent in the roasted unfermented bean. So far, in experiments made in imitation of fermentation, I have never observed a case where the true chocolate aroma was produced. For example, the experiment mentioned above indicates that treatment with acetic acid does not produce the correct bodies. It may be that enzymes existing in the seed produce the desired change.

The only information we have as to the composition of the essential oil of cacao is supplied by Bainbridge and Davies[6]. By steam distillation of the roasted Arriba cacao of Ecuador they obtained 0·001 per cent. of an oil, about half of which was *d*-linalool, and the remainder mainly amyl propionate, amyl acetate, amyl butyrate, and linalyl acetate. It would be a most useful research to repeat their valuable work on, say, Accra cacao or Trinidad cacoa, because Arriba cacao is different from all other cacaos in its aroma, which is strong and reminiscent of oil of coriander, and because it always consists of a mixture of fermented and unfermented cacao, usually containing 30—40 per cent. of the latter.

Assuming that the essential oil they obtained gives to ordinary roasted cacao its characteristic odour, one can account for the esters by possible reactions in the pulp, but so far no one has suggested the nature of the substance in the bean which is produced during the fermentation, and which *on heating to* 130° C. gives *d*-linalool.

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[11] E. Perrot, *Comptes Rendus Acad. Sci.*, 1913, **156**, 1394.
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[13] Bertrand, *Comp. Rend. Acad. Sci.*, 1895, **120**, 266.

BORIC OXIDE AS A CONSTITUENT OF GLASS

The durability of glass is important whether the glass be used in the home, in the laboratory, or in industry, and perhaps one of the chief factors which contribute towards durability is the content of boric oxide. Indeed, the use of boric oxide in the production of glasses of low expansibility and high durability is one of the most notable recent advances in glass technology. It is thus of considerable interest to record the appearance of a brochure in which the influence of boric oxide as a constituent of glass is discussed and the properties of boric oxide glasses indicated. The brochure (pp. 47) contains a short introduction, followed by a full description of a series of physical and chemical tests on laboratory ware, ending with a summary of the results showing the resistance to various agents—physical and chemical—imparted by varying contents of boric oxide. In conclusion, notes are given showing the use of boric oxide in improving the durability of table glassware and in the production of glass for electric insulators and there is a bibliography of recent papers on borate glasses. In an introduction Prof. W. E. S. Turner vouches for the impartiality of the discussion, which is presented in such a way as to be intelligible to both glassworker and chemist, and points out that the properties of borate glasses deserve to be more widely known to glass manufacturers. One cannot but compliment Messrs. Borax Consolidated, Ltd., on their enterprise in publishing such a useful summary of an important subject and on their willingness to supply copies to those interested.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

In accordance with the provisions of by-law 68 notice is hereby given that the Annual General Meeting of the Society of Chemical Industry will be held in the Arts Theatre, The University, Liverpool. on Wednesday, July 9, 1924, at 11 a.m.

A preliminary programme appears on this page.

In accordance with the provisions of by-law 23 intimation is hereby given that the following members of Council retire from their respective offices at the forthcoming Annual General Meeting: Dr. E. F. Armstrong, F.R.S., *President*; Mr. Julian L. Baker, Mr. C. S. Garland, Sir Max Muspratt, Bart., and Sir Wm. J. Pope, K.B.E., *Vice-Presidents*; Mr. John Allan, Prof. J. W. Hinchley, Dr. J. H. Paterson, and Mr. W. J. U. Woolcock, C.B.E., *Ordinary Members*.

Mr. W. J. U. Woolcock, C.B.E., has been nominated for election to the office of President under by-law 19; Dr. E. F. Armstrong, F.R.S., Prof. J. W. Hinchley, Prof. J. C. Philip, F.R.S., and Sir Richard Threlfall, K.B.E., F.R.S., have been nominated Vice-Presidents under by-law 20.

Mr. E. V. Evans has been re-elected Hon. Treasurer, and Sir Wm. J. Pope, K.B.E., has been re-elected Hon. Foreign Secretary.

Members are requested to nominate, on or before May 9 next, fit and proper persons to fill the four vacancies among the Ordinary Members of Council. Forms for this purpose can be obtained from the General Secretary of the Society.

By-law 22.—An Ordinary Member of Council shall be nominated by five or more members upon Form B in the Schedule, a copy of which form shall be furnished by the General Secretary upon the written or verbal request of any member, but a member shall not be eligible to sign more than one such nomination form, and the member nominated shall sign the declaration set forth on the form.

A nomination shall be declared invalid by the Council if :—

(*a*) The member thereon nominated is disqualified for election, or ineligible to be elected, as provided by the by-laws.

(*b*) The nomination is not made on the authorised printed form, or substantially not in the manner directed thereon.

(*c*) The nomination form is signed by less than five members not disqualified or not ineligible to nominate as provided by the by-laws.

(*d*) The nomination form is not received before or upon the day appointed therefor.

(*e*) The member nominated has not signed the declaration printed upon the form.

A member whose nomination aforesaid is declared to be invalid shall receive notice thereof from the General Secretary, and shall not be submitted for election.

J. P. Longstaff,
General Secretary

The following is a Preliminary Programme of the meetings to be held in Liverpool on July 9-12 inclusive.

Wednesday, July 9.—*Morning*: Council Meeting. Annual General Meeting in the Arts Theatre, the University. Presidential Address by E. Frankland Armstrong, D.Sc., F.R.S.; *Afternoon*: Business Session in the University. Visit to White Star Liner "Cedric," and tea on board by invitation of the White Star Line. *Evening*: Reception and Dance at the Town Hall by invitation of the Right Hon. The Lord Mayor of Liverpool (Arnold Rushton, Esq.).

Thursday, July 10.—*Morning*: Messel Memorial Lecture by the Right Hon. Viscount Leverhulme, in the Arts Theatre, the University, and presentation to the Lecturer of the Society's Messel Medal for 1924. Visit to the works of Messrs. Joseph Crosfield & Sons, Ltd., Warrington. Luncheon by invitation of the Directors. *Afternoon*: Inspection of the Works. *Evening*: Annual Dinner of the Society at the Midland Adelphi Hotel.

Friday, July 11. *Morning*: Business Session in the University. Luncheon at the Midland Adelphi Hotel, by invitation of the Chairman and Directors of the United Alkali Co., Ltd. Visit to a Works of the United Alkali Co., Ltd. *Evening*: Dinner at Lady Lever Art Gallery by invitation of the Chairman and Directors of Messrs. Lever Brothers, Ltd.

Saturday, July 12.—Visit to Lake Vyrnwy. Inspection of Liverpool Corporation Water Works.

A detailed programme will be sent later to every member of the Society.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

OTTAWA SECTION

A meeting was held in the University Club on March 13, and after minutes of the last meeting had been read and approved, notes on current literature were given by Mr. Connor, who referred to and showed a sample of a new drier—magnesium perchlorate tri-hydrate—which he said was very satisfactory. Dr. Shutt referred to the 11th edition of "Bloxam's Chemistry," and Dr. Macintyre referred to a book on "Clouds and Smokes," by Dr. Gibbs, and described the preparation of synthol by Fischer and Tropsch, which was recently referred to in the Ottawa Press. Mr. Elworthy called attention to the fact that a commercial plant had been erected in Germany for the synthetic manufacture of methyl alcohol.

Mr. Hambly called attention to a recent action of the Commissioner of Patents, which meant that applications for chemical and metallurgical patents would not be examined by a trained chemist. A committee, consisting of Mr. Lathe, Convenor, Mr.

Stewart and Mr. Hambly, were appointed to deal with the matter.

Mr. M. F. Connor then read a paper on the Investigation of Standard Methods of Analysis. In opening his address Mr. Connor stated that chemists owed a very great debt of gratitude to Dr. Hillebrand for the very valuable work he had done on Rock Analysis. A very interesting discussion followed the address, Mr. Stewart, Dr. Macintyre, Dr. Shutt, Mr. Hambly, Mr. Dick and Mr. Robinson taking part therein.

The meeting adjourned at 10.30, and light refreshments were served.

MANCHESTER SECTION

In the account of the annual meeting on April 4 published in the issue of April 11, p. 406, it was stated that "The whole of the committee and officers of the Section were re-elected, there being no occasion for a ballot." This sentence should have read as follows: "As only one nominee for membership of committee was received, the committee, acting according to rule 10 of the Section rules, made additional nominations to fill the vacancies and a ballot was therefore unnecessary. The new ordinary members of committee were Messrs. R. H. Clayton, F. S. Choale, J. R. Hannay, D. M. Paul, J. P. Shenton, F. N. Terleski, and Dr. Schedler."

THE SOCIETY OF DYERS AND COLOURISTS

The annual meeting of the Manchester Section of the Society of Dyers and Colourists was held on April 11, Mr. William Marshall in the chair. The hon. secretary (Mr. L. Thompson) presented his report for the session, stating that the membership of the section is now 407 as compared with 420 last year, being 282 members, 59 associates and 66 junior members for the present year, the comparative numbers for the previous year being 293 members and 135 junior members. There were five vacancies on the committee with six nominations, a ballot therefore being necessary. Messrs. Price and Burr were appointed scrutineers of the ballot papers, and, when they were collected, it was found there was a tie between two of the nominees. A second ballot was then taken, and the following gentlemen were declared elected to fill the vacancies. Messrs. Alfred Edge, S. H. Higgins, William Marshall, W. H. Pennington and L. Thompson. This concluded the business of the annual meeting.

The ordinary monthly meeting, being the last of the session, was then held. A paper entitled "The Identification of Insoluble Azo Colours on the Fibre, and of Azo Pigments in Substance," by Dr. F. M. Rowe and Miss C. Levin, M.Sc.Tech., was read by Dr. Rowe.

Dr. Rowe first reviewed the available methods for identifying azo compounds by reduction with acid stannous chloride, hydrosulphite in neutral or alkaline solution, etc., or by oxidation with fuming nitric acid, etc. Many azo pigment colours were derived from diazotised amino-compounds containing nitro groups, and in such cases treatment with fuming nitric acid afforded the most convenient means for the identification of this portion of the molecule, particularly when only a small quantity of the product was available. This led to the formation of a diazonium nitrate, but it was not clear from the literature whether this reaction was ever accompanied by the introduction of nitro groups into this residue, and if so in what cases. A series of azo derivatives of β-naphthol, therefore, was submitted to this reaction. When the diazotised amine used in the preparation of the azo compound did not contain a nitro group, a nitro derivative of the diazonium nitrate was always obtained. This nitro group usually entered the p-position with respect to the diazonium group when free, or entered the o-position when the p-position was already occupied. When a nitro group was present in the m- or p-position, the unaltered diazonium nitrate was obtained, but when only a nitro group was present in the o-position, a second nitro group was introduced in the m-position with respect to the first. Consequently, it was necessary to take these results into consideration when using this method for the examination of an aryl-azo-β-naphthol.

The diazonium compounds were identified by coupling one-half with beta-naphthol and one-half with β-hydroxynaphthoic acid anilide, crystallising the products and determining their melting points. Owing to the ease with which such compounds are prepared in a pure condition and the wide variation in melting points, this method was recommended for the identification of primary aromatic amines when only a small quantity is available. For this purpose, a table of melting points has been compiled comprising about 150 azo compounds derived from a variety of diazotised amines coupled with β-naphthol and various arylides of β-hydroxynaphthoic acid.

In view of the growing importance of insoluble azo colours on cotton, the extension of the number of bases and the variety of so-called naphthols now on the market, a method has also been devised for the absolute identification of such compounds on the fibre by means of this table of melting points. A pattern of the coloured calico about 2 in. square is washed with dilute ammonia and soap, dried and dissolved in diluted sulphuric acid (80 c.c acid and 20 c.c. water) at 10° C. The clear solution is poured on to ice, the precipitated colouring matter tiltered, crystallised, and its melting point determined.

Finally the means used for the determination of the constitution of Griesheim-Elektron's Naphthol AS-BO, naphthol AS-BS, naphthol AS-G, naphthol AS-RL, naphthol AS-SW, fast black LB base, fast red RL base, fast yellow G base and eight members of the series of rapid fast printing colours, were described.

Dr. R. E. Stradling, M.C., M.Sc., Ph.D., Assoc. M.Inst.C.E., Head of the Department of Civil Engineering, Architecture and Building in the Technical College, Bradford, has been appointed Director of Research of the Building Materials and Construction Research Board under the Department of Scientific and Industrial Research.

CORRESPONDENCE

ATOMIC STRUCTURE

Sir,—In my article on "Atomic Structure" in the issue of March 28, I stated that Bohr, to explain certain spectral anomalies, had resorted to "dividing elliptical orbits into two types *a* and *b*, such that electron transitions only occur from *a* to *b* or *b* to *a*, but never from *a* to *a* nor from *b* to *b*." This too brief statement fails to indicate the distinction between X-ray and optical spectra, *a* to *a* and *b* to *b* transitions not being excluded for optical spectra. It must be remarked that this subdividing device is as incompetent to account for the sodium yellow line doublet as Bohr's original theory, for, if both the "principal" series (3_2) lines and the "sharp" series (3_1) lines are doublets, as demanded by the *ab* device, the 3_2—3_1 transition ought to give rise to a *quartet*, not a doublet for the yellow line. It is possible, however, that the frequency separation of the observed doublet is a measure of the energy difference between the two types of 3_2 orbits, and the finite frequency width of each component of the doublet is a measure of the energy difference of the two 3_1 orbits, each component of the doublet being made up of two overlapping lines of the real quartet.

Bohr has so far not succeeded in attaching any physical significance to the orbits to which the *ab* distinction applies, though he has recently introduced a third quantum number to differentiate between the types, but this number appears to express no more than the *ab* notation. I hope at an early date to be able to indicate the physical difference between the forms of the *a* and *b* types or orbit having the same azimuthal quantum number, and to assign to them a third quantum number not identical with Bohr's third quantum number, and to show that the slight difference in energy of the two types is due to the difference in the third or subsidiary azimuthal quantum number. The form of these orbits was suggested by a point arising in my last article, in which it was inferred that the three 3_2 electrons in a chromic co-ordination compound could be assigned a symmetry little if at all inferior to that of four 3_2 electrons in a corresponding chromous compounds, if the orbits diverged only slightly from circular orbits. Consideration of the possible types of orbit having axial symmetry led to the conclusion that orbits having only axial symmetry were as probable as elliptical orbits having biaxial symmetry, and that elliptical orbits generally could not be orbits in a plane but orbits on an ellipsoid of revolution, relativistic precession, due to transverse mass, being still due to a velocity component at right angles, but also at right angles to the instantaneous orbital plane, the electron thus describing an orbit on a surface of revolution about a fixed major axis. This fixation of the major axis in an atom and the necessity for orbital precession in a small radial domain of the atom removes what has been hitherto probably the chief obstacle in the way of shared electrons in chemical fixed bonds being conceived as moving in orbits common to both atoms, such orbits being impossible with electrons having Sommerfeld-Bohr orbital precession in the orbital plane. The essential difference from the latter theory is that the perihelion of an orbit is fixed in space, and that the "inner loops" of the orbits are described spirally between perihelion and the region near the circular plane containing the rotating latus rectum of the orbit. This spatial form of orbit obviously allows for the facts of chemical double and treble bonds, and indicates a reason for their progressive instability, due to the mutual repulsions of two or more electrons moving in similar orbits oriented at various angles of the common surface of the "oval" of revolution.—I am, Sir, etc., J. D. MAIN SMITH

Chemistry Department,
Birmingham University
April 19, 1924

AN INTERNATIONAL LANGUAGE FOR SCIENCE ABSTRACTS

Sir,—The article by Prof. J. S. Patterson in *Chemistry and Industry* for April 11 again calls attention to a most promising avenue of escape from the language difficulty, an avenue which has been surveyed by various writers from different points of view. In particular, the writer, with H. C. Prideaux, in 1918 made a detailed examination of the pros and cons, and offered many suggestions as to the way in which Latin could be made to subserve the needs of chemistry. A few extracts may not be out of place, since the article in question (*Science Progress*, 1918-1919, **13**, 447) would probably have gained a wider publicity had *Chemistry and Industry* in its present form been available as a medium of publication. In the first place, the question of choosing an international language for chemistry cannot be dissociated from the wider one of an international language for science. In the next place it is evident that the official adoption of Latin as an international language for science abstracts and other communications might well precede its adoption as a "lingua franca" for scientists and the intelligentsia generally—a position which Latin only lost a few centuries ago, but which it does not seem likely to regain. The former use, however, seems to lie within the sphere of practical politics. Other effective rivals are English or one of the synthetic languages. The controversy between Esperanto and Ido seems to rule out the adoption of either. These are colourless languages, whereas Latin is rich in associations to educated Europeans and Americans. "The suitability of Latin as a medium for expressing the ideas of most sciences in their early stages may be abundantly illustrated, *e.g.*, from the works of Copernicus, Newton, Leibnitz, the two Bacons, Linnaeus, Harvey, Gilbert and Napier. As was remarked by Prof. F. Granger in the *Times Literary Supplement* (1918) 'Science in the pages of Descartes and Newton moved easily in a Latin dress, the materials of which were derived from a still spoken but un-Ciceronian tongue.'" A simplified Latin, more akin to that of the Vulgate than to that of Cicero is required. For chemists there is a precedent still lingering in the Latin of the pharmacopœia.

Certain reforms of nomenclature, needed for consistency or elegance, would be undertaken. Thus a revision of the terminations of the elements was suggested. The uniform adoption of "-um" for metals, and a rationing of this termination as applied to other substances in pharmacology; the use of "a" for all oxides of metals. The use of "on" for non-metals including "helion" would probably not be made quite uniform, but another class including phosphorus, oxygen, etc., would be recognised.

Finally, two parallel passages were almost literally translated into simple Latin in order to show how easily such could be readily understood by anyone who had retained traces of an ordinary school education.

The use of Latin would be taken as a compliment by Italy and be acceptable to all Romance countries, including the great South American Republics.

A standardised Latin could hardly fail to improve on any modern language in consistency, clearness, and precision. It would provide an incentive for the settlement of the confusion that prevails at present in the use of the prefixes mono-, uni-, etc., interchangeably; and generally for the expunging of the solecisms which abound in scientific literature, and which somewhat detract from the complete literary culture which should, and could, be characteristic of the utterances of a precise science.

Finally, it might lead to the definition and differentiation of words like "potential" in the interests of the several sciences which employ them, and to the free coinage of new words which are badly wanted on sound lines. The founders of our science being for the most part "free of their Latin" were able to coin words which were in the spirit of the language. We have almost lost this power, and hence are suffering from a severe "currency deflation."—I am, Sir, etc., E. B. R. Prideaux

University College,
Nottingham
April 16, 1924

QUALIFIED AND UNQUALIFIED CHEMISTS

Sir,—The criticisms levelled at the Institute of Chemistry by your correspondent "Iron" would appear to be unreasonable. The Institute was founded as long ago as 1877, receiving its charter in 1885, and anyone entering the profession of chemistry, without taking the trouble to acquaint himself with its regulations or to qualify for its examinations, has surely only himself to blame if he has difficulty in obtaining admission. For the Institute to open its doors to any applicant without evidence of qualification, as your correspondent suggests, would make the Associate diploma of the Institute of small value as a professional qualification.

The idea that chemists outside the Institute could form an opposing society and say that they only were qualified chemists is fallacious. They would possess no charter. In this connexion, however, I would suggest that the Institute, in order to protect itself and its members from the effects of the formation of such opposing societies, which can but have the effect of disintegrating the profession as a whole, should take steps to obtain powers under its charter to confer on its members the right to the distinctive title of Chartered Chemist. This would not only bring the Institute of Chemistry into line with other professional bodies, such as the Institute of Chartered Accountants, the Chartered Institute of Patent Agents, etc., but would also serve, to some extent at any rate, to distinguish a chemist from a pharmacist. The Institute of Civil Engineers, in this manner, has recently obtained for its Associate members and members the right to the title Chartered Civil Engineer, in order to distinguish the qualified engineer from the large number of unqualified persons calling themselves engineers.

The suggestion contained in Prof. Snell's letter is surely a joke. Would the professor, if asked his occupation, reply, "I am a chemor and I practise chemorry"?—I am, Sir, etc.,

John S. Bousfield

Cambridge
April 16

HYDROGENATION FLAVOUR

Sir,—I have just received a new publication on "Fats, Natural and Synthetic," by Dr. Myddleton and Mr. Barry.

It seems that writing books is a very pleasant sporting occupation, where the subject is the "game" and the sportsmen are the authors. The manner in which the game tries to seek shelter in the bush is very interesting. Were it not for the peculiar "odour" which it exudes it would have passed off as a piece of very clever work. I wish your readers to compare pages 788–789 and 790 of the August 17 issue of this journal with pages 94 and 95 of this original publication. Perhaps the authors will have something to say regarding their practice in précis writing.—I am, Sir, &c.,

Labor Omnia Vincit

THE DEPILATION OF SKINS

Sir,—If Dr. Ross will be good enough to read my paper a third time, he will find that he has not only failed to understand the elementary part of it, but has also misquoted me.

I shall not call on Heaven to support me, but would like to tell Dr. Ross that I have boiled solutions of gelatin on many occasions, but have never observed any coagulation; it is quite evident that there must have been some effect of dropsical imbibition.

I am greatly obliged to Dr. Ross for calling my attention to this very important point.—I am, Sir, etc., Joseph T. Wood

Nottingham
April 14, 1924

THE ANALYSIS OF LYSOL

Sir,—In the Journal of April 11, A. H. Dodd proposes to estimate cresylic acid in lysol by direct distillation of the mixed fatty acids and phenols. There appears to be no suggestion of absorbing the distillate in caustic soda or the adoption of any other means of distinguishing between phenols

and hydrocarbon oils or other neutral bodies which might be present and which would be returned as phenols according to the proposed method.

It is quite possible to obtain a clear solution of Lysol in distilled water even when 7½ per cent. of hydrocarbon oils are present.—I am, Sir, etc.,

JAS. GIBSON

Paisley
April 21, 1924

PERSONAL AND OTHER ITEMS

On the celebration of Founders' Day on May 21, the University of Manchester will confer the degree of D.Sc. on Prof. Niels Bohr.

The *Manchester Guardian* prints a notice from Christiania stating that the Nobel Institute has announced that each of the five prizes awarded during the year 1923 will be of a value of about 117,000 Swedish kroner (about £7,300). The main fund of the Institute now stands at a figure of slightly over 30 million kroner.—Reuter. The nominal value of each of the Nobel Prizes is about £6,500.

The Le Blanc Medal of the French Chemical Society was presented to Prof. T. M. Lowry recently, at a joint meeting of the Société Chimique de France and of the Société de Chimie Physique.

On April 4, the Rt. Hon. Noel Buxton, Minister of Agriculture and Fisheries, laid the foundation stone of the new building to be erected for the Department of Agriculture in Leeds University at a cost of £60,000. On the second floor of the new building will be the Chemical Department, which includes laboratories, lecture rooms, laboratories for research in nutrition, and rooms for microscopy and other special work.

Dr. R. Greydt, who died recently, will be remembered for his work on the estimation of raffinose in sugar-factory products.

Prof. M. R. Grose, head of the chemistry department of Temple University, Philadelphia, died on March 26.

Dr. F. Frank, whose death resulted from an explosion in the laboratory of the Catalytic Chemical Co., San Francisco, was responsible for important developments in the manufacture of gas and carbon black from petroleum and the utilisation of low-grade fuels.

Prof. H. Rössler, director of the Deutsche Gold- und Silberscheideanstalt has died in Frankfort, aged 79.

Reported German-Swiss Dye Agreement

We are informed by the Clayton Aniline Co., Ltd., that the statement, published in the daily Press and quoted in our issue of April 11, p. 391, to the effect that a large number of shares have been exchanged between the Basle colour manufacturers in Switzerland and a large German dye company is not true with regard to the Society of Chemical Industry in Basle, the Sandoz Chemical Works, or J. R. Geigy, S.A.

AUSTRALIA

New Petroleum Distillation Industry

Nearly 10,000 tons of crude oil, the first shipment of oil sent to Australia for distillation, has arrived at Spotswood from the Anglo-Persian Company's fields in Persia. The distillation is being carried out by the Commonwealth Oil Refineries, Ltd.

FRANCE

Mining and Metallurgy

Owing to increasing activity in the steel industry the production of iron ore has risen from 2,034,759 t. in December, 1923, to 2,257,220 t. in January, 1924, when stocks had greatly decreased. During January the mineral production included 14,967 t. iron pyrites, 24,800 t. bauxite, 3,761,687 t. coal and lignite, 196,939 t. coke, 284,048 t. briquettes, 585,978 t. cast iron, 541,022 t. steel. On February 1, 134 blast furnaces were alight, 42 were ready for use, and 43 were under repair or reconstruction. During January, 1,824,465 t. of coal was imported, including 1,105,919 t. from Great Britain, and 151,353 t. of coal was exported, 88,398 t. going to Belgium and Luxembourg. Imports of coke were 333,025 t., 266,697 t. coming from Germany. The export was 22,987 t., while imports of briquettes totalled 89,261 t., of which Germany provided 55,768 t., and exports were 10,212 t.

Sugar and Glucose Industry

The number of factories still working on February 15 1924, was three, the season having finished 91 works. The amount of sugar extracted during the first five months of the 1923–24 season has been so far 43,675,106 kg. During the same period 14 glucose factories produced 11,413,230 kg. of glucose, of which 186,980 kg. has been exported.

The Silk Industry

From a report presented to the Syndicat des Fabricants de Soieries de Lyon, it appears that the production of natural silk is increasing, the figures being approximately :—France, 198,000 kg. (1922), 280,000 kg. (1923); Italy, 3,735,000 kg. (1922), 4,500,000 kg. (1923); Europe, 700,000 kg. (1922), 1,000,000 (1923); China, 8,005,000 kg. (1922), 8,000,000 (1923); Japan, 18,845,000 kg. (1922), 18,000,000 kg. (1923); other countries, 177,000 kg. (1922), 175,000 kg. (1923), making a total of 32,955,000 kg. in 1923. A similar increase is shown in the production of artificial silk, which assumes more and more importance in France. The world production of this silk in 1923 is estimated 30 to 40 million kg., out of which nearly 3 million kg. was consumed in Lyons alone.

GERMANY

German Sugar Production

H.M. Commercial Secretary at Berlin has forwarded an extract from the *Frankfurter Zeitung*, which states that the production of sugar for consumption is estimated at 1,017,378 tons for 1923-24, as compared with 1,310,180 t. in the preceding year. The production of molasses in 1923-24 is estimated at 15,000 t. The sugar content of the beet, according to latest estimates, amounts to 15·31 per cent. on an average, as compared with 15·5 per cent., the October estimate, and 15·4 per cent., the actual average in the last crop year.

REVIEWS

The Vegetable Proteins. By Thomas B. Osborne. Pp. xiii+154. 2nd Edition. Monographs on Biochemistry. London: Longmans Green and Co. 1924. Price 9s. net.

It is thirteen years since the first edition of this work was published: the time which has elapsed has seen so much added to the knowledge of the vegetable proteins, largely owing, it should be said, to the work of Osborne and his school, that the new edition will be warmly welcomed. It is the essence of the now famous Hopkins-Plimmer monographs that the frequent appearance of new editions keeps them up to date.

After dealing with the occurrence of proteins in different parts of plants, the evidence for their chemical individuality is discussed. Not only do these proteins show constancy of composition and properties; they are also proved to be different by the anaphylaxis reaction, which is the best means available for establishing chemical identity. Apparently an almost indefinite number of chemically different proteins exist in plants, but the technique of dealing with them has so far advanced that the separation of two individual proteins from one another is practically perfect.

A lengthy chapter is devoted to the classification of vegetable proteins under the headings of simple, conjugated and derived. Of the former class the best studied are the albumins leucosin found in cereal seeds, legumelin found in peas and beans, phaselin and ricin. Even better known are the vegetable globulins, of which a number are described, some of which are crystalline. The glutelins, of which the glutenin of wheat is the best example, and the prolamins, including wheat gliadin, are of outstanding interest, owing to the influence they have on the vagaries of our daily loaf—a section of chemistry which we are still far from understanding.

Dr. L. J. Henderson contributes a chapter on the relation of proteins to acids and bases, which he concludes by accepting Loeb's views that normal salt formation is the primary phenomenon: the all too early death of Loeb is a very serious loss to chemistry.

Subsequent chapters deal with the solubility, precipitation and denaturing of the proteins, and contain just that type of practical information which is of greatest value to other workers.

The products and the rate of hydrolysis of the vegetable proteins are discussed at some length with the aid of tables and graphs—considerable importance is to-day attached to the partition of the nitrogen in these substances as measured by the elegant method of an American, Van Slyke.

The proteins of green plants are of importance, if only because they contribute large amounts of protein to the ration of farm animals; a chapter is devoted to their consideration, from which it appears that most of it occurs as a hitherto unrecognised type which is unlike any of the proteins of seeds.

The value of the proteins in nutrition is a subject which has almost entirely arisen since the first edition was written—in the interim Osborne and his co-workers, in particular Mendel, have made an elaborate study of this question. The results are summarised in a dozen pages, of which every line is full of interest.

The final chapter deals with the physiological effect of certain vegetable proteins on the animal organism, in particular the toxalbumins. It concludes with some significant remarks on seed proteins in relation to species. Similar proteins are found only in seeds which are botanically closely related, and such differences in the reserve food substances of the seeds must have an important bearing on the development of the embryo, which starts its life, as it were, with chemical processes already established along definite lines.

Altogether the book is a most attractive one and indispensable to all who have to do with plants and their products—it should be studied, too, by every honours student as an outstanding example of method in chemical science. E. F. A.

A Text-Book of Inorganic Chemistry. Edited by J. Newton Friend. Vol. VII, Part I, Oxygen. By J. Newton Friend and D. F. Twiss. Pp. xxv+370. London: C. Griffin and Co., Ltd. 1924. Price 18s.

The field covered by this book is a wide and interesting one. The authors commence with a short preliminary chapter on the elements of the oxygen group, which is followed by chapters on oxygen, its physical and chemical properties, ozone, the atmosphere, water, its physical and chemical properties, composition and molecular complexity, water as a solvent, water analysis and on hydrogen peroxide.

On the theoretical side of the matters dealt with the book is undoubtedly a useful and, on the whole, an able compilation. Those portions dealing with flame, explosion waves in gaseous mixtures, oxidation and with many of the physical properties of water may be mentioned as particularly interesting, and well presented to the reader. Copious references to original work are given in footnotes, and there are excellent name and subject indexes.

Had the authors confined themselves almost exclusively to pure chemistry and physics, there would probably be but little to criticise in their book. They have, however, very naturally, dealt to some extent with technical matters, and their treatment of these leaves much to be desired in many cases. Thus in dealing with the production of oxygen, no indication whatever is given of the fact that there are to-day only two methods of production which are in actual commercial use, namely, by fractionation of liquid air and by electrolysis of aqueous solutions. More attention might well have been devoted to these and less to other processes, mentioned without any critical comment, and of little interest either theoretical or practical. The description of the manufacture by way of liquid air is quite inadequate and by no means up to date, which is a pity as plenty of admirable literature on the subject is quite accessible. The important

technical applications of oxygen are dismissed very summarily in little more than half-a-page, much of which is misleading. For instance, it is stated that oxygen has been added with success to the blast of an ordinary blast-furnace, whereas in fact the commercial advantage shown by the only large-scale experiments yet tried was very doubtful.

The description of oxy-acetylene cutting and welding is also unsatisfactory. The methods of analysis of oxygen are not adequately dealt with, and some of the more usual and effective methods are not even mentioned. It is remarkable that four pages only are devoted to "The physical properties of gaseous water," and still more remarkable that in those four pages neither the name of Callendar nor the term "entropy" appears. In spite of defects the book can be recommended to those able to gather their more technical information from other sources.

Ernest Fyleman

(1) Colloid Chemistry. By The Svedberg. Pp. 265. New York: The Chemical Catalog Company, 1924.

(2) Chimie des Colloïdes et Applications Industrielles. By L. Meunier. Pp. 336. Paris: Librairie J.-B. Baillière et Fils, 1924. Price, bound 40 frs., paper 30 frs.

(3) Manipulations de Chimie Colloidale. By Wo. Ostwald, P. Wolski and A. Kuhn. Translated by Edmond Vellinger. Pp. xviii +201. Paris: Gauthier-Villars et Cie, 1924. Price f. 6·50.

(1) This is an extremely interesting book, the title of which, however, does not correspond very exactly to its scope. A much clearer indication of the ground covered is afforded by the headings of the three principal parts of the work: I. Formation of the Colloid Particle, II. The Colloid Particle as a Molecular Kinetic Unit, III. The Colloid Particle as a Micell, and by the following passage in the preface, in which the author frankly explains the choice of much of his material: "The author is conscious of having, perhaps, given undue space to description of research done in his laboratory at Upsala, but perhaps, in a science like colloid chemistry which is still in an undeveloped state, it is advisable to present as much as possible such phenomena as the author has really experienced." These beautiful investigations, and the book in general, deal with systems in which *the particles can be made visible*, and the sols in which this is not possible, *e.g.*, the proteins, although certainly not inferior in importance, are treated incidentally only, whilst the gels receive fifteen pages in all.

The first part covers the same ground as the author's monograph on "The Formation of Colloids" (this Journal, Vol. XL., 301 R, 1921), but contains much additional matter on silver and silver halide particles in the photographic plate, and on methods of purification. The second part gives an admirable account of the Brownian movement, Perrin's work on the vertical distribution of particles, Smoluchowski's work on the fluctuations in a given volume, the distribution of sizes (the pioneer work on which was carried out at Upsala) and optical methods of investigation. After dealing with Perrin's formula the author remarks: "Porter, in England, and Burton, in Canada, have made experiments that would show that the formula does not hold over a very wide range. . . . . With regard to Porter's experiments, it is quite likely that the sols had not reached equilibrium." This is hardly a complete statement of the case, as Porter gives a rigorous deduction of his formula, which shows, in good agreement with experiment, that at a short distance below the surface the concentration rapidly tends towards a constant value.

The third part of the book treats of "The colloid particle as a micell," the term being defined as "the particle together with its surrounding or adsorbed molecules and ions and probably a part of the surrounding liquid or gas." The subjects to be covered include adsorption, the electric properties, coagulation and peptisation, and the gels; a plethora of material necessitating somewhat condensed treatment, as this section is shorter than the preceding ones.

The style of the book is remarkably simple and clear, and the author remains lucid in dealing even with those difficult portions of the subject which are his particular delight. The volume—one of the American Chemical Society's series of monographs—is handsomely produced, but a great part of the mathematics appears to have been entrusted to compositors unfamiliar with this class of work.

(2) The plan of this work, which forms one of a series of "Grandes Encyclopédies Industrielles," is interesting and original. The author's object is to prepare the reader for the study of works dealing with the numerous industries concerned with colloids as raw material, intermediate product or finished article. He therefore devotes the first 126 pages to a brief, but very clear and sound, introduction to the theory of the subject. The second part, entitled "Industrial Applications" is really a short encyclopedia of colloidal materials, grouped under the following headings: Vegetable and animal fibres, and cellulose derivatives; artificial dyestuffs, and the practice and theory of dyeing; albumin, gelatin and casein; carbohydrates, including starch, gums and mucilages; tannins and tanning; soaps and emulsions; rubber, latex and vulcanised rubber; clays and soils. These chapters contain a large amount of information which, as far as the reviewer is competent to express an opinion, is sound, useful and shows every sign of having been critically sifted and selected. The book ought to be equally useful to the technical man without special knowledge of colloid chemistry, and to the colloid chemist who may be called upon to apply his theoretical knowledge to practical problems.

(3) This work is a translation, without additions or omissions, of the fourth edition of Ostwald's well-known Praktikum (for review of first edition see this Journal, XXXIX, 263 R, 1921). The translation is careful and competent, and its publication is to be welcomed in view of the somewhat detached attitude which eminent French workers in this field have so far taken up towards its development elsewhere.

Emil Hatschek

THE RECOVERY OF NITRATE FROM CHILEAN CALICHE, CONTAINING A VOCABULARY OF TERMS, AN ACCOUNT OF THE SHANKS SYSTEM, WITH A CRITICISM OF ITS FUNDAMENTAL FEATURES, AND A DESCRIPTION OF A NEW PROCESS. By A. W. ALLEN. Pp. XVI. 50. London: Charles Griffin and Co., 1921. Price 6s.

The purpose of this booklet, published three years ago, is to point a way to a more economical and efficient process for the extraction of nitrate from caliche, including low-grade material, which is based on the Shank's process of lixiviation at present in use. A description of the Shank's process is first given, occupying about half the book, and this is followed by a statement of the "fundamentals of the Allen process of extraction (patent applied for)." This consists in passing a solution or other solvent through a homogeneous mass of caliche which has been dry-crushed to such a size that no appreciable movement of borra (slime) takes place in the direction of percolation. The strong solutions are passed to the precipitation or crystallisation section; the weaker solutions are preferably reheated and used as solvent. The question of evaporation is considered, including vacuum and spray methods. No details of actual experiments or works trials are given.

In many quarters the preparation of nitrate from caliche is regarded as a dying industry. Synthetic methods have made giant's strides of late years, and the problem of the future economics of Chilean nitrate is evidently in the author's mind when he refers to "disquieting rumours" as to the success of synthetic methods. As a contribution to the great problem of fixed nitrogen supply his book would seem to be too little based on actual works achievement to be of much interest to the general reader.

J. R. PARTINGTON

FUEL OILS AND THEIR APPLICATIONS. By H. V. MITCHELL. Pp. xii+171. London: Sir I. Pitman and Sons, Ltd., 1924. Price 5s.

This little book, written in concise and colloquial language without being overburdened with chemical and engineering formulæ, should prove of practical utility to all interested in the application of fuel oils for commercial purposes.

The author illustrates and explains the uses of a wide range of typical burners and oil-burning installations.

Chapter 4, in particular, should be of use to the works' manager and works' engineer, as it not only deals with calorific values in a chatty manner, but draws particular attention to the necessity and the means of ascertaining and overcoming waste in factory plants.

Far too much, perhaps, has been made of colloidal fuel, which presumably the author had to notice in passing, but he gives up almost a chapter to it and draws attention to it in his preface. He also quotes the *Journal of the Institution of Petroleum Technologists* as his authority for a paper on the subject by Messrs. Bates and O'Neill. No such paper has, in fact, been published by the Institution of Petroleum Technologists in their Journal. The author, in dealing with colloidal fuel, seems to be a little inconsistent, having regard to his very necessary and apt hints on the removal of water and solids from oil, on p. 117.

N. A. ANFILOGOFF

PHOTOGRAPHY AS A SCIENTIFIC IMPLEMENT. A Collective Work by various Authors. Pp. viii+549. London: Blackie and Son, Ltd., 1923. Price 30s.

There seems to be no limit to the applications of photography; whether in the domains of criminology or of astronomy, in the recording of events or of physical phenomena, or in the study of metals or disease-carrying organisms, photography is sure to be wanted on occasion, to furnish easily, quickly and accurately, the impartial record. For some time a general survey of the applications of photography has been lacking and in publishing the book under review, Messrs. Blackie have done good service. In it fourteen different chapters have been contributed by as many different authors, and a wide field is surveyed, the following subjects being covered: History of photography, by C. R. Gibson; elementary optics of photography, by Dr. S. E. Sheppard; photographic optics, by Prof. A. E. Conrady; theory of photographic processes and methods; astronomical photography, by C. R. Davidson; application of photography in physics, by Dr. H. Moss; photography in the engineering and metallurgical industries, by J. H. G. Monypenny; photomicrography, by Dr. G. H. Rodman; colour photography, by W. L. F. Wastell; and other authors contribute chapters on photographic surveying, aeronautical photography, photography applied to printing, the technics of kinematography, and the camera as witness and detective. Of particular interest are the excellent review—though not without signs of its origin—of the theory of photographic processes and methods by Dr. Sheppard, and the equally good chapter on photography in engineering and metallurgy by Mr. Monypenny. The optical sections are also satisfying, and throughout the provision of references to the literature is a useful feature. The history of photography and colour photography are hardly treated with sufficient fulness, though useful outlines are given, and space could well be found for this purpose by condensation of the chapter on photomicrography. As a whole the book is excellent and can confidently be recommended.

The Faraday Medal of the Institution of Electrical Engineers will be presented to Dr. S. Z. de Ferranti on April 24, at 6 p.m., when Mr. G. Semenza of Milan will deliver the Fifteenth Kelvin Lecture, and will take as his subject "Kelvin and the Economics of the Generation and Distribution of Electrical Energy."

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Anglo-Persian Oil Company

Replying to Mr. Ormsby-Gore, the Prime Minister said that the Government had no intention whatever of selling the Government holdings in the Anglo-Persian Oil Company. Although he was unable to bind his successors in office, he did not consider that any Government would be justified in parting with the control of the company without the approval of Parliament.—(Apr. 14.)

Fuel Research Board

In a written answer to Sir H. Brittain, Mr. Trevelyan stated that the Fuel Research Board was established in February, 1917. The expenditure by the Department of Scientific and Industrial Research on the work of the Fuel Research Board up to March 31, 1924, amounted to £195,480. The premises of the Fuel Research Station at East Greenwich were provided and maintained by His Majesty's Office of Works; the expenditure by that Department on the station up to March 31, 1923, amounted to £203,352.—(Apr. 14.)

COMPANY NEWS

THE ENGLISH BEET SUGAR CORPORATION, LTD.

This company has been registered as a public company with a nominal capital of £500,000 in 50,000 Six per cent. cumulative participating preference and 450,000 ordinary shares of £1 each, to adopt an agreement with the English Beet Sugar Corporation, Ltd., and the liquidators and to carry on the business of cultivators of sugar beet, and other produce.

HADFIELDS, LTD.

The directors of this company have decided to recommend a dividend for the year of 4 per cent., less tax, on the ordinary shares. In the previous year the company distributed 5 per cent.

KENYA AND UGANDA AS SUGAR EXPORTERS

Until recently some 3,000 tons of sugar have had to be imported yearly to supply the needs of Kenya and Uganda. These countries are now, however, self-supporting, and in the immediate future are likely to have an annual exportable surplus of about 10,000 t., for three modern plants for the treatment of local cane have recently been erected. The Nanji Kalidas Mehta factory in Uganda, now being erected, will produce about 6000 t. of sugar per annum, and the two mills in Kenya should between them manufacture approximately the same quantity, or a total of 12,000 t. To enable this young industry to compete in oversea markets the Uganda Railway is being urged to grant specially low rates.—(*S.A.J.I., Mar.*, 1924.)

REPORTS

REPORT ON THE ECONOMIC AND FINANCIAL CONDITIONS IN PARAGUAY, SEPTEMBER, 1923. *By* F. W. PARIS, *H.M. Consul, Asuncion. Department of Overseas Trade. Pp.* 22. *H.M. Stationery Office*, 1923. *Price* 9*d*.

The increased volume and value of exports from Paraguay in 1922 shows that the effect of the political unrest was no more severe than the earlier effects of war conditions (*cf. Chem. and Ind.*, 1923, 158).

The timber industry is the most important in the country, and this suffered severely in 1922 from the transport difficulties due to political unrest, and exports were reduced by about £270,000, or 25 per cent. of the usual total. The cattle-breeding industry did well, and exports of tobacco in 1922 were 5020 tons, about 2000 t. less than in 1921. The total sugar production was 3240 t., about the quantity required for home demands. The cotton-growing industry has received a fillip from the shortage in the United States crop, and from propaganda work.

Under the conditions which have prevailed since June, 1922, trade and commerce have merely been marking time. Imports in 1922 were valued at £1,136,958, about 30 per cent. less than in 1921, exports at £1,929,177, somewhat more than in 1921. The United Kingdom is second to the Argentine in the list of countries supplying imports, and the United States comes a close third. Many of the imports from the Argentine are, however, of British origin, obtained indirectly in order to save time.

REPORT ON THE ECONOMIC AND FINANCIAL CONDITIONS IN BRAZIL. Dated September, 1923. By E. HAMLOCH, H.M. Commercial Secretary, Rio de Janeiro. Department of Overseas Trade. Pp. 104. H.M. Stationery Office, 1924. Price 3s.

The financial situation in Brazil is described as almost critical, a result of the fall in the rate of exchange due to the costly programme of the Government which went out of office at the end of 1922 (*cf. Chem. and Ind.*, 1923, 82). The effect on trade, however, has not been so serious as might have been anticipated and local industries are flourishing, largely owing to the cost of imports.

The coffee industry has been in a strong position, but cotton growing has suffered by reason of lack of attention to manufacturers' requirements and conditions of cultivation, and efforts are being made to remedy this; in 1922 33,950 t. of raw cotton was exported. The sugar industry has been improving of recent years, the 1922 production being 710,270 t.; Brazilian factories have a capacity of 480,000 t., 350,000 t. being used for home consumption.

The mineral resources of the country have never been systematically exploited. Iron and coal occur abundantly and at last steps have been taken by the Government to encourage their development. There is an export trade in manganese, controlled by the United States; 340,000 t. was exported in 1922. Gold is produced to the extent of about £650,000 annually.

Of manufacturing industries textiles are the most important, beverages, tobacco, and matches forming the other chief items; these four branches account between them for 90 per cent. of the total.

The total value of exports from Brazil in 1922 was £68,578,000 and of imports £49,192,000,000. Of the imports Great Britain supplied 25·8 per cent., the United States 22·8 per cent., Argentine 13·8 per cent. of the exports the United States took 38·6 per cent., France 11 per cent., Great Britain 10 per cent. Germany is rapidly increasing her tonnage of exports to Brazil, and in 1922 it was actually greater than that of Great Britain. Great interest has been shown recently in Brazil by the United States, both on the commercial side and in social questions.

Survey of the Economic and Commercial Conditions in Algeria, Tunisia and Tripolitania. 1922-23. Department of Overseas Trade. Pp. 80. H.M. Stationery Office. 1924. Price 2s. 6d.

For the third year in succession Algerian crops failed in 1922, but in spite of the world-wide economic depression the country has not suffered unduly, and though trade was not flourishing at the time of drafting the report optimism was general owing to the fine condition of the crops.

Imports into Algeria in 1922 were valued at 2007 million fr., against 1791 mill. fr. in 1921, whilst in the first six months of 1923 imports amounted to 986 mill. fr. In 1922 the imports included: animals and animal products, 115 mill. fr.; vegetables and vegetable products, 494 mill. fr.; minerals, 143 mill. fr.; manufactures, 1253 mill. fr. Imports of coal for internal use were 426,457 tons, of iron and steel 38,235 tons, both less than in 1921. An increase in the imports of chemical products occurred in 1922 and was maintained in 1923, owing to the demand from agriculturists.

Exports in 1922 were valued at 1379 mill. fr., agricultural produce being the most important item. Mineral production is going forward. In 1922, 1,046,251 t. of iron ore was produced, 482,304 t. of phosphate of lime, 33,949 t. of zinc ore, 13,789 t. of lead ore, and 6797 t. of iron pyrites.

The trade returns for Tunisia for the years 1917-22 show a steady increase in imports which in 1922 amounted to 856 mill. fr. Exports also increased up to 1921, when they were 673 mill. fr., but fell in 1922 to 445 mill. fr. Most of the trade is with France and Algeria, Italy coming next and Great Britain third, though Great Britain supplies more imports than Italy.

In 1922 the Tunisian cereal crops were poor, but the grape harvest was good. The fishing industry is important, most of the produce being exported. Minerals are also of importance. In 1922, the mineral output included 2,074,131 t. of phosphates, 601,626 t. of iron ore, 6161 t. of zinc ore and 18,935 t. of lead ore.

Tripolitan trade was bad in 1922 owing to internal troubles. The principal exports are esparto (which was only produced in small quantities in 1922), sponges and tunny.

Report on the Economic, Financial and Commercial Conditions in the Dominican Republic. By D. Wilson, Chargé d'Affaires, Santo Domingo City, and in the Republic of Hayti, by J. E. M. Carvell, Chargé d'Affaires, Port-au-Prince. September, 1923. Department of Overseas Trade. Pp. 56. H.M. Stationery Office. 1924. Price 1s. 6d.

The Dominican Republic forms about two-thirds of the island of Hayti. A central range of mountains running east and west divides the country into two well-defined sections. In the northern section tobacco and cocoa are the principal products, in the southern, sugar, coffee, and tropical woods; cattle are raised in both areas. For the past seven years the country has enjoyed conditions of peace and commerce has benefited accordingly. The administration was in the hands of an American Military Government which at the end of 1922 handed over control to a provisional Dominican Government.

Trade in 1922 showed an improvement over 1921, a step in the recovery from the economic crisis of 1920. The value of imports in 1922 was $14,317,497 about 40 per cent. less than in the previous year, though renewed activity was shown towards the end of the period. The value of imports from the United Kingdom in 1922 amounted to 6·82 per cent. of the total, the most important of the items being textiles, machinery, beverages, coal, wire, paints and chemicals. Exports in 1922 were valued at $15,231,355, about 25 per cent. less than in 1921. The principal articles of export are sugar, cacao, tobacco, coffee and other agricultural produce; mining and manufacturing are carried out only on a very small scale.

The Republic of Hayti consists of the western third of the island of the same name. The country stands now on the threshold of a new era, the period of political unrest having been replaced by one of security of life and property maintained by an efficient gendarmerie, the change having been effected by the Haytian American Convention of 1915.

Imports in the year 1921-22 were valued at $12,350,000, the United States supplying 80 per cent., France 9·5 per cent., and the United Kingdom 6·8 per cent. Exports, valued at $10,712,210, were made up principally of coffee, cotton, sugar, logwood, cocoa, and cotton seed and oil. The future of the country depends on its agricultural development, which after a slack period is again progressing.

Report on the Economic and Financial Conditions in Mexico, dated October, 1923. By N. King, H.M. Consul-General, Mexico City. Department of Overseas Trade. Pp. 30. H.M. Stationery Office. 1924 Price 1s.

Economic conditions in Mexico have improved but little since the issue of the last report (*cf. Chem. and Ind.*, 1923, 662). Political developments have played their part in hindering agriculture and reducing production and trade in general.

The mining industry has always taken a leading part in the prosperity of Mexico, and a considerable

increase in the output of metals, especially of gold and silver, in the next few years is indicated. In 1922 and 1923 the country produced 40 per cent. of the world's supply of silver, and in the former of these years occupied the fourth place among gold-producing countries, fifth for copper, and second for lead. The petroleum industry was seriously affected in 1922 by the fall in demands, and as a consequence prospecting for further supplies has been curtailed, even though some wells are nearly exhausted. In 1922 185,070,000 barrels of crude petroleum was produced, the estimate for 1923 being 145,000,000 barrels.

Agriculture is very important in the economic life of the country, though it is reported to have suffered from the breaking up of large estates. Cereals, cocoa, coffee and sugar are the principal crops; in the north-west cotton is grown.

Manufacturing is developed in Mexico, it is sometimes claimed, more than in any other Latin-American Republic. Paper and cement are made on a fairly large scale; for the latter there is an important factory controlled by British interests. Other manufactures include glass, soap, matches, and explosives.

On account of its proximity the United States has a predominant share of the external trade with Mexico; before the war Great Britain came second, and Germany third, but this order is now reversed. Foodstuffs, textiles, and machinery are obtained principally from the United States. Drugs, proprietary medicines, etc., are obtained mostly from the United States, and the better grades from France. Heavy chemicals in demand are chiefly cyanides for the mines, and caustic soda for soap manufacture.

SOUTH AFRICAN MINERAL OUTPUT IN 1923

The following table shows the mineral output of South Africa in 1923:—

		Quantity	Value
Gold ..	(fine oz.)	9,143,403·494 ..	£38,838,711
Silver ..	,,	1,375,536·268 ..	197,054
Osmiridium ..	,,	1,784·183 ..	43,528
Diamonds ..	(carats	2,055,470·00 ..	6,038,207
Coal	(tons)	11,915,497·000 ..	3,714,528
Copper	,,	9,489·090 ..	394,578
Tin	,,	1,424·680 ..	174,147
Arsenic white ..	,,	6·000 ..	290
Iron ore	,,	564·000 ..	230
Lead ore	,,	4,953·055 ..	123,217
Manganese ore ..	,,	432·500 ..	1,584
Vanadium ..	,,	51·250 ..	2,716
Asbestos	,,	8,392·765 ..	121,453
Corundum ..	,,	2,814,739 ..	22,543
Graphite	,,	605·842 ..	1,837
Iron pyrites ..	,,	2,014·000 ..	4,906
Magnesite ..	,,	2,470·000 ..	2,943
Mica	,,	15·674 ..	1,038
Iron oxide ochres etc.	,,	238·500 ..	468
Soda	,,	96;000 ..	1,018
Talc	,,	355·000 ..	1,065

With the exception of gold, silver, diamonds, and coal the figures given represent sales and shipments; those in respect of coal represent sales.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech. ..	£24 per ton. Fair inquiry.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¾d. per lb.
Potass. Chlorate	3d.—3¼d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76% ..	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton carr. paid.
Sod. Bisulphite Powder 60/62%	£18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

Antimony sulphide ..	Expected to advance in sympathy with the crude metal.
Golden	5¼d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide ..	4s. per lb.
Carbon Bisulphide ..	£24—£26 10s. per ton according to quantity.

Carbon Black	Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.
Lamp Black	40s. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	3s. 4d.—3s. 6d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade, but these are the only products in this section which show any activity.

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£19 £20 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw.
	1s. 2d. ,, ,, 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s.–5s. 3d. per gall. 60% O.P. market stiffer.
Solvent	5s. 6d.—6s. per gall. 40% O.P Fairly good demand but little offering.
Wood Tar	£5 per ton.
Brown Sugar of Lead	£49 per ton.

TAR PRODUCTS

Acid Carbolic—	
Crystals	7¾d. per lb. Only limited inquiry.
Crude 60's	2s.—2s. 3d. per gall. Market not so good.
Acid Cresylic, 97/99	1s. 11d.—2s. 1d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—2s. per gall. Steady demand.
Dark	1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	10d.—11d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure	1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90%	1s. 4½d.—1s. 7d. per gall.
Pure	1s. 8d.—1s. 11d. per gall.
Xylol coml.	2s. 3d. per gall.
Pure	3s. 3d. per gall.
Creosote—	
Cresylic 20/24%	10d. per gall. Few inquiries.
Middle Oil / Heavy / Standard Specification	7½d.—8d. per gall. according to grade and district. Market again weaker.
Naphtha—	
Crude	8d.—9d. per gall. Better demand. Prices show upward tendency.
Solvent 90/160	1s. 2d.—1s. 5d.
Solvent 90/190	1s. 2d.—1s. 3d.
Naphthalene Crude—	
Drained Creosote Salts	£6—£7 10s. Demand not so good.
Whizzed or hot pressed	£9 10s.—£12 per ton. Not much inquiry.
Naphthalene—	
Crystals and Flaked	£17—£18 per ton.
Pitch, medium soft	52s. 6d.—57s. 6d. per ton. Market steadier.
Pyridine—90/140	22s. per gall. Demand well maintained. Price again advanced.
Heavy	11s.—12s. Occasional inquiries: little business.

INTERMEDIATES AND DYES

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95%	1s. 6d. per lb.
Acid H.	4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic	2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther	5s. 9d. per lb. 100% basis d/d.
Acid Salicylic, tech.	1s. 4d. per lb. Steady demand.
Acid Sulphanilic	10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd.	1s. per lb. d/d.
Aniline Oil	7¾d.—8½d. per lb. naked at works.
Aniline Salts	7¾d.—9d. per lb. naked at works.
Antimony Pentachloride	1s. per lb. d/d.
Benzidine Base	4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95%	1s. 3d. per lb.
p-Chlorphenol	4s. 3d. per lb. d/d.
p-Chloraniline	3s. per lb. 100% basis.
o-Cresol 19/31° C.	4¾d.—5¼d. per lb. Demand moderate.
m-Cresol 98/100%	2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C.	2s. 1d.—2s. 3d. per lb. Demand moderate.
Dichloraniline	3s. per lb.
Dichloraniline S. Acid	2s. 6d. per lb. 100% basis.
p-Dichlorbenzol	£75 per ton.
Diethylaniline	5s. per lb. d/d., packages extra, returnable.
Dimethyaniline	2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene	9d. per lb. naked at works.
Dinitrochlorbenzol	£84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluene—48/50°C.	8d.—9d. per lb. naked at works.
66/68°C.	1s. 2d. per lb. naked at works.
Diphenylamine	3s. 2d. per lb. d/d.
Monochlorbenzol	£63 per ton.
α Naphthol	2s. 5d. per lb. d/d.
β Naphthol	1s. 1d. per lb. d/d.
α-Naphthylamine	1s. 4½d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 4d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.

m-Phenylene Diamine	4s. 2d. per lb. d/d.
p-Phenylene Diamine	10s. 4d. per lb. 100% basis d/d.
R. Salt	2s. 9d. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 6d. per lb. 100% basis d/d.
o-Toluidine	8½d. per lb.
p-Toluidine	3s. 10d.—4s. 3d. per lb. d/d.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The market is lifeless, values remaining at a low level.

Acid, Acetic 80% B.P.	£48 per ton. Market easier.
Acid, Acetyl Salicylic	3s. 5d.—3s. 9d. per lb. Easier.
Acid, Benzoic	Commercial acid 2s. 6d. per lb. B.P. quality is being sold in small lots at 4s. lb.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	19s.—21s. per lb.
Acid, Citric	1s. 6d. per lb., less 5% for ton lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst.	6s. per lb., for 28 lb. lots.
Acid, Salicylic	Prices quoted from 2s. 3d. per lb. down to 1s. 9d. for ton lots. Market rather weak.
Acid, Tannic B.P.	3s. per lb. Market quiet.
Acid, Tartaric	1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 6d. per lb. for quantity. Very weak.
Amidopyrin	13s. 6d. per lb.
Ammon. Benzoate	3s. 3d.—3s. 6d. per lb. according to quantity.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. 6d. per lb. Weak market.
Benzonaphthol	6s. 3d. per lb. Firmer.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
,, Citrate	11s. 4d.—13s. 4d. ,,
,, Salicylate	10s. 2d.—12s. 2d. ,,
,, Subnitrate	10s. 9d.—12s. 9d. ,,
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Market very firm and advancing. Heavy increase in price of bromine.
Potassium	9½d.—10½d. per lb.
Sodium	9½d.—10½d. ,,
Ammonium	10½d.—1s. ,,
Calcium Lactate	Prices vary over a wide range. Good English make can be had from 1s. 7d. to 2s. 3d. per lb.
Chloral Hydrate	3s. 9d. per lb.
Chloroform	2s. per lb. for cwt. lots. Very steady.
Creosote Carbonate	6s. per lb. Little demand.
Guaiacol Carbonate	12s. per lb. for cwt. lots. A cheaper market.
Hexamine	3s. 6d.—3s. 9d. per lb. for foreign makes. Weaker. Without much inquiry. Large stocks.
Homatropine Hydrobromide	30s. per oz.
Hydroquinone	4s. 3d. per lb. Foreign make.
Iron. Ammon. Citrate B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate— Light Commercial	£36 per ton net.
Magnesium Oxide— Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 3d. per lb., according to quantity. Steady market.
Menthol— A.B.R. recryst. B.P.	70s. Strong upward movement due to disappointing Japanese crop.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Very much firmer in view of the rise in the price of quicksilver. Prices have been advanced by 6d. per lb.
Red oxide	5s. 3d.—5s. 4d. per lb.
Corrosive sublimate	3s. 6d.—3s. 7d. ,,
White precip.	4s. 7d.—4s. 8d. ,,
Calomel	3s. 11d.—4s. ,,
Methyl Salicylate	2s. 3d.—2s. 9d. per lb. for carboys.
Methyl Sulphonal	24s. per lb. neglected.
Paraformaldehyde	3s. 6d. per lb., without much inquiry.
Paraldehyde	1s. 4d.—1s. 7d. per lb. in free bottles and cases.
Phenacetin	6s. 3d.—6s. 9d. per lb.
Phenazone	8s. per lb. for cwt. lots. Spot prices much lower than forward offers. Firmer tendency.
Phenolphthalein	7s.—7s. 6d. per lb. Firm.
Potass. Bitartrate— 99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. per lb., 1-cwt. kegs included.
Potass. Permanganate— B.P. Crystal	8¾d.—9d. per lb. carriage paid. English make.
Commercial	8d.—8½d. per lb. carriage paid. English make.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	5s. 6d. per lb.
Salol	4s. per lb.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	3s. 3d. per lb. In more plentiful supply.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite— Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	77s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.
Sod. Salicylate	Market weak. Powder 2s. 4d.—2s. 9d. per lb. Crystal at 2s. 6d.—2s. 10d. per lb. Flake 2s. 10d.—3s. 4d. per lb.

Sod. Sulphide—		
Pure recryst. ..	..	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous		£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal ..	..	.. 18s. 6d. per lb.
Tartar Emetic ..	..	.. 1s. 4d. per lb.
Thymol ..	..	.. 13s. 6d.—15s. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone	..	12s. 6d. per lb.
Aubepine ..	..	13s. 6d. ,,
Amyl Acetate	..	2s. 9d. ,,
Amyl Butyrate ..	..	7s. 3d. ,,
Amyl Salicylate ..	..	3s. 3d. ,,
Anethol (M.P. 21/22° C.)		4s. ,,
Benzyl Acetate from Chlorine-free Benzyl Alcohol		3s. 3d. ,,
Benzyl Alcohol free from Chlorine	..	3s. 3d. ,,
Benzaldehyde free from Chlorine	..	3s. 6d. ,,
Benzyl Benzoate	..	3s. 6d. ,,
Cinnamic Aldehyde Natural ..	..	15s. 6d. ,,
Coumarin	..	20s. ,,
Citronellol	..	16s. ,,
Citral	..	10s. ,,
Ethyl Cinnamate	..	15s. ,,
Ethyl Phthalate ..	..	3s. 9d. ,,
Eugenol ..	..	11s. ,,
Geraniol (Palmarosa)	..	35s. ,,
Geraniol ..	..	11s.—18s. 6d. per lb.
Heliotropine	..	8s. 3d. per lb.
Iso Eugenol	..	15s. 9d. ,,
Linalol ex Bois de Rose	..	32s. 6d. ,, Very much dearer.
Linalyl Acetate ..	..	32s. 6d. ,, Very much dearer.
Methyl Anthranilate	..	9s. 6d. ,,
Methyl Benzoate	..	6s. ,,
Musk Ambrette ..	..	52s. 6d. ,,
Musk Xylol	..	19s. ,,
Nerolin ..	..	4s. ,,
Phenyl Ethyl Acetate	..	12s. 6d. ,,
Phenyl Ethyl Alcohol	..	16s. ,,
Rhodinol ..	..	57s. 6d. ,,
Safrol ..	..	1s. 10d. ,,
Terpineol ..	..	2s. 9d. ,,
Vanillin ..	..	25s. 3d.—26s. 6d. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. ..	..	15s. 6d. per lb.
Anise Oil ..	..	3s. per lb. Firmer market forward.
Bergamot Oil ..	..	18s. 6d. per lb.
Bourbon Geranium Oil	..	35s. ,,
Camphor Oil	..	75s. per cwt.
Cananga Oil, Java	..	9s. 9d. per lb.
Cinnamon Oil, Leaf	..	$6\frac{1}{2}$d. per oz.
Cassia Oil, 80/85%	..	9s. 3d. per lb.
Citronella Oil—		
Java 85/90% ..	..	5s. 3d. ,,
Ceylon ..	..	3s. 9d. ,,
Clove Oil ..	..	8s. $4\frac{1}{2}$d. ,,
Eucalyptus Oil 70/75%	..	2s. 3d. per lb.
Lavender Oil—		
French 38/40% Esters		26s. per lb.
Lemon Oil	..	3s 4d. ,,
Lemongrass Oil ..	..	$2\frac{3}{4}$d. per oz.
Orange Oil, Sweet	..	13s. per lb.
Otto of Rose Oil—		
Bulgarian	..	27s. 6d. per oz.
Anatolian	..	23s. 6d. per oz.
Palma Rosa Oil ..	..	19s. per lb. Very short supply.
Peppermint Oil—		
Wayne County	..	21s. 9d. per lb. Again advanced.
Japanese	..	20s. per lb. but very little being offered.
Petitgrain Oil	..	10s. per lb.
Sandal Wood Oil—		
Mysore ..	..	25s. per lb.
Australian	..	21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patent those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition before June 9th; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, 15 days after the date given.

I.—Applications

Burt, Boulton, and Haywood, Ltd., and China. Producing disruptive forces in films of liquid china etc. 8284. Apr. 1.

Douglas and Grant, Ltd., and Laud. Drying-apparatus. 8453. Apr. 3.

Lindner, and Wunderlich and Co. Heat retaining and radiating blocks for furnaces etc. 8436. Apr. 3.

Lodge-Cottrell, Ltd. 8449. See XI.

Marks (Grasselli Chemical Co.). Heating and distilling liquids. 8172. Mar. 31.

Myrop. Mixing, emulsifying, and/or atomising. 8474. Apr. 3.

Schulz. 8540. See IX.

Wood. Drying-apparatus. 8425. Apr. 3.

I.—Complete Specifications Accepted

9798 (1923). Goedecke. See XIII.

18,362 (1923). Marks. See VII.

3306 (1924). Fouard. Filtering-devices. (212,233.)

3782 (1924). Bayer Co. Apparatus for producing intimate mixture between gases and liquids. (213,521.)

II.—Applications

Burrows, Simpkin, Sinnatt, and Slater. Method of freeing coal wash water etc. of suspended solids. 8225. Apr. 1.

Crozier. Fractionation of hydrocarbon oils. 8575. Apr. 4.

Dempster and Sons, Ltd., and Toogood. Retort settings. 8405. Apr. 3.

Donald. Drying peats etc. 8088. Mar. 31.

Heyl. Production of greases etc. from oil shale, coal, etc. 8098. Mar. 31.

Regenerative Coal Gasification System, Ltd., Clark, and Travers. Manufacture of gas from coal etc. 8653. Apr. 5.

Sauer. Manufacture of decolorising carbon. 8655, 8656. Apr. 5.

Wilson. Composition fuel. 8602. Apr. 5.

II.—Complete Specifications Accepted

26,114 (1922). Lewis. Molecular conversion of hydrocarbon oils and separation of products. (213,295.)

1646 (1923). Davies. Carbonisation and/or gasification of fuels. (213,363.)

III.—Application

Crozier. 8575. See II.

IV.—Application

British Dyestuffs Corporation, Ltd., and Hodgson. Manufacture of azo dyestuffs. 8268. Apr. 1.

V.—Applications

British Celanese, Ltd., and Ellis. Treatment of products etc. made with cellulose derivatives. 8562. Apr. 4.

Burlin. Removing ink etc. from liquid used in treatment of waste paper. 8186. Mar. 31.

Classen. Manufacture of cellulose-containing solutions. 8371. Apr. 2.

Green. Manufacture of cellulose acetate. 8435. Apr. 3.

Loewe. Spinning artificial silk. 8177. Mar. 31. (Ger., 3.4.23.)

Toman. Process for desizing and degumming fibres etc. 8558. Apr. 4. (Fr., 4.4.23.)

V.—Complete Specifications Accepted

29,254 (1922). Levy. Production of artificial filaments. (213,300.)

10,990 (1923). Koch Kommanditges., and Runkel. Producing half-stuffs and cellulose for the manufacture of paper pulp and paper. (213,447.)

VI.—Applications

Blicquy and Callebaut. Vats for treatment of textile fibres. 8391. Apr. 3.

Thies. Suction-dyeing textile materials. 8454. Apr. 3.

Wheelwright. Production of printed fabrics. 8191. Mar. 31.

VI.—Complete Specification Accepted

471 (1923). Calico Printers' Assoc., and Fourneaux. Treatment of cotton fabrics. (213,353.)

VII.—Applications

Fabrique de Soie Artificielle de Tubize Soc. Anon. Production of concentrated acetic acid from aqueous solutions thereof. 8375. Apr. 2. (Ger., 4.4.23.)

Klopstock, and Neumann. Production of potassium carbonate. 8245. Apr. 1.

VII.—Complete Specifications Accepted

26,000 (1922). Nitrogen Corp. Synthesising ammonia. (186,912.)

18,362 (1923). Marks (Carbide and Carbon Chemicals Corp.). Purifying chlorine and other corrosive gases. (213,486.)

IX.—Applications

Goffart. Artificial marble, granite, etc. 8143. Mar. 31.

Schulz. Production of acid-proof coating for concrete vessels. 8540. Apr. 4.

IX.—Complete Specifications Accepted

5339 (1923). Tolmer. Preservation of wood. (194,683.)

11,358 (1923). Eaton. Substitute for wood etc. (213,468.)

19,725 (1923). Minache. Building-material. (213,495.)

X.—Applications

Aarts. Producing pig-iron or steel in blast furnaces. 8478. Mar. 31. (Ger., 8.5.23.)

Jensen (International Metal Products Co.). Production of ingot iron. 8250. Apr. 1.

Jensen (International Metal Products Co.). Metal-degasifying process. 8251. Apr. 1.

Symonds. Flux for brazing iron etc. 8440. Apr. 3.

X.—Complete Specifications Accepted

78 (1923). Taplin, and Metals Production, Ltd. Leaching of copper ores containing slimes. (213,343.)

1603 (1923). Basset. Direct reduction of ores, particularly iron ores. (194,280.)

15,230 (1923). Leroux. Utilisation of old metals containing aluminium. (206,811.)

XI.—Applications

British Electrical and Allied Industries Research Association, and Flight. Electric insulating material. 8482. Apr. 3.

Lodge-Cottrell, Ltd. (International Precipitation Co., Inc.). Electrical precipitation of suspended particles from gaseous fluids. 8449. Apr. 3.

XI.—Complete Specifications Accepted

3511 (1923). Armitage. Electric accumulators. (213,380.)

12,243 (1923). Katatani. Electric resistance materials. (197,340.)

13,967 (1923). Rhodin. Electrolytic separation with fused electrolytes. (198,376.)

22,803 (1923). Metropolitan-Vickers Electrical Co. Electric cells. (204,694.)

XII.—Application

Vidal. Soaps and detersive preparations. 8235. Apr. 1.

XIII.—Applications

Dowson. Varnish. 8158. Mar. 31.

Fairweather (Magnetic Pigment Co.). Preparing pigments. 8091. Mar. 31.

XIII.—Complete Specification Accepted

9798 (1923). Goedecke (Eberlein). Manufacture of decolorising earths and body colours. (213,438.)

XIV.—Applications

Bateman. Rubber solutions or cements. 8096. Mar. 31.

Calvert. Rubber compounds. 8080. Mar. 31.

XIV.—Complete Specification Accepted

12,373 (1923). Jackson (New Jersey Zinc Co.). Manufacture of compounded rubber. (213,454.)

XV.—Complete Specification Accepted

19,294 (1923). Moeller. Manufacture of tanning extract. (213,493.)

XVII.—Application

Stoffen. Continuous deposition of tricalcium saccharate. 8271. Apr. 1.

XVIII.—Application

Blair, Campbell, and McLean, Ltd., and Moeth. Dehydration of alcohol. 8630. Apr. 5.

XVIII.—Complete Specification Accepted

32,361 (1922). International Takamine Ferment Co. Yeast stimulant. (201,512.)

XIX.—Applications

Dorfmüller. Clarifying sewage water. 8541. Apr. 4.

Grard. Synthetic preparation of butter. 8445. Apr. 3.

Hobbs and Lane. Preserving and storing meat. 8108. Mar. 31.

Leach, Thornley and Maypole Margarine Works. Apparatus for manufacture of margarine etc. 8367. Apr. 2.

XIX.—Complete Specification Accepted

1920 (1924). Declercq. Water-purifying apparatus. (210,437.)

XX.—Application

Farbwerke vorm. Meister, Lucius, und Brüning. Manufacture of complex metallic arsenobenzene compounds. 8632. Apr. 5. (Ger., 9.4.23.)

XXI.—Complete Specification Accepted

624 (1923). Shaw. Sulphide toning or intensifying of photographic images. (213,354.)

I.—Applications

Barron and Son, Ltd., and Garron. Impact grinder. 8996. Apr. 9.

Carrier. Refrigerating mediums etc. 9005, 9016. Apr. 9.

Freeman. Centrifugal separators. 8895. Apr. 8.

Gall, Scholield, Tinsley, and Tinsley and Co. Optical pyrometers. 8888. Apr. 8.

Lang, Lang and Son, and Salaman. Dehydrating compositions. 9035. Apr. 9.

Marks. (Liptak Fire Brick Arch Co.) Furnaces. 8749, 8750. Apr. 7.

Norbeck. Furnaces. 8983. Apr. 9.

Reddie. (Campbell). Open-hearth furnaces. 9052. Apr. 9.

Schnell. Heat-insulating materials for steam pipes. 9157. Apr. 10.
Schneany. Regenerative furnaces. 8877. Apr. 8.
Stafford. Drying system. 8850. Apr. 8.
Wreesmann. Desiccating liquid substances. 9314. Apr. 12

I.—Complete Specifications Accepted

1795 (1923). Deschamps. Facilitating physical or chemical reactions in masses of loose material. (192,089).
10,311 (1923). Robson. Apparatus for filtering liquids. (213,777).

II.—Applications

Algem. Norit Maatsch. and General Norit Co. Process of producing activated carbon. 8772. Apr. 7. (Ger., 26.5.22).
Algem. Norit Maatsch. and General Norit Co. Reactivating decolorising carbon. 8896, 8897. Apr. 8. (Ger., 26.5.22).
Deschamps. Method of stimulating combustion of fuels. 9152. Apr. 10. (Fr., 16.4.23).
Helps. Gas manufacture. 9217. Apr. 11.
Prescott and Worger. Fuel briquettes. 8883. Apr. 8.
Umpleby. Gas-generators. 8693. Apr. 7.

II.—Complete Specifications Accepted

29,780 (1922). Butler. Process of making liquid fuel. (213,628).
175 (1923). Internationale Bergin Compagnie voor Olie en Kolen-Chemie, and Hofsass. Purifying and hydrogenating heavy mineral oils, coal distillates, coal slimes, etc. (213,661).
17,269 (1923). Humphreys and Glasgow, Ltd. (Evans O. B.). Manufacture of water-glass. (213,818).

III.—Application

Potts. (Stinnes and Weindel.) Decomposing coal tar etc. into phenols and neutral oils. 8950. Apr. 9.

III.—Complete Specification Accepted

175 (1923). Internationale Bergin Compagnie voor Alie en Kolen-Chemie, and Hofsass. See II.

IV.—Applications

Imray. (Soc. of Chemical Industry in Basle.) Manufacture of green triphenylmethane-azo dyestuffs. 8808. Apr. 7.

IV.—Complete Specifications Accepted

20,046 (1923). Eberlein. Manufacture of silicates of the basic dyestuffs. (201,941.)

V.—Applications

Dieker. (Rubber Latex Research Corporation.) Paper. 8706. Apr. 7.
Dicker. Batted or felted materials. 8708. Apr. 7.
Hammy, and Know Mill Printing Co. Treatment of cellulosic fibres etc. 8963. Apr. 9.
Ioco Rubber and Waterproofing Co., Ltd. Manufacture of metallised waterproof fabrics etc. 9260. Apr. 11. (Fr., 20.10.23.)
Jackson, and Jackson, Ltd. Apparatus for hydrating fibrous pulp. 9107. Apr. 10.

V. Complete Specifications Accepted

30,136 (1922). Levy. Manufacture of cellulose acetate. (213,631.)
1949 (1923). Jackson. Paper and paper-making. (213,709.)
8967 (1923). Courtaulds, Ltd., Napper, and Diamond. Treatment of cellulose. (213,765.)
15,519 (1923). Brumby, Howard, Mercer, and Brumby and Clarke, Ltd. Manufacture of transparent paper. (213,810.)

VI.—Application

Farbenfabr. vorm. F. Bayer u. Co. Process for dyeing acetate silk. 8904. Apr. 8. (Ger., 14.4.23.)

VII.—Application

Metal Traders, Ltd. Production of chamber crystals. 8744. Apr. 7. (Ger., 7.4.23.)

VIII.—Application

British Refractories Research Assocn., Dale, and Mellor. Manufacture of clay-industry products. 8935. Apr. 8.

IX.—Applications

Child and Lutyens. Composition for roofing, road surfacing, etc. 9230. Apr. 11.
Davis. Manufacture of cement. 8903. Apr. 8.
Gaertner. Process of making cement etc. 9269. Apr. 11
Mackay. Bituminous emulsions. 8926. Apr. 8.
Ross. Treatment of concrete, brickwork, etc. 8695. Apr. 7.
Schnell. 9157. See I.
White. (Tehafo Technische Handels-u.-Forschungs-Ges.) Concrete. 8900. Apr. 8.

X.—Applications

Aarts. Oven for treating iron ores. 9192. Apr. 10.
Bown, and Bown. Composition for welding cast steel. 8999. Apr. 9.
Clark, Sumpter, and Vickers, Ltd. Heat treatment of steel tyres etc. 9335. Apr. 12.
Guise, and Scriven. Treatment of metal articles for prevention of tarnish. 9279. Apr. 11.
Marino. Process of recovering constituent metals of tin-plate etc. 9292. Apr. 12. (Belgium, 28.11.23.)
Reddie (Campbell). 9052. See I.
Wilson. Welding. 9070. Apr. 10.

X.—Complete Specifications Accepted

27,342 (1922). Haneiau. Recovery of gold, platinum, and other metals. (213,626.)
33,109. (1922). Harris. Separation of arsenic and tin in presence or absence of antimony. (213,639.)

XII. Complete Specification Accepted

1980, (1923). Lund. Production of alkali salts of higher fatty acids. (213,710.)

XIII.—Applications

Caspari. Manufacture of protective paints etc. 8793. Apr. 7.
Defries, and Sorbo Rubber-Sponge Products, Ltd. Manufacture of paints, varnishes, etc. 8892. Apr. 8.
Soc. of Chemical Industry in Basle. Manufacture of artificial resins. 8809. Apr. 7. (Switz., 9.4.23.)

XIV. Applications

Hammond. Coagulation of rubber latex. 8848. Apr. 8.
Wescott. Rubber emulsions. 8707. Apr. 7.

XIV. Complete Specifications Accepted

22,876, 8, and 9 (1923). Plantation Rubber Manufacturing Co., Ltd., and Dessau. Printing on rubber. (213,835-7.)

XV.—Application

Atkin, and McCandlish. Treatment of hides etc. 9073. Apr. 10.

XV.—Complete Specification Accepted

5625 (1923). Forster. Treatment of hides for the production of articles of leather. (213,740.)

XVII.—Application

Burunat. Treatment of bagasse. 8901. Apr. 8.

XIX.—Application

Squibb and Sons. Preventing vitiation of vitamine A 8699. Apr. 7. (U.S., 9.4.23.)

XX.—Applications

Lockemann. Manufacture of 1-phenyl-2.3-dimethyl-4-dimethyl amino-5-pyrazolone. 9163. Apr. 10. (Ger., 10.4.23.)
Sokal (Kalle and Co., Akt.-Ges). Process for producing perylenetetracarboxylic acid or its derivatives. 8895. Apr 7..

XX.—Complete Specifications Accepted

1980 (1923). Lund. *See* XII.

17,375 (1923). Chemische Fabrik Flora. Producing para-amino-benzoyl derivatives of 2-methyl-4-diethylaminopentanol-5 and 2-methyl-4-dimethylaminopentanol-5. (200,810.)

24,306 (1923). Farbwerke vorm. Meister, Lucius und Bruning. Manufacture of arsenobenzene derivatives. (204,721.)

XXI.—Complete Specification Accepted

31,721 (1923). Comp. d'Exploit. des Proc. de Photographie en Coleurs L. Dufay. Manufacture of photographic prints in colours. (208,564.)

FORTHCOMING EVENTS

Apr. 28. The Ceramic Society. Annual meeting in the Central School of Science and Technology, Stoke-on-Trent, at 7.30 p.m. "Note on the Use Wood-wool as a Packing Material," by B. Olsen.

Apr. 29. Society of Chemical Industry, *South Wales Section*. Visit to the works of Messrs. Vivian and Sons, Ltd., Copper Works, Llandore, at 2.15 p.m.

May 2. Society of Chemical Industry, *Chemical Engineering Group*. Fifth annual general meeting, to be held in the Watt Room of the Engineers' Club, 39, Coventry Street, W. 1, at 6.30 p.m. An informal dinner (tickets 6s. 6d.) will be held after the meeting, followed by a social evening, including musical and other items.

May 2. Institute of Metals, *Swansea Local Section*. University College, Singleton Park, Swansea, at 7.15 p.m. Annual general meeting.

May 2. Society of Chemical Industry, *Manchester Section*, Textile Institute, 16, St. Mary's Parsonage, Manchester, at 7 p.m. "Some Organic Sulphur Compounds" (in relation to the determination of total sulphur in petroleum), by J. Atkinson, M.Sc., and L. Guy Radcliffe, M.Sc.

May 5. Society of Engineers. Apartments of the Geological Society, Burlington House, W., at 5.30 p.m. "Some Factors of Sea-defence Work," by C. H. J. Clayton.

May 5. Institution of the Rubber Industry, *London Section*, Engineers' Club, Coventry Street, London, W., at 8 p.m. "The Rubber Industry—A Plea for Closer Working," by J. Fairbairn.

May 8. Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C. 2, at 6 p.m. Annual General Meeting.

May 8 and 9. Iron and Steel Institute, at the Institution of Civil Engineers, Great George Street, London, S.W. 1. Annual Meeting. Annual dinner at the Hotel Cecil, Strand, W.C. 2, on May 8, at 7.15 for 7.30 p.m.

May 21. Royal Microscopical Society, 20, Hanover Square, W. 1, at 7.30 p.m. "Brief Observations on the Mounting and Photomicrography of Radulæ," by Dr. E. W. Bowell, M.A.

May 28. Royal Microscopical Society, 20, Hanover Square, W. 1, at 7 p.m. *Industrial Applications Section*. (1) Lecture Demonstration 6. A résumé of the whole subject, "The Efficient Use and Manipulation of the Microscope," by J. E. Barnard. (2) "Use of the Microscope in the Examination of Paper," by Mr. Lester.

GENERAL NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number :—*Australia :* Steel, (13520/E.D./E.C./2) ; (13521/E.D./E.C./2) ; *Belgium :* Manganese ore, acetone, sodium sulphate, (416) ; Artificial silk, (418) ; *Chile :* Steel, (9649/F.L./E.C./2) ; *Czechoslovakia :* Raw phosphates, (420) ; *Germany :* Silk, (421) ; *Greece :* Metals, hardware, (422) ; *Latvia :* Kerosene, (9085/F.R./C.C./2) ; Iron, (9103/F.R./E.C./2) (A) and (B).) ; *Netherlands :* Copper, phosphor bronze, iron cutlery and enamel ware, (432) ; *Portugal (Madeira) :* Metal, tinplate, (436) ; *Sweden :* Shellac, (438) ; Silk, (440) ; *Switzerland :* Steel, timplate, (442) ; Pig and cast iron (21235/F.W./E.C./2).

Notes from Italy

Orders and Notices, issued by the Italian Government, have of late been of particular interest to chemists. Thus, one Royal Decree (Dec., 18, 1923) establishes the "Consiglio Nazionale di Ricerche," affiliated to the International Research Council, and the "Unione Accademica Nazionale," affiliated to the International Academic Union. The National Research Council is composed of the presidents and general secretaries of the national committees, a delegate from the Accademia dei Lincei, one from the Ministry of Foreign Affairs, and one from the Ministry of Public Instruction. A State subvention of 175,000 lire is accorded for the work of the National Research Council, and 100,000 lire for that of the Academic Union.

Another Decree, dated December 31, lays down the list of professions the exercise of which requires the possession of a State certificate, awarded on examination. The use of the title of specialist in any of the professions named is permitted only to those possessing an appropriate diploma, and offenders will be excluded from the profession as well as subjected to other penalties. The professions listed included those of chemist, engineer and pharmacist, and each applicant is required to possess appropriate degrees (laurea) in his particular subject. In addition, special regulations control the admission of candidates to the teaching profession.

PUBLICATIONS RECEIVED

Low Temperature Carbonisation. By C. H. Lander and R. F. McKay. Pp. 277. London: E. Benn, Ltd., 1924. Price 35s.

The Cocoa and Chocolate Industry. *By* A. W. Knapp. *Pp.* 147. *London: Sir I. Pitman and Sons, Ltd.*, 1924. *Price* 3s.

Solubility. By J. H. Hildebrand, Ph.D. Pp. 206. American Chemical Society Monograph Series. New York: The Chemical Catalog Co., Inc., 1924.

ORGANIC SYNTHESES. Edited by H. T. Clarke, R. Adams, O. Kamm, J. B. Conant, and C. S. Marvel. Vol. III. Pp. v.+104. New York: John Wiley and Sons, Inc., 1923. Price 7s. 6d.

OFFICIAL CHEMICAL APPOINTMENTS. Fifth edition. Compiled under the supervision of the Publications Committee of the Institute of Chemistry by the Registrar. Pp. 312. London: Institute of Chemistry, 1924.

TRANSACTIONS OF THE OPTICAL SOCIETY. Vol. XXV., No. 2. Pp. 41+96. London: The Optical Society, 1924. Price 10s.

PROCEEDINGS OF THE TECHNICAL SECTION OF THE PAPER-MAKERS' ASSOCIATION OF GREAT BRITAIN AND IRELAND, 1912 (INCORPORATED). Volume IV. Part 2. Pp. 125-228. London: 1924. Price 10s. 6d.

PUBLICATIONS OF THE DEPARTMENT OF THE INTERIOR. *United States Geological Survey, Mineral Resources of the United States*, 1922. *Part I. Washington: Government Printing Office*, 1924.
COPPER IN 1922 (GENERAL REPORT). *By* H. A. C. JENISON *Pp.* 257—304. 1:19
GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA IN 1922. MINES REPORT. *By* V. C. HEIKES. *Pp.* 489—518. 1:25.
GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA AND OREGON IN 1922. MINES REPORT. *By* J. M. HILL. *Pp.* 405—451. 1:23.
GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH IN 1922. MINES REPORT. *By* V. C. HEIKES. *Pp.* 377—403. 1:22.

FIRST GENERAL REPORT OF THE LIGNITE UTILISATION BOARD OF CANADA, covering operations October 1, 1918, to January 1, 1924. Pp. 263. Montreal: The Lignite Utilisation Board of Canada, 1924. Price $1.50.

ANNUARIO PER LE INDUSTRIE CHIMICHE E FARMACEUTICHE, 1921 E 1922. Ministero Dell' Economia Nazionale. Pp. xxxix+559. Rome: Tip. Oper. Rom. Cooperativa, 1923. Lire 30.

KOHLENCHEMIE ENTSTEHUNG UND CHEMISCHES VERHALTEN DER KOHLEN UND IHRER BESTANDTEILE; UNTERSUCHUNG DER KOHLEN. By Dr. H. Strache and Dr. R. Lant. Pp. xvi+599. Leipzig: Akademische Verlagsgesellschaft M.B.H., 1924. Price paper 24 goldmarks, bound 26 gm.

DIE PHYSIKALISCHEN UND CHEMISCHEN GRUNDLAGEN DES EISENHÜTTENWESENS. By W. Mathesius. Second edition. Chemische Technologie in Einzeldarstellungen, edited by Prof. A. Binz. Pp. xviii.+483. Leipzig: O. Spamer, 1924. Price bound 30 goldmarks, paper 27 gm.

CHEMISCH-TECHNISCHE VORSCHRIFTEN. Part IV. Düngemittel (Sprengstoffe). Futtermittel, Lebensmittel. By Dr. O. Lange. Third edition, completely revised and enlarged. Pp. 24+750. Leipzig: O. Spamer. 1924. Price, paper 45 goldmarks, bound 50.

REPORT ON THE ECONOMIC AND COMMERCIAL CONDITIONS IN SWITZERLAND. By O. A. Scott, D.S.O. Department of Overseas Trade. Pp. 88. H.M. Stationery Office, 1924. Price 2s. 6d.

REPORT ON THE ECONOMIC, FINANCIAL, AND INDUSTRIAL CONDITIONS OF THE NETHERLANDS. By R. V. Laming, O.B.E. Pp. 69. Department of Overseas Trade. H.M. Stationery Office, 1924. Price 2s.

CHEMICAL ENCYCLOPÆDIA. A DIGEST OF CHEMISTRY AND CHEMICAL INDUSTRY. By C. T. Kingzett. Third edition. Pp. x+606. London: Ballière, Tindall and Cox. 1924. Price 30s.

COLOUR INDEX. Society of Dyers and Colourists. Edited by F. M. Rowe, D.Sc. Pp. iv+371. Bradford: Society of Dyers and Colourists, 1924. Price, bound in Pluviusin cloth, £5 15s.; Edition de Luxe, £6 10s.

SCHWEFEL- UND STICKTOFFSTUDIEN. By Dr. F. Raschig. Pp. 310. Leipzig: Verlag Chemie G.m.b.H., 1924.

PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY, DEPARTMENT OF THE INTERIOR. Mineral Resources of the United States, 1922. Part I. Washington: Government Printing Office, 1924:—
GOLD, SILVER, COPPER, LEAD AND ZINC IN COLORADO IN 1922. MINES REPORT. Pp. 519-556. By C. W. Henderson, No. 1:26.
GOLD, SILVER, COPPER, LEAD AND ZINC IN MONTANA IN 1922. MINES REPORT. By C. N. Gerry. Pp. 453-488. No. 1:24.

FULLER'S EARTH, STATISTICS 1919—1921. The Mineral Industry of the British Empire and Foreign Countries. Imperial Mineral Resources Bureau. Pp. iv.+3. H.M. Stationery Office, 1924. Price 6d.

CONSOLIDATED LIST OF GOVERNMENT PUBLICATIONS FROM JANUARY 1 TO DECEMBER 31, 1923. Pp. 190. H.M. Stationery Office, 1924.

PRELIMINARY REPORT OF THE MINERAL PRODUCTION OF CANADA DURING 1923. Dominion Bureau of Statistics, Mining, Metallurgical, and Chemical Branch. Pp. 38. Ottawa: F. A. Acland, 1924.

ROYAL MICROSCOPICAL SOCIETY

A meeting of the Industrial Applications Section of the Royal Microscopical Society was held at 20, Hanover Square, on March 26, 1924, with Dr. Stephen Miall in the chair.

Mr. G. O. Searle (Linen Industry Research Association) communicated a paper, entitled "Methods of Mass-Production in Sectioning Flax Stems." He said that in carrying out a genetic investigation of certain fibre characters of the flax plant it was found necessary to devise a method by which transverse sections of up to 3000 flax stems could be cut and mounted by one person within a limited available period of about four months each year. The method finally devised consists essentially of making kite tails of cotton, each with small pieces from forty stems; in this way 1000 stems could be dehydrated and embedded in celloidin at one time without mixing. After microtoming, the sections, six from each stem, three of which were later discarded, were placed in small silk ended tubes, and forty of these tubes were placed in a larger long glass tube, into which solutions could be poured as required; in this manner the sections were uniformly double stained and dehydrated ready for mounting. A careful record of time and materials was kept, and it was found that 2000 stems could be dealt with, and three sections from each stained and mounted at an expenditure in time amounting for one person to six hours per day for 84 days, and an expenditure of materials equalling 2½d. per stem, half of which was for slides and cover glasses.

Mr. Harold Wrighton, B.Met., also read a communication on "Microscopical Metallurgy."

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EDITORIAL

THE short article in this week's issue on "Steam Generation at the Critical Temperature," recalled to us our student days. It seems a very long time ago since we struggled with Carnot's cycle and the formulæ of Gibbs and Helmholtz, and we confess that we have forgotten what little we then knew of thermodynamics and have no inclination to return to it. But we should enjoy sometime reading again the tracts of Andrews on the continuity of the gaseous and liquid states. Who Andrews was and what he looked like, we never knew; whether he was addicted to verse or worse; but we have a vague recollection of his researches and will refresh this. Did he not deal with mixed gases—or was it Cailletet? and find that carbonic acid could be liquefied at a higher temperature if mixed with air than if pure? Has anyone repeated these experiments? is there an easy explanation of the facts and are the matters of any practical value? Perhaps some reader can enlighten us on some of these points connected with critical temperatures. It is not surprising that one retains a curiosity about some parts of a science and some parts only. If the science is your business or avocation you are spurred by the thoughts of home and the tax-collector to know your subject. But the amateur must choose somewhat daintily, perusing only those topics which appeal to him and the books whence he may learn and clearly discern such truths as attract his inquisitive turn. Voltaire, whose advice to a journalist constitutes our only text-book in that art, said, "Les livres sont la peinture de la vie humaine, il en faut de solides, et on en doit permettre d'agréables." Somebody else, of like nature to our own, after speaking of the value of Greek as a school subject, said that a wise man on leaving school will throw away his Euclid but keep his Theocritus. We all make a selection for ourselves, usually preferring that which is the most interesting or the least fatiguing, even Jinny: Some parts of the Bible by heart she recited, and much in historical chapters delighted, but in points about faith she was something short-sighted.

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The Cantor Lectures now being delivered by Mr. E. V. Evans at the Royal Society of Arts are of interest and importance, and Mr. Evans is introducing some novel features such as kinematograph films to show the changes which occur in some of the molecules, with which the gas manufacturer is dealing. The scientific examination of the distillation of coal at various temperatures and under various conditions has received much attention during the last twenty years, and Mr. Evans' own contribution to this subject is by no means inconsiderable. The products of coal distillation have received an amount of attention incredible except to those who have followed the subject closely and since the discovery of naphthalene and benzene a hundred years ago the gas manufacturers have made great advances in the output of intermediates. It is from one of these, H-acid, that the cure for sleeping sickness, Bayer 205, is derived, as we announced in last week's issue. But though the literature on coal products is extensive the actual knowledge we possess of the structure and properties of coal is comparatively scanty. This fossilised sunshine is steadily yielding to research and the fuel problem is at last being approached by men of insight and practical experience. When, as sometimes happens, we have occasion to light or re-light a fire in what is called a domestic hearth we wish someone, Mr. Evans for instance, would explain to us exactly what happens. The flame of the paper, sufficing to light the wood, the exact process of the burning of the wood and then the way in which a piece of coal begins to ignite; all these present problems which we should like to explain to a younger generation whose curiosity is insatiable, but we are ourselves not sure of the facts and they seem not readily accessible in *Evenings at Home* or the *Boys' Own Paper*; consequently, we shirk the subject. Some of our chemical friends have shown us that a lump of sugar cannot be ignited by a match unless the lump be "activated," if that is the right word, by the addition of some cigarette or other ash to a corner of the lump. At present this is merely a parlour trick, perhaps Mr. Evans can include this problem in his third Cantor Lecture. By the way, we owe him and our readers our apology for omitting in our previous issue a notice of his second lecture. We much regret the omission.

REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The advent of the Annual Reports of the Progress of Applied Chemistry is always awaited with a certain eagerness, even if one wishes only to see how far the review of the development of one's own particular subject coincides with one's own views, or to glean ideas from the trend of other departments of applied chemistry. Whatever may be the reasons—and there are many—for procuring the Reports, these are now indispensable, and the Society of Chemical Industry has done well in offering advantageous terms to those who, having one, wish for all, though they will be too late to procure the first volume.

Volume VIII, which will be issued in a few days, is again edited by Mr. T. F. Burton, B.Sc., editor of the Transactions and Abstracts. Plant and machinery are this year treated by Mr. J. H. West, who records the important events of the foundation of the Institution of Chemical Engineers and that of the Ramsay Memorial Chair of Chemical Engineering, and describes Dr. Hele-Shaw's "stream-line filter," and other developments in the domains of fine grinding, "heat pumps," heat transference, leaching and other chemical-engineering subjects. In the review of Fuel, Mr. E. C. Evans discusses the scientific, economic and social aspects of the fuel problem. Peat, lignite, oil shales and liquid fuel provide material for some interesting discussion, especial mention being made of hydrogenation, as in the Bergius process. Coal receives full attention under the heads of analysis, constitution and low-temperature carbonisation, and coke is discussed from a variety of standpoints, particular attention being paid to "combustibility." Messrs. F. M. Potter and D. Ivor James contribute a lengthy account of progress in the Gas Industry, and refer to an unusually large number of papers embodying the results of careful work directed towards obtaining a maximum of efficiency and a reduction of operating costs. Naturally, carbonisation is to the fore, but the accounts of benzol recovery, corrosion, the yield of ammonia, tar and its products will be found of much interest. Recent work on the origin of petroleum, the analysis, distillation and other treatments of crude oils, is described by Dr. S. J. M. Auld in the section on Mineral Oils, which also includes chapters on motor fuels, lubricants, and lubrication, wax, natural gas, asphalt and shale.

An interesting review of the dyestuff industry is given by Mr. J. Baddiley in "Colouring Matters and Dyes," in which he points out that the quality and range of British-made dyes is now satisfactory but that the industry still needs nursing. This section will be read most closely owing to recent events, but apart from the economic side, numerous points of a scientific and technical nature are deserving of close attention. Much steady progress is recorded by Dr. C. Dorée, who deals with Fibres, Textiles, Cellulose and Paper. Interesting work on the chemistry and structure of cotton is reviewed, and wool and flax receive attention, as well as other fibres, natural and artificial. The discussion of recent work on the constitution of cellulose is particularly full, and the chapters on cellulose compounds, lignin, wood pulp, and paper will be found to contain many interesting points. Mr. Fort, who writes on Bleaching, Dyeing, Printing and Finishing, complains that bad trade has hindered the development of inventions and improvements, but he nevertheless finds that there is plenty of attractive work to draw attention to, of particular importance being the development of the dyeing of cellulose acetate silk.

In Acids, Alkalis, Salts, etc., Mr. H. J. Bailey discusses the recovery in the heavy chemical industry, and its set-back owing to the trade depression. He gives a clear description of the Quinan and Schmiedel processes of sulphuric acid manufactures, and reviews the increasing use of electrolytic methods for producing soda and its consequence, the growing output of synthetic hydrochloric acid. The subjects treated in this section include, *inter alia*, hafnium (celtium), nitrogen fixation, ammonium compounds, various acids and salts. Mr. E. A. Coad-Pryor in the section on Glass, remarks on the improvement in the quality of scientific glassware and glass containers, an improvement due to the growing recognition of the value of technical control, and indicates the increasing importance that is being attached to the physical side of the subject. As in former years, this section shows the valuable work done by the Society of Glass Technology. Dr. G. N. White observes that the meagre results in the Ceramic Industries is due to the complexity of the materials used and the type of work involved. As usual a good deal of work on clays has been done, particularly in relation to colloidal phenomena and hydrogen-ion concentration, and attention is called to various improvements in kilns, and work on the crazing of glazes on semi-porcelain. Much recent work on refractories is noticed and, under building materials, the decay of building stone and the setting of cement are dealt with. Important work by Japanese investigators in this and the preceding section is noteworthy.

Prof. C. O. Bannister contributes the section on Iron and Steel, which treats of the manufacture of iron and steel, foundry practice, the properties of iron and steel, and metallography, concluding with a full discussion of the important problem of corrosion. Non-Ferrous Metals are again dealt with by Prof. C. A. Edwards and Mr. H. I. Coe, who cover recent advances in metallurgy, metallography, including accounts of the mass of work on aluminium alloys. The section on the Electrochemical and Electrometallurgical Industries, by Dr. J. N. Pring, contains a full account of progress in the construction of electric furnaces, and in their use, such as for the manufacture of calcium carbide, electric steel, ferro-alloys and non-ferrous alloys.

Under Oils, Fats and Waxes, Mr. R. G. Pelly outlines the state of the trade in and technology of these products, and discusses drying oils, marine animal fats, solid fats, hardened oils, soap, fatty acids, and waxes. Dr. R. S. Morrell comments upon the steady increase of literature relating to Paints, Pigments, Varnishes and Resins, and provides a very full discussion of that relating to drying oils, resins, both natural and synthetic, and varnishes. Under pigments and paints, points such as the preparation of chrome pigments, the use of lead in

paint, plastic flow and other subjects receive attention. Mr. B. D. W. Luff contributes some interesting material in the section on India-rubber, special reference being made to the growing use of rubber latex. Problems of the chemical and physical properties and constitution of rubber are reviewed, other subjects in this section being vulcanisation, compounding ingredients, accelerators, ageing, testing and analysis. The contribution on Leather and Glue is due to Mr. D. Woodroffe, who deals with curing and salting, liming, bating, tanning and analysis, the " most interesting work during the year " having been done in connexion with the last-named subject. There is also a short account of work on glue and gelatin.

Mr. H. J. Page opens his account of " Soils and Fertilisers " by considering the nitrogenous fertiliser industry, showing the increasing use of synthetic products, and mentioning the newer ones. After discussing the relative efficiency of various nitrogenous fertilisers, space is devoted to phosphatic and potassic fertilisers, and to various materials for soil treatment. The report on " Soil " is confined mainly to work on methods of examination. " Sugars, Starches and Gums " are reported on by Mr. R. F. Lyle under the heads of the cane-sugar industry, the beet-sugar industry and the analysis of sugar products. Mr. Lyle finds there is not much of particular interest to report in regard to starches and gums, though reference is made to Prof. Ling's work on the determination of starch.

Mr. H. Lloyd Hind, in his account of the Fermentation Industries, notices the centenary of Pasteur, and shows how the conception of hydrogen ions is linking up isolated facts in fermentation and providing explanations for processes that were formerly empirical. Starch is dealt with at length in this report, as are enzymes, yeast and fermentation and cellulose fermentation, and an interesting description of the research scheme of the Institute of Brewing is given. In the report on Foods, Dr. Monier-Williams records advances in our knowledge of vitamins, milk and dairy products, fruit juices, and discusses the use of food preservatives, and food poisoning, and in Sanitation and Water Purification, Mr. J. H. Johnston chiefly reviews work on the theory of purification, the disposal of sewage, water supply, and disinfectants. Dr. H. King has much of interest to record in his reports on Fine Chemicals, Medicinal Substances and Essential Oils, *e.g.*, work on the pituitary hormones, on insulin, synthetic thymol, anaesthetics and hypnotics, organo-arsenic and antimony compounds. Bayer 205 and other antiseptics. Dr. John Weir contributes the section on Explosives, and remarks that there was no outstanding advance in the manufacture or application of explosives during the past year, although interesting activities were shown in certain directions.

In the course of a short notice, it is impossible to treat such a large subject in any way adequately, but it is hoped that enough has been said to show the wide scope and interest of the Reports of the Progress of Applied Chemistry, and to indicate their value to all who are in any way connected with or interested in chemistry and chemical industry.

SCIENCE AND SCIENTISTS UNDER NAPOLEON I.

By A. R. PEARSON, M.Sc., LL.B.

Fauvelet de Bourrienne, who was Bonaparte's private secretary from 1797 to 1802, referring to the fact that the class of sciences had been given precedence over that of literature in the *Institut National*, says in his Memoirs; " Considering the state of literature and science at that period, the First Consul did not make a wrong estimate of their importance. . . . Although the literature of France could boast many men of great talent, . . . yet they could not be compared with Lagrange, Laplace, Monge, Fourcroy, Berthollet and Cuvier, whose work has so prodigiously extended the bounds of human knowledge." France, during the Napoleonic period, was indeed extremely rich in men whose names are writ large in the history of science; Vauquelin, Proust, Guyton de Morveau, Gay-Lussac, Coulomb, Haüy, Biot, Arago, Lamarck, de Candolle may be added to Bourrienne's list. The state of literary depression, which prevailed throughout the Consulate and Empire, was partly due to the attitude of Napoleon himself. His practical mind was naturally attracted by science; but literature had not much appeal to him, and in his later years he disliked and distrusted literary men. They were theorists, phrasemongers. " These people," he said, " are good for nothing under any government. I give them rewards because it is my duty as Chief of State; they occupy and amuse idle minds. But I will make Lagrange a senator; there is a brain."

The period of the French Revolution was a time of revolution also in physical science. Speculation and the construction of " systems " were giving place to quantitative experiment with balance, burette and calorimeter. The overthrow of the phlogiston hypothesis by the work of Lavoisier, Laplace's investigations in celestial mechanics, and the discovery of galvanism, had not only stimulated the enthusiasm of the initiated, but had aroused a more general interest in science. This revivification or renascence was nowhere more evident than in France. The tragic fate of Lavoisier and Bailly during the Terror was quite unconnected with their status as scientific men. It was part of the result of a transient outburst of political fanaticism, and must not be construed as representing a general hostility towards science. The famous dictum of a member of the revolutionary tribunal, that the Republic had no need of savants, was meant rather to silence a petitioner than to lay down a principle of Republican government. The Jacobins made much use of the services of scientific men in the national defence; and some of the latter, who would have been condemned on political grounds, were saved on account of their possible utility to the State. It was on this plea that Guyton de Morveau saved the great mathematician Lagrange from being exiled on account of his foreign birth.

In the social reaction after the fall of Robespierre, it was fashionable to take an enlightened interest in science and literature. Thus Bonaparte writes from Paris to his brother Joseph in July, 1795:

"Luxury, pleasure, and the arts are reviving here in a wonderful manner. . . . Libraries are formed, and we have lectures on history, chemistry, botany, astronomy. . . ." In the same year, the Convention founded the *Ecole Polytechnique* as a school of pure and applied science, to rank beside the colleges hitherto exclusively devoted to law, literature and medicine. (The last of these three subjects was rather an art than a science in those days.)

The old *Académie française* and the *Académie des Sciences* having gone the way of other royal institutions in 1793, the Convention created in 1795 a National Institute, composed of men distinguished in various branches of learning. The Institute was originally divided into three classes, devoted respectively to science mathematical and physical, to science moral and political, and to literature and the fine arts. It was reorganised in 1803 under the First Consul's direction in four classes, namely :—

(1) Physical and mathematical science.
(2) French language and literature.
(3) Ancient literature.
(4) Fine arts.

It was characteristic of Bonaparte to suppress the class of moral and political science. He would not encourage discussion, criticism and possible ridicule of his government by the *idéologues* whom he so despised.

Bonaparte had himself been elected a member of the Institute in the classes of science and arts at the end of 1797, and he acknowledged his election in the following letter, which displays a clear perception of the value of research and the contribution which science can make to national prosperity :—

"CITIZEN PRESIDENT,—I am honoured by the suffrage of the distinguished men who compose the Institute. I feel that before being their equal I shall long be their pupil. If I can convey in any more expressive manner my esteem for you, I shall be glad to do so.

True conquests, the only ones which leave no regrets, are those which are gained over ignorance. The most honourable, as well as the most useful, occupation for nations, is to assist in extending human knowledge. The true strength of the French Republic should henceforth consist in not allowing a single new idea to exist without adopting it as part of its own property. BONAPARTE."

Acting on these opinions, he included in the Egyptian expedition of 1798 a band of scientific men—chemists, physicists, biologists—who were to assist in developing the resources of the country. The idea of adding a corps of savants to a military expedition was a novel one, and the party was an object of some suspicion to the rank and file during the hot and thirsty march up the Nile to Cairo. The men, having noticed that all vestiges of antiquity were carefully examined, vented their discontent in invectives against the savants ; who, they said, had started the idea of the expedition in order to carry out antiquarian researches. And when, on any alarm, they were ordered to open the square and give the learned party, mounted on asses, with their instruments and baggage, safe footing within, they used to receive it with military jests : "Room for the asses. Stand back, here come the savants and the *demi-savants* !"

One of the General's first acts after subduing the country was to form an Institute of Science and Arts at Cairo, modelled on that of Paris. It consisted of the savants, staff-officers and others interested in learning. The mathematician Monge was president, Bonaparte was vice-president, and the secretary was Fourier, afterwards famous for his work on the mathematical theory of heat-conduction. The papers read before the Institute show a great diversity of topics. Thus we find contributions by Berthollet on the occurrence of salammoniac and on the production of indigo in Egypt ; Fourier describes "a general method of extracting the roots of equations" ; and one of the staff-officers gives an account of a bust of Isis found near the Nile.

Bonaparte's intention was to plant a permanent colony in Egypt, and with this end in view he proposed a number of important practical matters for consideration by the Institute. Scarcity of fuel is a perennial problem in that country, and it is not surprising to find, among the first of these questions : What means are there of economising fuel in the army ovens ? Water supply naturally claimed attention ; the relative advantages of windmills and water-mills were discussed, and Berthollet and his assistants carried out complete analyses of the dissolved solids of the Nile water. The resources of the country for manufacturing gunpowder, and the possibility of finding a substitute for hops in beer, were other problems dealt with.

Of all his scientific advisers at this time, Bonaparte seems to have placed most confidence in Berthollet. Their connexion had begun in 1796, when Berthollet and Monge were sent to follow the victorious general in Italy, and to select the works of art which were to be sent from the captured towns to Paris. Berthollet was one of the small party which accompanied the General's sudden return from Egypt in 1799.

During the Revolutionary wars against the First Coalition, Berthollet had been employed by the Committee of Public Safety to superintend the manufacture of nitre, and this work seems to have given rise to his first ideas on chemical statics and affinity. He observed that the earthy matter from which the nitre was extracted always retained a portion of it, in spite of the fact that the aqueous solution was far from saturated ; and he attributed this to an equilibrium between the "affinity" of the nitre for the earthy matter and its tendency to pass into solution. The phenomenon is now called adsorption, and it is well known that the proportion of a substance adsorbed can vary continuously. Hence doubts arose in Berthollet's mind as to the validity of the Law of Constant Proportions. These ideas were further developed during his stay in Egypt by an investigation of the natron lakes in the desert south-west of the Delta. The action of brine on the calcareous rock has caused deposits of carbonate of soda, and these deposits were the subject of Berthollet's first paper on chemical affinity and mass action, read before the Cairo Institute. The complete theory was published in the famous *Essai de Statique chimique* in 1803.

Berthollet used to give frequent experimental demonstrations before the Institute in his laboratory, which was installed in the palace of one of the Beys. The Mamelukes had a great respect for prophets and magicians, and Bonaparte, with his usual readiness to draw advantage from circumstances, determined to oppose sorcerer to sorcerer. He therefore invited the principal sheiks to one of these demonstrations, expecting to enjoy their astonishment and to impress them with awe of the French conquerors. "But," says Bourrienne, "all the wonders of the transformations of liquids, electrical commotions, and galvanism occasioned in them no surprise. They watched our clever chemist with imperturbable calm." And when the demonstration was concluded, the Sheik, El Bekri, informed the interpreter that it was very fine; "but ask him," he said, "if he can make me be in Morocco and here at the same time." Berthollet shrugged his shoulders. "Then in that case," answered the Sheik, "he is but half a magician." The standard of professional competence for magicians has always been high in Egypt; he needs both courage and skill who will claim succession to Moses and Hermes Trismegistos, or maintain the traditions of Memphis and Alexandria.

Berthollet's services ultimately gained him the Cross of the Legion of Honour, and he became a Senator and Count under the Empire.

Bonaparte became First Consul towards the end of 1799, and in organising his administration he chose Laplace as Minister of the Interior. Laplace's studies in mathematical astronomy, his nebular hypothesis, his theory of capillarity and his proof that sound-waves are propagated under adiabatic conditions, form a sufficiently imposing monument in the temple of science: but as a minister he was a failure. Bourrienne says of him: "As to Laplace, Bonaparte always held a high opinion of his talents. His appointment to the Ministry of the Interior was a compliment paid to science, but it was not long before the First Consul repented of his choice. Laplace, so well adapted for science, displayed the most inconceivable mediocrity in administration; as if his mind, constructed to grasp the system of the universe and to interpret the laws of Newton and Kepler, could not descend to the level of matters of detail nor apply itself to the duties of the department with which he was entrusted." Laplace was indeed wasted in the ephemeral details of administration. Of his ministerial colleagues, Carnot set a high example of integrity in public life; Talleyrand has left us a few epigrams and a reputation for political agility; while Cambacérès was famed for the excellence of his dinners. But what permanent fruits have their labours given to posterity? *Tenues recesserunt consumti in ventos.* Laplace has rendered humanity a more enduring service, and can say, with Horace, *Monumentum feci aere perennius.*

Laplace was superseded after a ministry of six weeks, and nominated to the Senate. He and the First Consul, each the most eminent living man in his *métier*, had a cordial regard for each other. The statesman gave the scientist the Cross of Honour, and the scientist dedicated his *Mécanique céleste* to the statesman.

After a short period under Lucien Bonaparte, the Ministry of the Interior was again offered to a man of science, Jean Antoine Chaptal, Comte de Chanteloup.

Chaptal was primarily an industrial chemist. Although his name is still to be found in chemical textbooks, it is not associated with any fundamental discoveries such as those of his contemporaries, Berthollet, Gay-Lussac and Vauquelin. The value of his work lay in his applications of chemistry to agriculture and manufactures. Already in 1781, when professor of chemistry at the College of Montpellier, he had started a factory where he made mineral acids, alum, sal-ammoniac, white lead, copperas and other chemical products. He devised improved processes for the extraction and application of the dye in madder root, and was the author of several works on applied chemistry (*Teinture du coton*, 1807; *Chimie appliquée aux arts*, 1807; *L'industrie française*, 1816). During the Terror, on the repeated invitation of the Committee of Public Safety, seconded by the entreaties of his friend, Berthollet, Chaptal devoted himself to organising the great powder factory at Grenelle. This circumstance saved him from sharing the fate of Lavoisier, for he had been imprisoned once as a leader of the southern Girondists, and would certainly have been brought before Fouquier-Tinville as a political "suspect" had not his services been necessary to the Jacobins.

Chaptal became a member of the Institute in 1799, and was called to the Council of State in the following year. Here he came in contact with the First Consul, and in November, 1800, succeeded Lucien as Minister of the Interior. He was an active and successful administrator. It was he who was charged with the reorganisation of the Institute in 1803, and with the formation of the Society for the Encouragement of National Industry. Many useful reforms and projects in education, public works, and the improvement of agriculture and manufactures were carried out under his ministry.

As Napoleon developed his system, he no longer wanted men of independent mind. He wished everything to be under his own immediate cognisance. As Chaptal puts it*: "He needed valets, not counsellors. His ministers were merely head clerks." Chaptal was by no means this kind of man, and in August, 1804, two months after Napoleon became Emperor, he tendered his resignation, alleging the desire to resume his scientific work. Napoleon accepted the resignation, but nominated him to the Senate, where his scientific knowledge and experience continued to be of great use. Méneval, the Emperor's *Secrétaire de Portefeuille*, says in his Memoirs: "I have heard Napoleon complain that this minister did not seek opportunities to talk to him . . . and did not inform him often enough of the business of his department. Perhaps the Emperor was yielding to certain prejudices inspired by the recollection of his unsuccessful experiment in entrusting the same ministry to Laplace . . . and he thought it was a bad thing for savants to be distracted from their studies, and that they were not able to devote themselves entirely to the multifarious details of administration. . . . How-

* *Mes Souvenirs sur Napoléon.* Published by Chaptal's grandson, Paris, 1893.

ever, this was not so in the case of M. Chaptal, who was a practical savant. For the rest, he continued to be treated with great regard by Napoleon, who constantly gave this distinguished scientist the proofs of appreciation of his talents."

Chaptal rejoined the Emperor during the Hundred Days, being made director-general of agriculture, commerce and industry. His declining years were spent in agricultural pursuits at Chanteloup, where he enjoyed the society of his friends Laplace, Berthollet and Monge.

After Trafalgar, it became of the first importance to make France as nearly as possible independent of overseas products. A Council of Commerce and Manufactures, of which Chaptal was a member, was formed to advise on this problem. Strenuous efforts were made to find substitutes for indigo, cotton, cane-sugar, coffee, quinine and the like, and large rewards were offered to inventors. Chevreul, then assistant to Vauquelin at the Museum of Natural History, carried out one of the earliest researches of his long career on the colouring-matter of the woad plant (*Isatis tinctoria*), with a view to restoring it to the position in the dyeing industry from which Indian indigo had ousted it.

Coffee, so extensively used in France, was very difficult to replace. *Tisanes* of various herbs were an alternative rather than a substitute. The annual report of the Institute in 1814 mentions that an infusion of the roasted seeds of the yellow flag (*Iris pseudacorus*) is recommended, and is said to possess febrifuge properties which make it a possible substitute for quinine. Other roasted seeds and roots had been tried, but the report finally admits that "the drinks so obtained resemble coffee only in their dark colour and bitter taste."

The scarcity of sugar was the most keenly felt of all privations. Proust, the famous defender of the Law of Constant Proportions against the attacks of Berthollet, had discovered grape-sugar while working in Madrid in 1799. As the overseas markets for wines were cut off, an alternative use for the grapes was welcome; and a member of the Institute named Parmentier published in 1811 directions for purifying grape-juice and preparing a sweet syrup from it. Proust received the Cross of Honour and a considerable sum of money from the Emperor. The reward was clearly well deserved, but public opinion at that time was unaccustomed to seeing honours conferred for any but military and political services, and the learned pharmacist seems to have incurred some ridicule in the press:

"Pour avoir composé
De sirop de raisin trois ou quatre topettes,
Mon vieil apothicaire est mis dans les gazettes!"

The existence of sugar in beetroot had long been known, and the first beet-sugar factory had been started in Silesia under the patronage of the King of Prussia in 1799. The Institute therefore appointed a committee to inquire into the production of sugar from beet and other vegetables. This committee, which included Chaptal, Fourcroy, Guyton de Morveau and Vauquelin, published in 1811 "Instructions pour extraire le sucre de betterave." The first successful French manufacturer was Baron Delessert, one of the leading industrialists of the day, and a member of the Council of Commerce On hearing of the success of Delessert's process the Emperor at once rode off with Chaptal to the factory at Passy. Having examined everything, he took off his own Cross of Honour and fastened it on Delessert's breast. Under the drastic protection of the Continental System the industry grew apace; but at the Restoration, the market being suddenly flooded with the West Indian product, many factories were closed.

Napoleon recalled with pride at St. Helena that he had established a system of technical education to supply the needs of industry. From his technical colleges, he said, "hundreds of able chemists went to the different manufactories. In each of them I caused a person well-skilled in chemistry to reside. In consequence, everything proceeded upon certain and established principles, and they had a reason to give for every part of their operations, instead of the old vague and uncertain mode."† The provision of teachers for the technical colleges was the function of the Imperial University, which was created in 1806, and placed under the control of a council of eminent savants. These educational measures were drawn up and piloted through the *Corps Législatif* by the Comte de Fourcroy, director of public education under the Ministry of the Interior. Fourcroy, like Chaptal, was not only a chemist but an efficient minister. Indeed, his work in organising the educational system, successively under the Convention, the Consulate and the Empire, is a better title to fame than his chemical work; for, although he turned out a great bulk of research, chiefly in collaboration with his pupil and friend Vauquelin, much of it was superficial and hasty. He was an excellent teacher, however, and his lectures on chemistry at the Jardin des Plantes drew large audiences.

Professor Volta, of the University of Pavia, invented his electric pile in the year 1800, and the First Consul invited him to come to Paris and demonstrate some experiments before a committee of the Institute. In spite of his load of administrative work and the peace negotiations with England, Napoleon insisted on being present at the session when Biot presented the committee's report, and on his proposal a gold medal and a sum of money were awarded to the inventor. So struck was he with the importance of Volta's work, that he created an annual prize of 3000fr. for the encouragement of studies in the science of electricity and galvanism. This prize was awarded to Davy in 1808 for his work on electrolysis of solutions, and was divided in 1809 between Gay-Lussac and Thénard.

Napoleon was similarly interested by Chladni's observation that sand spread on a metal plate forms regular figures when the plate is set in vibration. After seeing the experiment he desired the Institute to offer a prize, open to all the scientists of Europe, for a mathematical theory of the phenomenon. There appears to be no record that this prize was ever awarded.

† Napoleon in Exile. A Voice from St Helena. B. E. O'Meara, 1822.

In the year 1802 the Institute was charged to present to the Council of State a report on the progress and condition of science, literature and art since 1789. Owing to the war, the report was not presented to the Emperor until 1808. The deputation of the class of science was admitted first into the Imperial presence, and after an introductory speech by the president Bougainville, the secretaries Delambre and Cuvier read the reports of their respective sections. These reports give a striking picture of the foundations of modern science in the making.

Delambre, for the mathematical section, dealt with the measurement of the arc of longitude on which the metric system is based. He was himself responsible for the northern half, from Dunkirk to Rodez, and his colleague Méchain for the rest as far as Montjouy, near Barcelona; a further extension to the Balearic Isles was carried out by Biot and Arago.

Cuvier then gave an account of the advances in physical science, of which may be briefly mentioned: Lavoisier's theory of combustion; the work of Dalton and Gay-Lussac on thermal expansion; Berthollet's theory of affinity and mass action; Haüy's proof of the uniformity of corresponding angles in crystals; the discoveries of Galvani and Volta, and Davy's applications of the voltaic pile; Jenner's discovery of vaccination; the application of chlorine to destroy "germs of contagion" by de Morveau; the analytical work of Fourcroy and Vauquelin on vital products.

The Emperor replied briefly to the deputation, assuring the Institute of his support. "The well-being of my peoples and the glory of my throne," said he, "are alike interested in the progress of science."

Méneval, who was present on this occasion, says that "the Emperor remained struck by the eloquence and clearness of ideas of M. Cuvier, who spoke fluently for several hours. Suspending the rule which he had imposed on himself, of not distracting learned men from their studies, Napoleon made M. Cuvier Master of Requests in the Council of State, and gave him a high appointment in the Imperial University."

Cuvier, whose first paper on palaeontology had appeared at the opening of the Institute in April, 1796, was in fact made a Councillor of the University, and later Councillor of State.

It has been mentioned above that the Emperor became increasingly reluctant to hear any opinion but his own on administrative matters. His contempt for men in general, the habit of despotic power, and his confidence in his star, made it useless to offer advice directly, however good the arguments by which it was supported. But he was always more receptive towards scientific men. He welcomed their conversation; he was always alive to the possibilities of their work, and ready to encourage research. The following anecdote, recounted by Chaptal himself, shows the circumspection necessary in approaching him, and at the same time proves his real regard for scientific work. The celebrated Prussian scientist and traveller, Alexander von Humboldt, had settled in Paris in 1808, and the Emperor suspected him of being a spy. "One day he ordered Savary, Minister of Police, to have him removed from Paris within 24 hours. The order was communicated to Humboldt, who at once came to me and asked me to speak to the Emperor on his behalf. I went to the soirée at the Tuileries; as usual, the Emperor drew me aside to converse.

"What is there now in the scientific world?" he asked.

"Nothing," I answered, "and were not M. Humboldt publishing his travels in Central America, we should be in a state of complete stagnation."

"These works are very important, very important?"

"They could not be more so. M. Humboldt is master of all the sciences, and when he travels, it is as if all the Academy of Science went too. It is astonishing that he has been able to collect in three years all the material on which he is working in Paris. Moreover he has adopted our country; he publishes his work in our language, he employs our engravers, our artists, our printers."

"Does he not also engage in politics?"

"His reputation brings him into contact with many foreigners, who come to see him; but I have never known him concern himself with anything but science."

"You think he is necessary to France?"

"There would be general regret if he chanced to leave us."

Napoleon called Savary, and ordered him not to put into execution the order which he had received that morning. . . . "If I had appeared to be aware of the step he had taken, and had spoken to him on the subject, I should have obtained nothing."

Napoleon's predilection for science was not entirely a white passion. It was made subservient to aggressive political designs. But whatever his ultimate motives were, we must ascribe to him this merit, that he was the first great monarch to give science its true place as a factor in human life. Others before him had indeed patronised science. The Academy of Sciences under Louis XIV. and XV. was an appendage of the Court, and the Court took an interest in the little tricks and wonders of science, just as it did in Madame du Barry's Indian dwarf or a new ballet. Frederick the Great liked to surround himself with learned men such as Voltaire and Lagrange, not so much because their knowledge was of value to the State, as because they gave an intellectual lustre to his Court. British monarchs would sign charters allowing a Society or an Institution to call itself Royal; but it is to be feared that their interest evaporated with the ink.

These rulers cannot, of course, be blamed for not seeing beyond their generations. They lived for the most part when physical science was as yet in its childhood. But Napoleon came at a time when it had begun rapidly to prove itself, and was prepared to play a fundamental part in civilisation and progress. He encouraged it to do so. His Legion of Honour was open to scientific, as well as military and political, achievements. His keen and enlightened interest in the advancement of science and his respect for scientific men are in refreshing contrast to the ruthless combativeness and self-will of the rest of his career: and under his rule science enjoyed a prestige which it had not known before.

A STUDY OF THE DESTRUCTIVE DISTILLATION OF COAL

In the first of a series of Cantor Lectures delivered at the Royal Society of Arts on February 25, Mr. E. V. Evans considered the question of coal conservation from the viewpoint of a chemist in the gas industry. After indicating the particular conception of efficiency which the gas manufacturer may acquire from a study of methods adopted in the chemical industry, he demonstrated that carbonisation as practised in the gas industry is not the wasteful process which the pure chemist has often believed it to be. One ton of coal containing 300 therms will yield about 72 therms of gas of 560 B.Th.U. per cb. ft., 17 therms of tar, and 199 therms of coke. The process loss will be 12 therms. Under conditions of low-temperature carbonisation the coal will yield about 35 therms of gas of 1090 B.Th.U. per cb. ft., 26 therms of tar, and 223 therms of coke; under these conditions the process loss will be 16 therms.

Low-temperature coke contains about 9·3 per cent. of volatile matter, and this represents about 29 therms of the potential volatile matter of the original coal which is subsequently burned in the household fire as a gas of low calorific value. It would appear that, if the process of low-temperature carbonisation is to be as remunerative as that of high temperature, the consumer of the solid fuel must be prepared to pay for practically the whole of the potential volatile therms at their true gas price. If these potential volatile therms be added to those actually obtained in low-temperature carbonisation the result is not materially different from that obtained in high-temperature practice. Thus the low-temperature process is not superior from the point of view of efficiency; it is simply a different distribution of the thermal energy of the original coal, and may be considered as a high temperature process arrested.

The secret of preventing wastage of gaseous therms and of conserving the energy of the original coal lies firstly in the possession of a well-designed retort house maintained in the highest possible state of efficiency and repair. Improvements which may be obtained as a result of laboratory investigation are of slight importance compared with the wastage that may occur owing to imperfect working conditions on a large scale. The results of working under known imperfect conditions have been examined in some detail in an experimental plant.

Particulars were first obtained relative to the volume, calorific value, and analysis of the gas evolved from hour to hour when a typical Durham coal was carbonised under standard conditions. One of the outstanding observations was the large volume of gas of very high calorific value evolved during the first few minutes after charging the coal into the retort and this led to the application of a higher vacuum during the early stage of the carbonising period for the purpose of preventing decomposition of the unstable hydrocarbons evolved during this period. An initial vacuum of 18 in. water gauge was gradually reduced until a normal vacuum was reached at the end of the first hour. Under these conditions a larger volume of gas of lower calorific value was made, but there was no apparent increase in the yield of gaseous therms.

In other experiments the normal vacuum of $\frac{1}{10}$ in. was reduced to level gauge for 10 minutes during each hour in order to reproduce the conditions under which a retort is worked in actual practice when a proportion of the retorts connected to a common retort-house governor is charged with fresh coal each hour. There was a definite indent in the volume curve when the vacuum was reduced and immediately afterwards the calorific value of the gas rose appreciably. Again the thermal yield of gas was not materially affected.

The results obtained when carbonising coal in a retort in the crown of which there was a hole $\frac{1}{2}$ in. in diameter were, however, fundamentally different. With a uniform vacuum of $\frac{1}{10}$ in. throughout there was evidence that the rich gases were being lost through the hole during the early stages of the carbonising period. During the later stages there was a more rapid evolution of gas due to the influence of the furnace gases pulled into the retort. The calorific value of the gas was reduced materially, but it was noteworthy that the manufacture of gas was prolonged over a longer period owing to the manufacture of producer gas. In this case the thermal yield of gas was slightly increased, but it was very difficult to determine what was the yield of true coal gas owing to the inclusion of the producer gas reaction. It was estimated from the gas analyses that about 2 therms of coal gas (per ton of coal) had been replaced by producer gas therms. Superior results might be obtained by continuing the process and increasing the quantity of producer gas formed. Were it desired, however, to mix producer gas with coal gas for the purpose of dilution it would be more economical to manufacture this gas in a producer and to add it under control.

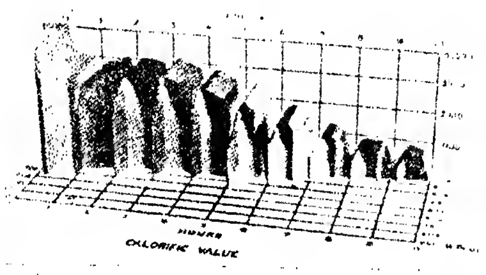

Fig. 1

The admission of air to the retort at a point corresponding to that at which the furnace gases were added resulted in the destruction of about 5 therms of true coal gas as a result of combustion. This loss was partly counterbalanced by the formation of producer gas to the extent of about 2 therms.

The admission of air through the door of the retort resulted again in the loss of rich gas by leakage during the early stages of carbonisation and in

the production of increased volumes of low grade gas during the later stages. In this case there was evidence that hydrogen had been burnt in the ascension pipe of the retort; in was noteworthy that the oxygen content of the gas was not increased.

A feature of the lecture was the number of models exhibited to illustrate the results obtained. A "thermal model" is illustrated in Fig. 1. The height represents the rate at which gas is evolved, the width, calorific value, and the length, time. Thus the volume representes the yield of gas in therms. The example illustrated shows the effect

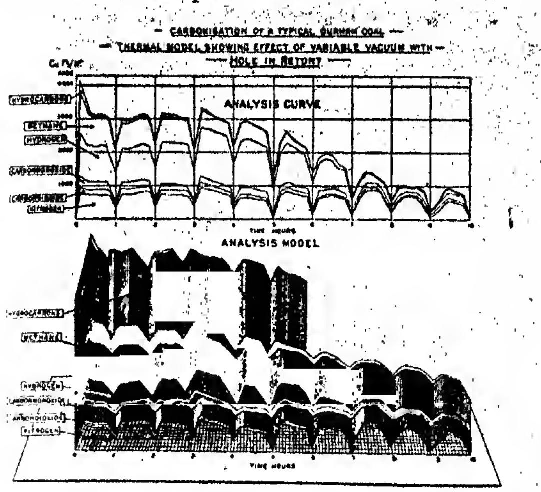

Fig. 2

of reducing the normal vacuum to level gauge each hour when there was a hole in the retort. The marked effect upon the volume and calorific value of the gas is realised at once by an inspection of this model. The volumes of the several constituents of the gas are shown in the curves reproduced in Fig. 2. In the analysis model the plan is a reproduction of the analysis curves and the height represents calorific value. Thus by dissection of the model the contribution of each constituent of the gas to the therm yield at any stage of the carbonisation is clearly demonstrated.

STEAM GENERATION AT THE CRITICAL TEMPERATURE

THE BENSON 3200 lb. PRESSURE BOILER

(From a Correspondent)

The Benson 3200 lb. pressure steam generator or coil "boiler," the invention of Mr. M. Benson, of the Benson Engineering Co., Ltd., 109, Kingsway, London, W.C. 2, which, it is understood, has now been put into operation with great success at Rugby, possesses extraordinary interest for the chemist and the chemical engineer. In the first place it means that power can be generated from coal by means of steam in large power stations at an overall efficiency of something like 28–30 per cent., even when usi the principle of condensing, as compared with, sa 17–18 per cent. for the most modern superpow station at 350 lb. pressure and 700° F. superhea This is, of course, a complete revolution in stea practice, and in fact, enables an efficiency to l obtained from raw coal almost equal to the Dies engine using expensive oil. Secondly, for the fir time we have a successful large-scale production steam at the actual critical temperature, that i about 706° F. (375° C.), equivalent to 3200 l pressure. The most familiar example to the chemi of critical temperatures of liquids is the use of carb dioxide in a thick glass tube, and it may be remen bered that this phenomenon was first observed long ago as 1822–1823 by Cagniard de la Tour, ar much work on the subject was also carried out l Faraday (*Philosophical Transactions*, 1823 and 1845 If liquid carbon dioxide contained in a glass tube slowly heated it expands and then at about th critical temperature (in this case 88·7° F.), th definite meniscus of the liquid begins to get indistin and suddenly vanishes, the whole of the liquid havir been converted into a gas at the same volume. Th exact difference between a liquid and a gas at th same volume is not known and is presumably som thing to do with molecular complexity.

In the "Benson" generator water is converte in the same way into steam at the critical temperatu of 706° F., that is, the whole mass of the water in th coils is bodily changed into steam at the same volun without the absorption of any latent heat, since th volume remains the same, about three times th original water at 60° F. It will be obvious that no latent heat is absorbed, and this figure, of cours diminishes in proportion to the rise in pressure can be seen on consulting the steam tables, there no ebullition or "boiling," that is, the sudde conversion of small particles of water into compar tively large bubbles of steam, the energy require for this increase in volume constituting the late (lost) heat. It is on these highly ingenious lin that the essential trouble of the small-bore co steam-generator has been overcome, the fact th because of the absorption of latent heat and cons quent ebullition the water will not stop in conta with the sides of the tube, and the generation steam is spasmodic and apt to be explosive. Th generation of steam at the critical temperature ha of course, completely eliminated this difficulty that narrow-bore steel coils can be used which w withstand almost any pressure; in fact, we a informed that the present installation has been teste hydraulically to 6400 lb. pressure.

The actual installation at Rugby, which is only o of a number of different arrangements possibl consists of generator coils of $\frac{3}{4}$ in. steel tube, $\frac{1}{4}$ i thick, placed to a height of 8 ft. 0 in. round an inn vertical cylinder of firebrick. This is surrounded b an outer casing of lighter refractories and a supe heater, consisting of similar coils is placed on the to the whole installation having overall dimensions 17 ft. 0 in. and 7 ft. 0 in. wide. Distilled water passed in continuously at the bottom of the coil b means of a motor-driven hydraulic force pum

working at 3200 lb. pressure, the evaporation on the trials being about 8000 lb. per hour, although 10,000 lb. is the normal figure and is easily obtained. The installation is heated from the bottom by means of an oil blast flame with heated air, simple for convenience in an experimental unit, and, of course, pulverised fuel or gas would do equally well. The water as it travels upwards through the coil is gradually raised to a higher and higher temperature, until when 90 per cent. of the total length has been traversed the critical temperature of steam 706° F. is attained the pressure being, of course, all the time 3200 lb. At this point the whole mass of the water in the coil, three times the volume when at 60° F., as already stated, is bodily and quietly converted into steam at the same volume without the absorption of latent heat, and therefore without ebullition. For the remainder of the travel in the coil the steam is then very slightly superheated to 720° F., and subsequently passed through a reducing valve, during which the temperature is lowered to 620° F. and into the superheater, being finally discharged from the latter at 1500 lb. pressure, and 850° F. It will then be used in a small high-pressure turbine, running at 20-25,000 revolutions per minute, exhausting at 200 lb., generating 350 kw. in the process, into an ordinary condensing turbine, giving a further 900 kw. down to 29 in. vacuum.

The enormous economy to be obtained by working at 1500 lb. and 850° F., will be apparent on studying the heat entropy or Mollier diagram, and in the chemical industry still further substantial economies would be possible by using exhaust steam from the second turbine at, say, 40 lb. pressure for heating and process work, or using one special turbine from 1500 lb. and 850° F., direct down to 40 lb., and little or no superheat. Further details will, therefore, be awaited with interest, as the work unquestionably represents a complete revolution in steam practice.

GRAPHITE AS A METALLIC MODIFICATION OF CARBON

The metallic character of an element is determined mainly by the presence of free electrons, which enable the element to conduct electricity without an accompanying transference of matter, make it a good conductor of heat, and produce its opacity and metallic lustre. In all these respects graphite is definitely metallic in character. It is highly opaque and lustrous, and reflects light without appreciable selective absorption; its electrical conductivity is greater than that of mercury, and the temperature co-efficient is the same in sign and magnitude as that of the majority of pure metals; its thermal conductivity at high temperatures is even greater than that of the metals. Chemically, also, graphite resembles the metals in being insoluble (without pronounced chemical change) in all solvents, with the exception of molten metals. The resemblance even extends to the power possessed by graphite of yielding the positive C···· ion in sufficient concentration to be electromotively active.—(*Chem. Ztg., Feb.* 27, 1924.)

FORTHCOMING EVENTS

Mar. 7. SOCIETY OF CHEMICAL INDUSTRY, *Chemical Engineering Group*, the Engineers' Club, Coventry Street, W. 1, at 4.30 p.m. "Adsorbents: With Special Reference to Silica Gel," by Prof. E. C. Williams. "Activated Carbon," by Major V. F. Gloag. Dinner will be held at 6.45 p.m., and at 8 p.m. discussion on the two papers will commence.

Mar. 7. ROYAL COLLEGE OF SCIENCE CHEMICAL SOCIETY. Annual dinner at the Imperial College Union, Prince Consort Road, S.W. 7, at 7.15 p.m.

Mar. 7. SOCIETY OF CHEMICAL INDUSTRY, *Manchester Section*, the Textile Institute, 16, St. Mary's Parsonage, Manchester, at 7 p.m. "Some Chemical Qualities of the Living Cell," by Prof. F. Gowland Hopkins.

Mar. 10. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2, at 8 p.m. (Cantor Lecture.) "A Study of the Destructive Distillation of Coal," by E. V. Evans.

Mar. 10. THE CERAMIC SOCIETY, Central School of Science and Technology, Stoke-on-Trent, at 7.30 p.m. "Improperly Pugged Clay, and its Effect on (a) the Wage-earning Capacity of the Operative, and (b) the Loss by Defective Ware to the Employer," by A. Hollins.

Mar. 10. BIOCHEMICAL SOCIETY. Annual General Meeting, the Lister Institute, S.W. 3, at 4.30 p.m. (1) "Demonstration of Method for Investigating Calcium and Phosphorus Metabolism in Rats," M. A. Boas. (2) "Variations in Growth-Promoting and Anti-Rachitic Value of Milk from the same Cow kept under Varying Conditions of Light and Diet," E. M. Luce. (3) "Influence of Diet and Management of the Cow upon the Calcium and Phosphorus Retention of Rats Fed upon the Milk," M. A. Boas and H. Chick. (4) "The Possible Significance of Hexosephosphoric Esters in Ossification: Part II. The Phosphoric-Esterase of Ossifying Cartilage," R. Robison and K. M. Soames. (5) "Part III. The Action of the Bone Enzyme on the Organic Phosphorus Compounds in Blood," H. D. Kay and R. Robison. (6) "The Effect of Insulin on the Phosphoric Esters Present in Blood and Muscle," H. D. Kay and R. Robison.

Mar. 11. INSTITUTION OF PETROLEUM TECHNOLOGISTS. Annual General Meeting at the Royal Society of Arts, John Street, Adelphi, W.C. 2, at 6 p.m. Address to be delivered by H. Barringer, M.I.Mech.E.

Mar. 11. ROYAL COLLEGE OF SCIENCE CHEMICAL SOCIETY. At 5 p.m., "Colloids," by H. D. Murray, B.A.

Mar. 12. INSTITUTION OF CIVIL ENGINEERS, Great George Street, Westminster, S.W. 1, at 7 p.m. Discussions on "CO_2 Recorders," introduced by C. E. Stromeyer, and "The Practical Testing of Steam Boilers," introduced by R. H. Parsons.

Mar. 12. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2, at 8 p.m. "Personal Recollections of Some Notable Scientific Men," by A. A. Campbell Swinton, F.R.S.

Mar. 12. and 13. THE INSTITUTE OF METALS, Annual General Meeting, the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 1, commencing at 10 a.m. and concluding at 5 p.m. each day. The following papers will be submitted:—(1) The Relation Between the Tensile Strength and the Electrical Resistivity of Commercially Pure Copper," W. E. Alkins. (2) "The Brittle Ranges in Brass as Shown by the Izod Impact Test," D. Bunting. (3) "The Cadmium-Lead-Zinc System," M. Cook. (4) "The Relative Corrosion of Zinc and Lead in Solutions of Inorganic Salts," J. Newton Friend. (5) "Determination of the Thermal Coefficients of Expansion of Some Commercial Metals and Alloys," J. Newton Friend. (6) "Copper-Zinc Alloys which Expand on Solidification," K. Iokibe. (7) "The Equilibrium Diagram of the Copper-Tin System," M. Isihara. (8) "The Constitution of the Alloys of Copper and Cadmium," C. H. M. Jenkins. (9) "X-Ray Studies on the Copper-Aluminium Alloys," E. R. G. P. Jette and A. F. Westgren. (10) "The Tensile Properties of Aluminium at High Temperatures," T. Martin. (11) "The Investigation of a Fatigue Failure of Brass Tubes in a Feed Water Heater—with a Consideration of the Nature of Fatigue," W. E. W. Millington and Prof. F. C. Thompson. (12) "The Effect of Casting Temperature on the Physical Properties of a Sand-Cast Zinc-Bronze," F. W. Rowe. (13) "The Aluminium-Copper Alloys. Alloys of Intermediate Composition," D. Stockdale. (14) Note on the Effect of Cold-Drawing and Annealing on Some Electrochemical Properties of a Low-Tin Bronze," H. J. Stuart Wilson.

Mar. 14. SOCIETY OF CHEMICAL INDUSTRY, *South Wales Section*, the Technical College, Mount Pleasant, Swansea, at 7.15 p.m. Joint discussion with the Faraday Society on "Slags and Fluxes in Melting and Refining, with Reference to the Problems of Slag Inclusions."

Mar. 17. BIRMINGHAM UNIVERSITY CHEMICAL SOCIETY, the Chemical Lecture Theatre, Edgbaston, Birmingham, at 5.30 p.m. "Ionisation in Non-Aqueous Solvents," by R. L. Wormell, B.Sc.

Mar. 17. INSTITUTION OF THE RUBBER INDUSTRY, *Manchester Section*, Midland Hotel, Manchester, at 7.30 p.m. "Selling Rubber Goods," by Capt. E. E. Buckleton.

Mar. 17. INSTITUTION OF ELECTRICAL ENGINEERS, Savoy Place, Victoria Embankment, W.C. 2, at 7 p.m. "Illuminating Engineering, its Application and Value to the Electrical Industry." Discussion to be opened by Messrs. L. Gaster and J. S. Dow.

Mar. 18. SOCIETY OF CHEMICAL INDUSTRY, *Birmingham and Midland Section*, the University Buildings, Edmund Street, Birmingham, at 7.15 p.m. "The Fermentation of Cacao," by A. W. Knapp.

Mar. 18. THE HULL CHEMICAL AND ENGINEERING SOCIETY, Hull Photographic Society's Rooms, Grey Street, Park Street, Hull, at 7.45 p.m. "Anthracene and its Derivatives," by W. Thevenaz, Ph.D.

SOCIETY OF CHEMICAL INDUSTRY

GLASGOW SECTION

The fifth meeting of the session was held in the Institute of Engineers and Shipbuilders, Glasgow, on February 22.

Mr. W. E. Moodie occupied the chair, and a paper by Messrs. Walmsley and Stewart on "Notes on Continuous Causticising and Cresylic Acid" was read by Mr. Stewart.

The process outlined was one in operation in the chemical works department of the Corporation of Glasgow. The various stages in the continuous process for the production of caustic soda from soda ash by treatment with lime was first described. Attention was directed to the reversible nature of the essential reaction: $Na_2CO_3+Ca(OH)_2\rightleftarrows CaCO_3+2NaOH$ and to the fact that the production of caustic soda depended largely on the strength of the sodium carbonate solution. There was no advantage in obtaining the maximum causticity—a causticity of between 85 per cent. and 90 per cent. being ideal for the treatment of tar acids. In the continuous process the settling rate of the calcium carbonate was of prime importance and was governed by (*a*) the physical and chemical character of the lime used, (*b*) the conditions of mixing the reacting substances, and (c) the presence of organic impurities in the sodium carbonate solution. The rate of causticisation was much more rapid than generally supposed and varied from 3 to 15 minutes, according to whether the lime had been slaked before mixing or allowed to slake in the carbonate solution. The temperature of the carbonate liquor was also important as rapid settling was obtained with higher temperature.

A full description of the "Dorr" continuous causticising plant was then given. The presence of organic impurities in the liquors containing the regenerated sodium carbonate affected the texture of the cake of calcium carbonate produced and by so doing the process of filtering. The caustic solution was used in the treatment of tar oils. The resulting cresylate solution was allowed to settle, evaporated and carbonated with the waste gases—containing 80—90 per cent. of carbon dioxide—from the sulphate of ammonia plant. The carbonated liquors were allowed to settle and the regenerated sodium carbonate was, after settling, returned to the feed pans of the causticising plant. The extraction of cresylic acid was next described and the character of the acid was shown to depend to a considerable extent on the character of the mother tar.

The liability of unrefined tar acids to discoloration on exposure to light was commented upon. The discolorisation in alkaline solution was found to be due to the absorption of oxygen. It had been proved that on separating a distillate into two fractions, those distilling above and below 206° C., the lower boiling fraction would not, in alkaline solution, absorb oxygen to any extent. The higher boiling fraction did absorb oxygen. In works practice a certain amount of purification took place

as some of the bodies responsible for the discoloration dissolved in sodium carbonate solution, giving rise to a dark coloured alkaline liquid. The substances show the chemical characters of both acids and phenols and are soluble in water, which accounted for their presence in the drainage water from tarred road surfaces. It was suggested that the toxic character, towards fish, of such drainage water might be due to these substances.

The property, which cresylic acid possessed, of darkening in sunlight was detailed and shown to be due to two distinct reactions. (1) A slow development of a pink colour—of purely academic interest, and (2) a rapid development of a dark red colour—a property associated only with certain samples of cresylic acids. The mechanism of change was believed to be similar in the two cases.

An interesting catalytic action of "conditioned" metals was mentioned as being responsible for the production of a red colour. Freshly distilled samples of cresylic acid—of the darkening variety—turned red when boiled under a reflux condenser and in contact with a steel strip. The peculiar "pitting" action of cresylic acid upon aluminium was mentioned. A useful practical test to ascertain whether, or not, a sample of cresylic acid would darken on standing was given. An acid, which on warming with paraformaldehyde, did not darken in colour was not likely to undergo change on standing.

An animated discussion followed and largely centred round the disposal and value of the "cake" of calcium carbonate formed in the cauticising process. It was mentioned that this waste material could be used as a "filler" for tar preparations and also for agricultural purposes provided that it was sufficiently dried and of low caustic and phenolic content.

BRISTOL SECTION

At the meeting held on February 7, a paper entitled "Further Applications of Thallium Compounds. I. Thallous Hydroxide" was read by R. C. Menzies and E. M. Wilkins.

The convenient solubilities and ease of crystallisation of most organic thallous salts, the insolubility of the iodide, and the ready solubility of the hydroxide in water with formation of a strongly alkaline solution, make a standard solution of the hydroxide a reagent by means of which almost any acid may be titrated with simultaneous formation of a readily analysed salt. Thallous normal adipate and pimelate made in this manner are described, the latter being more readily soluble in water than the former. Dilute aqueous solutions of thallous palmitate and oleate behave as dilute soap solutions forming froths on shaking, only the oleate giving a froth permanent in the cold. Thallous oleate is soluble in ether. When salts of the alkali metals are too soluble for convenient preparation information as to their probable nature may be obtained by preparing the more sparingly soluble but generally isomorphous thallous salts. Thus the thallous salt of salicylaldehyde (m.p. 186° with decomposition) crystallises in yellow needles from a solution of salicylaldehyde in an equivalent amount of 10 per cent. (= ·0453N) aqueous thallous hydroxide, while the addition of acetone dicarboxylic ester to the same reagent in the cold causes the immediate formation of the crystalline monothallium salt.

On February 16 a successful dinner of the Bristol and South-Western Counties Sections of the Institute of Chemistry and of the Society of Chemical Industry was held at the Royal Hotel, College Green, under the chairmanship of Mr. M. W. Jones, supported by Messrs. W. J. U. Woolcock (general manager of the Association of British Chemical Manufacturers), R. D. Littlefield (H.M. Alkali Inspector), E. Halliwell and R. Robertson (Bristol Gas Co.), J. Bernard (manager, Netham Chemical Works), Prof. F. Francis, Prof. J. McBain, Dr. T. Howard Butler, Mr. A. Marsden and Mr. A. Wintle.

Following the loyal toast, the chairman regretted that Sir E. Cook had been prevented from attending by illness.

Mr. R. D. Littlefield, in proposing "The Society of Chemical Industry," outlined the history of the Society and said that the Society was recognised as the leader in all matters affecting the interests of the chemical industry and of those connected with it. The Society had life and vigour and so had the elements necessary to continue its vigorous existence. In reply, Mr. W. J. U. Woolcock, after reading a letter in which the President, Dr. E. F. Armstrong, F.R.S., regretted his inability to be present, spoke of the progess of the Society during the past year and said the Council was most anxious to obtain the closest co-operation between the Sections and the Council. After paying a tribute to the work of the Bristol Section, and to that of its hon. secretary, Mr. Marsden, Mr. Woolcock then discussed the need for informing the public, referring to the great demonstration of chemical industry and chemistry to be provided in the British Empire Exhibition, and the movement for *rapprochement* between scientific societies.

Prof. J. W. McBain then proposed "The Institute of Chemistry," paying a warm tribute to its work, and Mr. G. S. W. Marlow replied. Dr. T. Howard Butler proposed "The University of Bristol," to which Prof. F. Francis responded. A musical programme was provided.

CHEMICAL ENGINEERING GROUP

On February 26 a symposium was held jointly with the Institution of Mechanical Engineers on "The Treatment of Water for Industrial Purposes."

In the first paper, Mr. J. P. O'Callaghan described the sedimentation and filtration of turbid river water for works use, illustrating his remarks by means of the Beckton plant. This plant, one of the largest in use, deals with four million gallons of Thames water daily, and consists of four sedimentation basins of great efficiency and eight rapid sand filters of the gravity type. Lime is added in suitable proportions and the treated water is allowed 4 hours for reaction and sedimentation. By this means the Gas Light and Coke Co. relieves the

London water board from supplying over 1000 million galls. per annum. Mr. O'Callaghan then described softening by the lime-soda process, of which he showed the advantages to boiler users, and softening by the Permutit zeolite process.

Mr. B. Heastie, B.Sc., discussed the chief methods for the purification of water, viz., distillation, filtration, water softening by purification, softening by filtration through zeolites, and the use of boiler compounds. In conclusion the author considered physical purification by means of heat, the action of vacuum and by electrolysis, and the elimination of iron. The extraction of oil was treated under the heads of mechanical, chemical and electrolytic methods. The paper was richly illustrated by numerical and other data.

"Water Softening by Means of Doucil", was the title of the contribution by Messrs. T. P. Hilditch and H. J. Wheaton. The softening effect of natural zeolites was largely a surface action, so that only a small proportion of the soda content was utilised. If suitable porosity and surface could be secured, a base-exchanging compound could be made in which a much larger proportion of the combined soda could be utilised to produce soft water. This had been realised by Messrs. J. Crosfield & Sons, Ltd., who had discovered how to produce a complex silicate containing replaceable combined soda in the form of a dried gel. The dried product contained 13·3 per cent. Na_2O, 22·0 per cent. Al_2O_3, and 64·7 per cent. SiO_2; rather more than 3 per cent. of the soda was converted into non-exchangeable calcium silicate, and the remaining 10 per cent. could be completely replaced alternately by lime and soda. In practice and if completely softened water were required, about 40 per cent. of the exchangeable soda, or 4 per cent. of the weight of anhydrous doucil present, was exchangeable for lime before the doucil allowed appreciable quantities of calcium or magnesium salts to escape. The production and application of doucil were described in detail.

Mr. H. W. Coulson read a paper on "The Treatment of Condensing Water"; in which he discussed the use of water contaminated with minute organisms and showed how the use of a minute dose—sometimes as little as ½ part per million—of chlorine inhibited the formation of the jelly-like deposit that was otherwise produced, preventing heat transference, causing loss of vacuum, and entailing frequent cleaning. Experience gained in a number of power plants indicated that there was no danger of corrosion due to the chlorine, which, apparently, was at once absorbed by the organic matter in the water.

BIRMINGHAM UNIVERSITY CHEMICAL SOCIETY

At a meeting of the University of Birmingham Chemical Society, held on February 18, a paper was given by Mr. G. E. Forstner, B.Sc., on "Vitamins: their Chemistry and Importance to Life."

The speaker sketched briefly the growth of the idea of vitamins, discussed the work of Eykman and Hopkins, and showed how the three vitamins influence growth in animals. Vitamin B and beri-beri were then described, mention being made of the isolation of a very rich vitamin fraction, by Funk. Vitamin C was the least stable of the vitamins, and a deficiency of this in the diet was the cause of scurvy. Vitamin A and the deficiency disease rickets were dealt with. It was suggested that this vitamin may be of an aldehydic nature and contained no nitrogen. Vitamins were also of some importance in the vegetable world. Their influence on yeast growth and bacteria was mentioned and the effect of "auximones" on plant growth referred to.

SOCIÉTÉ DE CHIMIE INDUSTRIELLE

On February 11, the Fuels Group met under the presidency of Monsieur R. Etienne to discuss the refining of petroleum.

Monsieur A. Guiselin, member of the General Petroleum Committee, considered the necessity for the scientific extraction in France of petrol and oils from petroleum and the future of petroleum in Madagascar. The question of origin was lightly touched upon by the speaker, who traced the necessity for refining crude oils to yield petrol, paraffin, lubricants, fuel oils, etc. The first use of petroleum was for lighting as a substitute for shale oil, but further uses had been developed. If, during the initial period, only one quality of crude oils had been available, such results could not have been obtained, especially in the absence in those days of methods for separating or modifying the constituents. It is owing to the many qualities of natural oils that the variations in commercial needs could be met at the beginning, but in 1910 there was a crisis in the production of petrol which was avoided by the excess production of crude oils so that stocks of by-products grew apace. The war equalised matters by the great demand for residues, but later caused a new crisis owing to the enormous increase in the demand for petrol which had to be made either by recovery from natural gas or by cracking. At present equilibrium had not been established, and the refiners concentrated on the oil fields were profiting from the situation. Owing to this situation the consuming countries were affected by variations in the markets in neighbouring countries; thus France, requiring small amounts of residue, had to pay highly for them because England required a large amount. This dependence would be less felt were it possible to import crude petroleum from all sources and refine them as required. Monsieur Guiselin then discussed the report of the U.S. Geological Survey in 1921, and criticised the opinion therein expressed that exhaustion of the world's resources of petroleum was approaching. He then quoted figures from American literature to uphold the contrary argument. In discussing refining, the speaker pointed out that the American gallon varied in weight, and drew the conclusion that refining was immensely profitable to the American refiners and could be equally profitable to France were

crude oils refined there. He then considered the numerous advantages, technical, transport, economic, storage, of refining petroleum at the point of consumption. Concluding the first part of the address, Monsieur Guiselin discussed technical problems of refining, such as treatment of emulsions. In the second part of the address, the oilfields of Madagascar were discussed. These fields were discovered in 1899 by an engineer prospecting for coal, and since 1919 many efforts have been made to persuade the public authorities to pay attention to them.

Professor L. Bertrand then followed with a paper entitled "General considerations on the Bituminous Sands and Grits of Madagascar," which described the results of a mission carried out in Madagascar by the speaker and Monsieur Joleaud. It was concluded that these bituminous deposits were the residues of old oil-fields which had lost almost entirely the lighter oils owing to the fact that the triassic sands of that region had been long deprived of their former covering of more recent and impermeable strata. It seemed, he said, that there was little chance of finding petroleum in commercial quantity in regions where triassic sands are uncovered, an opinion borne out by borings in another locality. This, however, did not imply that no petroleum was to be found in Madagascar, as there was every reason to suppose that oil-fields did exist there, but a thorough geological study was needed of the region before exploration could be begun satisfactorily.

INTERNATIONAL CEMENT CONGRESS

The Institution of Structural Engineers is arranging to hold an International Cement Congress at the International Building Exhibition, Olympia, London, on Tuesday and Wednesday, April 22 and 23, 1924.

It is proposed that the following and probably other subjects shall be discussed during the course of the Congress :—

1. Ciment fondu in practice.
2. Surface dust on concrete floors in factories.
3. Cement in sea water.
4. Cement in concrete roads.
5. Preparations to withstand oil.
6. The influence of size and shape in compression test blocks.
7. Microscopy of cement.
8. Porosity of concrete blocks.
9. The use of sea water in mixing cement.

The papers in these subjects will be grouped and printed in advance so that when the Congress meets a group of papers may be taken as read and discussed without waste of time.

The hours of meeting of the Congress will be 11 to 1 and 3 to 5 on each day.

The Council of the Institution believes that this Congress will do much towards the solution of problems which confront chemists, engineers, manufacturers and others connected with the cement industry.

The Council of the Society of Chemical Industry has nominated Dr. Geoffrey Martin and Dr. David Prentice as its delegates to the Congress.

CORRESPONDENCE

THE PROFESSION OF CHEMISTRY AND ITS POSITION

Sir,—The Editorial in the issue of February 22 once again laments the fact that chemistry is not, as yet, a "closed" profession, and as usual, a comparison is made with the professions of law and medicine.

I venture to submit that this attitude is open to criticism which, though it may not be generally accepted, is, I maintain, not altogether unreasonable. There is but little real analogy either in its origin, or in its relation to the general public between the profession of chemistry and those of law and medicine, with which it is compared. The legal professions are actually "closed," for as is well known, they can only be practised by those who either have been called to the Bar or have passed the examinations of the Law Society. Its unique position is derived, no doubt, partly from its ancient association with Ecclesiastical Authority and partly from the privileges with which law makers, even in comparatively primitive states of society have hedged themselves about. It is in many ways an entirely unproductive profession (except to its practitioners) and its cost to the community is one of the overhead charges which are part of the price of a complicated state of society.

Medicine on the other hand, though for practical purposes largely a "closed" profession, is not absolutely so, for there is nothing to prevent anyone practising the art of healing, providing they do not hold themselves out to be legally qualified, though such unqualified practitioners are, of course, in a serious position if accidents happen in the course of their treatment.

The legal qualification to practise medicine is the entering of the name of the practitioner on the Medical Register of the General Medical Council, but there is this difference between medicine and law, that in the former there are several qualifications which entitle the holder to registration, for a degree in medicine of a British university and also the various diplomas of the Conjoint Colleges of Physicians and Surgeons and the Society of Apothecaries are, *ipso facto*, registrable. In passing it is worth remembering that these qualifications do not merely involve theoretical training, but also actual practical experience. The esteem in which the medical profession is held by the public is due to its intimate association with individuals, for they attend both to one's arrival and departure from this world, and their assistance is called in to deal with those "ills which human flesh is heir to."

No such conditions apply to the position of the profession of chemistry, nor are they likely to, for despite the admitted importance of chemical science to the community, the personal services of chemists are never likely to be required by the average member of the public.

It is therefore unlikely that the Legislature will take action to put the profession of chemistry into a position similar to that of medicine, for it would argue that the usual employers of chemists not being the

general public are or ought to be the best judges of what qualifications are desirable. In actual fact, in cases where chemists have to undertake statutory duties in official appointments—*i.e.*, Public Analysts and Official Agricultural Analysts—the profession is, for practical purposes, more or less closed, for it is now almost invariable for appointments to these positions only to be sanctioned by the Government Departments concerned when held by Fellows (or Associates) of the Institute of Chemistry.

It cannot be said therefore that the State has been altogether neglectful to provide for a standard of competence in practitioners of chemistry where the interests of the public demand such.

It may be doubted if excessive introspection is any more a healthy sign in a profession than it is in an individual, and the public, if they take any interest in this matter, may well think these continual complaints neither dignified nor reasonable, for in the end the status of a profession in the public esteem depends more on the attitude of its practitioners than on the intrinsic value of their services to the community.

In discussing the general position of the profession of chemistry it would be more reasonable to compare it with the profession of engineering. Both are of comparatively recent growth, and the relationship of the bodies granting diplomas are similar. In both cases it was realised in the early years that the academic training of the universities and colleges of university rank was not altogether adequate, and chartered bodies were organised within the professions with powers to examine and grant diplomas of competence, the qualifications for which required not only a high standard of theoretical knowledge, but also of practical professional work. There is, however, this difference, that in the case of chemistry there is only one body, the Institute of Chemistry, which grants diplomas in several branches of chemistry, whereas in the case of engineering there are different institutions such as those of the Civil, Mechanical and Electrical Engineers, each dealing with its own branch of the science. To this extent then the profession of chemistry is more united and better organised than is engineering.

In both cases the actual word "chemist" or "engineer" has a wide significance, and is used by many whom the chartered bodies would not recognise as in any way qualified practitioners of their science—in the case of chemists the position is unfortunately complicated by the Pharmacy Acts giving the title "chemist and druggist" to those who are legally on the register as qualified to sell and dispense poisons within the meaning of the Acts, so that to the general public the word "chemist" connotes the keeping of a pharmacy store. On the other hand, the gentlemen who quite recently held up the railway traffic of the country call themselves "Locomotive Engineers," though it is permissible to doubt if they could any more design a locomotive than could a chemist, whilst a plumber, whose business is expanding, blossoms out into a "Sanitary Engineer."

The word "profession" again offers some difficulty, for in its widest significance it connotes the art of publicly announcing one's skill in an art or science, and is quite loosely used—one has heard of "professional ratcatchers," Professor "So and So," the famous prestidigitateur, and so forth. In the case under discussion it is arguable that it is permissible to restrict the phrase "profession of chemistry," to connote only those who practise this science in virtue of holding the technical diploma of the chartered body—*i.e.*, The Institute of Chemistry.

It must be admitted that even if the phrase "profession of chemistry" be limited to this, it is not practical politics to attempt to limit the use of the word "chemist" to the same limited significance, at any rate without the voluntary reliquishment by the pharmacists of the claim to this title.

There are, of course, many distinguished "chemists," especially among the members of the teaching profession, holding academic qualifications of a high order who are not at present members of the profession of chemistry in the restricted sense indicated, but unless and until university degrees in chemistry involve definite practical professional training, in addition to theoretical knowledge, which, to return to the analogy of medicine, is fully comparable with the "clinical" experience necessary for a degree in medicine, it is perfectly reasonable to regard such as insufficient qualifications for membership of the profession of chemistry.

The Institute of Chemistry has already done much to open its portals to all *bona fide* chemists, indeed more than some members think altogether desirable. In the near future it may be hoped that all chemists worthy of the name will take these qualifications for it is increasingly probable that without them it will be impossible for a chemist to obtain a first-class post. This has already largely occurred in engineering, for in advertisements for engineers it will usually be seen that the applicants must hold the diploma of the appropriate chartered body.—I am, Sir, etc., C. L. CLAREMONT

247, Kennington Road
London, S.E. 11

INTERNATIONAL CHEMICAL RELATIONSHIPS

SIR,—Your columns are scarcely the place to indulge in a historical discussion, but editorial matter is legitimate game, and on February 29 your remarks contain much on which comment is needed.

With the motive and tone of your article no one can quarrel, and it is refreshing to find one of our leading technical journals recognising, what has long been forgotten, namely, that the search for knowledge should be above the barriers that divide nations from each other.

In your remarks on the relationship between French and German chemists you say, "During the last sixty years . . . now defend." There are two questions which must follow a comment like the one just quoted. Can any intelligent chemist anywhere, who has taken the trouble to study the history of the matter deny: (1) That in the Franco-Prussian war France got what she asked for, and richly deserved. (2) That the increasing mass of evidence goes to show that there is little to choose

between the culpability of France, Germany and other countries for the outbreak of 1914.

As for the fact of invasion, Germany was invaded by France's ally on her Eastern frontier in a manner which left nothing to be desired even by the most whole-hearted anti-German. The question of invasion is about as broad as it is long. International amity will never be secured while we maintain the fiction of a pariah nation who attempted to upset a number of friendly, innocent, unprepared neighbours, and no German chemist who is worth his salt will ever acquiesce in such a preposterous version of what occurred.

It is interesting to observe how the passion for investigation and truth seems to leave scientific men of all nations when they deal with matters outside their own science. Why, say on a matter like the origins of the war, is it left to a historian like Mr. Gooch to display the real scientific attitude while scientists display all the prejudice and partisanship which one associates with the street corner rather than with men whose life work is the careful pursuit of knowledge.

One recent instance of this attitude occurs in Mellor's recent "Inorganic Chemistry," where, in dealing with the Stassfurt deposits (p. 428, vol. 2), the author disfigures his book by introducing a wholly irrelevant comment on the origins of the recent war, which merely shows that on matters outside his own province the author is as unscientific as he well can be. Truly the fact that a man is a great chemist does not mean that he is a great scientist.—I am, Sir, etc.,

Wallsend-on-Tyne T. WALLACE

SIR,—The writer has read your "Editorial" in the issue of February 29 with a good deal of interest. Do you not think that your suggestion rather tends to show that, as a matter of fact, German scientific men are still of the same opinion as they were in 1913 or 1914? Surely, for a really repentant man, a suggestion such as you offer is unnecessary. If the man is repentant, he will confess and acknowledge that he has done amiss, without undue prompting. Do you not think that your "Editorial" might be misconstrued by the French, who have been invaded considerably oftener than twice by the German nation, and whose attitude is one of ineradicable suspicion? They would probably say that writing such as yours cannot be its own reward. And offers such as yours would make things worse. The writer's recollection is that Germany and France have fought considerably more than 30 or 40 times in the last 500 years, and in the majority of these cases France has been invaded.

Before the war, the writer has been told by Germans, in his own office, that we were a dying nation; that Germany intended to occupy our place, and that of France; that force was the only argument that really mattered. It is impossible to deal with this idea, except by meeting it on its own ground.

The writer very diffidently ventures to suggest that we are here as a nation to do judgment and justice, and neither of these have been accomplished. Germany has not yet suffered to anything like the extent she made other nations suffer. She has not yet made adequate restitution, or repayment, or done anything, except attempt to evade the consequences of her actions. She has appealed to force, and until she is compelled, by force, to feel retributive justice, she will be unrepentant. Offers like your own—no matter how well-meaning—will simply be used as an argument for escaping the penalties she should be compelled to pay. As a chemist, you will understand that the balance should be equipoised—that is justice. No correct analysis can be given if that fundamental law were trifled with—and you cannot speak about mercy unless it is founded on justice. The writer says this while bearing in mind the verdict of the Roman General, who summed up the Teutons in his day: "Cunning in ferocity; born to lie." It would seem that this strain of mentality is not yet extinct in the German "Republic," and it would be well to think of it in making any suggestions of the kind you have done. In other words, Germany must first of all prove by deeds, and not by letters, that she is willing to recompense all those countries she treated so barbarously. Apparently, you seem to have some faint agreement with the writer in your remarks on the Hamburg declaration of The Association of Tropical Diseases. This is hardly a sign of a repentant race, is it? And what effect would the letter you suggest, signed by a dozen scientific men, have on a nation like France, and to what extent would it represent the seventy millions of people who constitute Germany?—I am, Sir, etc.,

Wolverhampton T. MOORE HICKMAN

[We do not think our columns are suitable for the discussion of history or foreign politics; if any correspondents can make suggestions for more cordial relations between foreign chemists we shall welcome them.—ED.]

THE EPILATION OF SKINS

SIR,—When we have lived for another 5000 years we may be in a better position to judge whether Mr. Jerome Alexander's mummies are better than those of the Ancient Egyptians. His criticism of my knowledge of rigor mortis would be fairer if he quoted my remarks more fully and did not leave out a subsequent sentence "and probably other times as well," which supplies the omission he complains of. But my paper was not a dissertation on rigor mortis, information on which can be found in textbooks on physiology; it merely outlined the connexion between rigor mortis and its resolution with epilation and bating.

While all leather workers appreciate Mr. J. T. Wood's unbounded zeal for research it is obvious that, neither he nor any other individual could have made himself thoroughly acquainted with all the highly technical sciences concerned. It is not surprising, therefore, that he begins his criticism of a medical subject with a "howler." He demands the word "depilation" which means pulling the hair down. An animal has to be described as standing in a certain posture (*e.g.*, man at attention). We cannot pull the hair down from the top of his head any

more than we can pull the epidermis up from the soles of his feet. The skin is the outermost organ of the body not the uppermost or lowermost. Therefore the hair can, anatomically, only be pulled out. It is as easy to be accurate as inaccurate and saves confusion in science. Mr. Wood's second "howler" is "bacterial trypsin." Shade of Pasteur! Trypsin is a name given to a specific enzyme system made by an animal's pancreatic gland and has nothing to do with bacteria which are vegetable organisms. His third "howler" is to misquote my nomenclature and thus attempt to make it appear that I, also, am not conversant with my subjects. I do not think it just for him to misquote people, especially when he is criticising the quotation.

His statement that I "had no knowledge of tanning" may or may not be true, but what has that got to do with it? Tanning is not mentioned in my paper. Why Mr. Wood should choose me to hurl this onslaught at I do not know; I have never yet expressed any knowledge about tanning. I fancy that he must be thinking of somebody else.

He goes on to say that I am not telling the truth in my paper but produces no evidence to bear out his accusation. In my paper I have been frank and open, describing not theories, as he alleges, but experimental facts as lucidly as I can so that anybody, including Mr. Wood, can repeat the experiments. Yet he does not do this, but merely produces statements. For instance, he has examined the limes and has found few enzymes there. But we are vouchsafed no details; we do not know what tests he refers to or which class of enzyme he has tested for. Completely ignoring my experiments he declares that ammonia will unhair a hide, yet he does not tell us what precautions were taken to remove or stop the action of thrombase at the hair-roots. One can put skin into ammonia as I described, but that is no proof that it is the ammonia which is doing the unhairing. Perhaps Mr. Wood will be kind enough to give us the technique for the exclusion of thrombase and saproprotease from the experimental "ammonia unhairing" to which he refers.

Mr. Wood's strictures about the medical profession will cause them to listen to him when he can tell them something new about the chemistry of childbirth or even lupus of the skin. He will then also hear of Hunter's famous advice to Jenner to "Be accurate." It is as important to be as accurate in controversy as in nomenclature, and to place, as I have done in my paper, one's cards on the table. As I have tried to demonstrate experimentally, the blood in the skin is a valuable agent for the tanner. Blood is probably the most important and powerful chemical in the world, yet I have not seen the word given even a line in a leather chemist's index, in spite of the fact that tanners deal with an organ which has recently been an elaborate living structure—the skin.

Mr. Wood refers me to a paper by Mr. Collett, which only seems to refute Mr. Wood's former finding about the bacterial infectivity of the limes.—I am, Sir, etc., H. C. Ross

Liverpool

PERSONAL AND OTHER NOTES

Prof. W. H. Perkin, F.R.S., Waynflete Professor of Chemistry in the University of Oxford, has been elected to the board of the British Dyestuffs Corporation, Ltd. Prof. Perkin has for some time supervised the research department of the Corporation, and he will continue to do so whilst serving as a director.

Dr. J. I. O. Masson, M.B.E., reader in organic chemistry in the University of London, has been appointed a fellow of University College, London.

Sir Arthur Duckham, the well-known authority on the carbonisation of coal, is at present visiting the United States in connexion with the development of carbonisation in that country.

On February 15, the degree of D.Sc. was conferred on Mr. F. A. Freath, director of the scientific laboratory of Messrs. Brunner, Mond and Co., by the University of Leyden for a thesis on "The Ternary and Quaternary Equilibria in the System Sodium Perchlorate—Ammonium Sulphate—Ammonium Perchlorate—Sodium Sulphate—Water."

The retirement of Dr. H. J. H. Fenton, of the University Chemical Laboratory, Cambridge, is announced.

It is reported that Mme. Curie has been given the freedom of the City of Warsaw in recognition of her researches on radium.

The Council of the Royal Society has decided to recommend for election in the Society the following candidates:—Dr. T. N. Annandale, Mr. J. E. Barnard, Prof. J. F. Gemmill, Dr. M. H. Gordon, Prof. P. Groom, Dr. C. K. Ingold, Prof. P. F. Kendall, Prof. L. V. King, Prof. L. J. Mordell, Dr. T. Slater Price, Prof. C. V. Raman, Prof. L. J. Rogers, Dr. Alexander Russell, Prof. C. Spearman, and Dr. F. Twyman.

Mr. Theodore Rendle has taken up the appointment of technical works manager to Messrs. Chivers and Sons, Ltd., Histon, Cambridge. Up to the present, Mr. Rendle has acted as technical consultant to the group of polish manufacturers associated with Messrs. Hargreaves Bros. & Co., Ltd., of Hull, being a director of Hargreaves (London), Ltd., and chief chemist to Messrs. E. Brown and Son, Ltd., Manufacturers of Meltonian Polishes.

Protest against the Proposed Anglo-German Dyestuffs Agreement

A protest against the proposed agreement between the British Dyestuffs' Corporation and the Interessen-Gemeinschaft was made by a deputation from the British Association of Chemists, which was received by the President of the Board of Trade, the Rt. Hon. Sidney Webb, M.P. The deputation, which was introduced by Mr. C. S. Garland, consisted of Messrs. J. T. Allpas, J. Barr, E. M. Marchant and A. Stewart Mills.

Mr. Sidney Webb expressed his pleasure at meeting the representatives of the chemical profession, and expressed the view that the present Government had the greatest sympathy and appreciation of the labours of scientific workers. The future, not only of this nation but of civilisation, was to a large extent in their hands, and the problem facing statesmen of all countries was that of reconciling scientific progress with the social and economic aspirations of the community. He was not at all certain whether

members of the deputation present were in possession of that solution of all economic problems, the application of the infinite resources of atomic energy to production and social needs, but he was conscious that it was in the direction of the utilisation of hitherto undiscovered forces that progress would be made, and he was confident that the world in the year 2000 A.D. would be as different from the world of 1924 as the world of to-day differed from that of a century ago. He did not visualise in the immediate future the possibility of scientific men being placed in control of the whole administrative machine; the scientific man must for a long time at least depend upon the lay administrator and the representatives of democracy, politicians, liaison officers, and the interpreters of the conscious consent of democracy.

Members of the deputation expressed their concern for the future of the organic chemical industry if the terms of the proposed agreement were correct. The possibility of the British Dyestuffs Corporation becoming the mere agents for the United Kingdom for the I. G. must have a disastrous effect upon the industry in this country, and completely reverse the policy of H.M. Government with regard to the building up of the industry which was regarded as one of our first lines of defence in peace and war. The dyestuffs industry was the only training ground for technological chemists. The dyestuffs industry was not merely concerned with the manufacture of dyestuffs, but was at the basis of the whole organic chemical industry with its innumerable products applied to services of the community in the most diverse spheres. The comparative failure of the British Dyestuffs Corporation was attributed to the want of appreciation of science and the attitude of hostility to the technical directors of the Board by those whose interests were purely commercial, and a plea was made for the strengthening of the scientific direction of the Corporation. In marked contrast to the failure of the British Dyestuffs Corporation figures were given where the dyestuffs industry of this country had carried on successfully and profitably under the direction of scientific men. In one case production had been quadrupled since the year 1920, and the scientific staff correspondingly increased. It was emphasised that the superiority of the German Dyestuffs Corporations was due to the scientific direction and appreciation of scientific work in Germany, and that if the same condition prevailed in this country we need not fear German competition, given the necessary protection which has been promised under the provision of the Dyestuffs Act.

In reply it was stated that no definite agreement had been submitted to the Board of Trade, and that before any such statement could be ratified it would have to be ratified by the shareholders of the British Dyestuffs Corporation at a general meeting, and would require the approval of H.M. Government. Before that approval could be given full consideration would be given to all parties interested. A full consideration would be given to the points now raised by members of the deputation and the interests of dyestuffs makers other than the British Dyestuffs Corporation.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

In spite of labour troubles the demand for heavy chemicals is well sustained, but there are no fundamental changes in prices to report. The effect of the revision of the German reparation levy is somewhat obscure, and it remains to be seen whether the rebate of the duty will be counterbalanced by the increased cost of manufacture, caused partly by the stabilisation of the currency.

Acetic Acid, 40% tech. ..	£24 per ton. Fair inquiry.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5½d. per lb.
Potass. Chlorate	3d.—3¼d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76% ..	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton carr. paid. In
Sod. Bisulphite Powder 60/62%	£19—£20 10s. per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis ..	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included

RUBBER CHEMICALS

Antimony sulphide ..	Expected to advance in sympathy with the crude metal.
Golden	5½d.—1s. 3d. per lb., according to

Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.

Arsenic Sulphide, Yellow 1s. 11d. per lb.

Cadmium Sulphide .. 4s. per lb.

Carbon Bisulphide .. £24—£26 10s. per ton according to quantity.

Carbon Black .. .. Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.

Carbon Tetrachloride .. £56 per ton, drums free.

Chromium Oxide .. 1s. 3d. per lb.

Indiarubber Substitutes, White and Dark — 5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.

Lamp Black .. .. 40s. per cwt., barrels free.

Lead Hyposulphite .. 7½d. per lb.

Lithopone .. .. £22 10s. per ton.

Mineral Rubber "Rubpron" .. .. .. £15 10s. per ton f.o.r. London.

Sulphur .. .. .. £10—£12 per ton, according to quality.

Thiocarbanilide .. .. 2s. 9d. per lb.

Vermilion, pale or deep .. 3s. 4d.—3s. 6d. per lb.

Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade, but those are the only products in this section which show any activity.

Acetate of Lime—

Brown .. .. .. £14 10s. per ton d/d. Demand active.

Grey .. .. .. £21 per ton.

Liquor .. .. .. 9d. per gall. 32° Tw.

Charcoal .. .. .. £7 5s.—£9 10s. per ton, according to grade and locality. Market steady.

Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. " " 24° Tw.

Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.

Wood Creosote .. .. 2s. 7d. per gall. Unrefined.

Wood Naphtha—

Miscible .. .. 5s. per gall. 60% O.P. Dull market.

Solvent .. .. 5s. per gall. 40 % O.P. Dull market.

Wood Tar .. .. £5—£6 per ton according to grade. Demand not very brisk. Ample supplies.

Brown Sugar of Lead .. £47 per ton. Demand active.

TAR PRODUCTS

Acid Carbolic—

Crystals .. .. 7¾d.—8d. per lb. Better demand, and firmer market.

Crude 60's .. .. 1s. 10d.—2s. per gall. Firmer, with more inquiry.

Acid Cresylic, 97/99 .. 1s. 11d.—2s. 1d. per gall. Steady. Increasing business and numerous inquiries.

Pale 95% .. .. 1s. 10d.—2s. per gall. Steady demand.

Dark .. .. .. 1s. 11d. per gall. Steady business.

Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.

Anthracene Oil—

Strained .. .. 10d.—11d. per gall. Very quiet.

Unstrained .. .. 8½d.—9d. per gall.

Benzole—

Crude 65's .. .. 10½d.—1s. per gall. ex works in tank wagons.

Standard Motor .. .. 1s. 4½d.—1s. 6d. per gall. ex work. in tank wagons.

Pure .. .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.

Toluole—90% .. .. 1s. 4½d.—1s. 7d. per gall.

Pure .. .. 1s. 8d.—1s. 11d. per gall.

Xylol coml. .. .. 2s. 3d. per gall.

Pure .. .. 3s. 3d. per gall.

Creosote—

Cresylic 20/24% .. 11d.—11½d. per gall. Few inquiries

Middle Oil .. .. }
Heavy .. .. .. }
Standard Specification } 8½d.—10d. per gall. according to grade and district. Market quieter.

Naphtha—

Crude .. .. 8d.—9d. per gall.
Solvent 90/160 .. 1s. 1d.—1s. 3d.
Solvent 90/190 .. 1s. 1d.—1s. 3d.
} More inquiry. Prices show upward tendency.

Naphthalene Crude—

Drained Creosote Salts £7—£8. Fair business.

Whizzed or hot pressed £10—£14 per ton. Price nominal. No business.

Naphthalene—

Crystals .. .. £16 10s. per ton.

Flaked .. .. .. £17 per ton.

Pitch, medium soft .. 60s.—70s. per ton. More enquiry. Prices hardening.

Pyridine—90/140 .. 15s.—15s. 6d. per gallon. More demand at higher prices than of late. In the South as much as 17s. 6d. has been quoted.

Heavy .. 11s.—12s. Steady with fair business.

INTERMEDIATES AND DYES

Business in dyestuffs is maintained, but without much improvement. Prices remain firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.

Acid H. .. .. .. 4s. 6d. per lb. 100% basis d/d.

Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.

Acid Neville and Winther 5s. 11d. per lb. 100% basis d/d.

Acid Salicylic, tech. .. 1s. 4d.—1s. 5d. per lb. Steady demand.

Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.

Aluminium Chloride, anhyd. .. .. .. 1s. per lb. d/d.

Aniline Oil .. .. 7¾d.—8½d. per lb. naked at works.

Aniline Salts .. .. 7¾d.—9d. per lb. naked at works.

Antimony Pentachloride 1s. per lb. d/d.

Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.

Benzyl Chloride 95% .. 1s. 3d. per lb.

p-Chlorphenol .. .. 4s. 3d. per lb. d/d.

p-Chloraniline .. .. 3s. per lb. 100% basis.

o-Cresol 29/31° C. .. 5d. per lb. Demand moderate.

m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.

p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate

Dichloraniline .. .. 3s. per lb.

Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.

p-Dichlorbenzol .. .. £75 per ton.

Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.

Dimethyaniline .. .. 2s. 5d. per lb. d/d. Drums extra.

Dinitrobenzene .. .. 9d. per lb. naked at works.

Dinitrochlorbenzol .. £84 10s. per ton d/d. Advanced in sympathy with benzol.

Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.

Diphenylamine .. .. 3s. 3d. per lb. d/d.

Monochlorbenzol .. .. £63 per ton.

a-Naphthol .. .. 2s. 6d. per lb. d/d.

β-Naphthol .. .. 1s. 1d. per lb. d/d.

α-Naphthylamine	1s. 5d. per lb. d/d.
β-Naphthylamine	4s. per lb. d/d.
m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 5d. per lb. d/d.
Nitrobenzene	5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	4s. 6d. per lb. d/d.
p-Phenylene Diamine	10s. 6d. per lb. 100% basis d/d
R. Salt	3s. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 7d. per lb. 100% basis d/d.
o-Toluidine	7d.—8d. per lb.
p-Toluidine	3s. 10d.—4s. 5d. per lb. d/d.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The principal items are in good demand for home trade and export orders generally show some indication of an improvement, which is expected to continue.

Acid, Acetic 80% B.P.	£52 per ton.
Acid, Acetyl Salicylic	3s. 6d.—3s. 9d. per lb. Weaker tendency.
Acid, Benzoic	Commercial acid 2s. 9d. per lb. B.P. quality remains scarce at 4s. per lb.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	18s.—20s. per lb.
Acid, Citric	1s. 5½d. per lb., less 5% for ton lots. Market firm.
Acid, Gallic	3s. per lb. for pure crystal. Steady market.
Acid, Pyrogallic, Cryst.	6s. per lb., for 28 lb. lots.
Acid, Salicylic	English make, 2s. 3d. per lb., which is below the price of imported material.
Acid, Tannic	3s. 0d. per lb. for B.P. quality.
Acid, Tartaric	1s. 1d.—1s. 1¼d. per lb. less 5%. Firmer with more demand. Continental acid offered at 1s per lb. less 5% c.i.f. U.K. port.
Amidol	9s. per lb. d/d.
Acetanilide	3s. per lb. Weak.
Amidopyrin	13s. 3d. per lb. Demand negligible.
Ammon. Benzoate	3s. 9d. per lb. English make.
Ammon. Carbonate B.P.	£35 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make. Market neglected.
Barbitone	15s. per lb. Weak market.
Benzonaphthol	6s. per lb. Firmer.
Bismuth Salts	A steady market. Prices according to quantity;
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Per lb.
Potassium	9d.—10d. } Uncertain market.
Sodium	9½d.—10d. }
Ammonium	11d.—1s. }
Calcium Lactate	2s. 6d. per lb. for [illegible] English make. Prices reduced.
Chloral Hydrate	3s. 9d. per lb.
Chloroform	2s. per lb. for cwt. lots.
Creosote Carbonate	6s. 0d. per lb. Little demand.
Guaiacol Carbonate	12s. 6d. per lb. for small stocks.
Hexamine	3s. 9d. per lb. for foreign make. Weaker. Large supplies available.
Homatropine Hydrobromide	30s. per oz.
Iron. Ammon. Citrate, B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	1s. 6d.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B. P.	55s. per lb.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Prices reduced. Market quiet.
Red oxide	4s. 9d.—4s. 10d. per lb.
Corrosive sublimate	3s.—3s. 1d. „
White precip.	4s. 1d.—4s. 2d. „
Calomel	3s. 5d.—3s. 6d. „
Methyl Acetanilide	20s. per lb.
Methyl Salicylate	2s. 9d.—2s. 10d. per lb. for carboys. Slightly easier.
Methyl Sulphonal	24s. per lb. Scarce.
Methylene di-tannin	7s. 6d. per lb. In good demand.
Paraformaldehyde	3s. 6d. per lb., without much inquiry.
Paraldehyde	1s. 4d.—1s. 8d. per lb. Cheaper.
Phenacetin	7s. per lb. Dull.
Phenazone	7s. 9d. per lb. for cwt. lots. Spot prices much lower than forward offers.
Phenolphthalein	7s. 6d. per lb. Firm.
Potass. Bitartrate— 99/100% (Cream of Tartar)	88s.—90s. per cwt., less 2½%. Firm market. Inquiry good.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Ferricyanide	3s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. lb., 1-cwt. kegs included.
Potass. Permanganate	8½d.—9d. per lb. for B.P. crystal English make.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	6s. 3d. per lb.
Salol	4s. per lb. Price fluctuates.
Silver proteinate	10s. per lb.
Sod. Benzoate, B.P.	3s. 3d. per lb. In more plentiful supply.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite— Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	76s. 6d.—81s. 6d. per cwt., according to quantity. Prices reduced
Sod. Salicylate	Powder 2s. 9d.—2s. 10d. per lb. Crystal at 2s. 10d.—2s. 11d. per lb Market weaker.

Sod. Sulphide—		
Pure recryst.	10d.—1s. 2d. per lb., according to quantity.	
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.	
Sulphonal	18s. 6d. per lb.	
Tartar Emetic	1s. 4d. per lb.	
Thymol	13s. 6d.—14s. 6d. per lb. for good white crystal from ajowan seed.	

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine	13s. 6d. „	
Amyl Acetate	3s. „	
Amyl Butyrate	7s. 3d. „	
Amyl Salicylate	3s. 6d. „	
Anethol (M.P. 21/22° C.)	3s. 9d. „	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. „	
Benzyl Alcohol free from Chlorine	3s. 3d. „	
Benzaldehyde free from Chlorine	3s. 6d. „	
Benzyl Benzoate	3s. 9d. „	
Cinnamic Aldehyde Natural	17s. 6d. „	Cheaper.
Coumarin	21s. „	
Citronellol	16s. „	Much cheaper.
Citral	10s. „	
Ethyl Cinnamate	10s. „	
Ethyl Phthalate	3s. 9d. „	
Eugenol	10s. 9d. „	
Geraniol (Palmarosa)	35s. „	Cheaper.
Geraniol	10s.—17s. 6d. per lb.	
Heliotropine	9s. per lb.	
Iso Eugenol	15s. 9d. „	
Linalol ex Bois de Rose	20s. „	
Linalyl Acetate	20s. „	
Methyl Anthranilate	9s. 6d. „	Advanced.
Methyl Benzoate	6s. „	
Musk Ambrette	52s. 6d. „	
Musk Xylol	20s. „	Advanced.
Nerolin	4s. „	
Phenyl Ethyl Acetate	10s. „	
Phenyl Ethyl Alcohol	16s. „	
Rhodinol	62s. 6d. „	
Safrol	1s. 10d. „	
Terpineol	2s. 9d. „	
Vanillin	26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	14s. 6d. per lb.	
Anise Oil	1s. 11d. „	
Bergamot Oil	15s. 6d. „	Dearer.
Bourbon Geranium Oil	29s. 6d. „	
Camphor Oil	75s. per cwt.	
Cananga Oil, Java	9s. 4½d. per lb.	
Cinnamon Oil, Leaf	Very little offering.	
Cassia Oil, 80/85%	9s. 9d. per lb.	
Citronella Oil—		
Java 85/90%	4s. 10d. „	
Ceylon	3s. 7½d. „	
Clove Oil	8s. 7½d. „	
Eucalyptus Oil 70/75%	2s. 3d. per lb.	
Lavender Oil—		
French 38/40% Esters	24s. 6d. per lb.	
Lemon Oil	3s. 1d. „	
Lemongrass Oil	2½d. per oz.	
Orange Oil, Sweet	12s. 6d. per lb.	
Otto of Rose Oil—		
Bulgarian	27s. 6d. per oz.	Much cheaper.
Anatolian	21s. per oz.	„
Palma Rosa Oil	18s. 6d. per lb.	
Peppermint Oil—		
English	70s. per lb.	
Wayne County	18s. per lb.	Advanced.
Japanese	15s. per lb.	Advanced.
Petitgrain Oil	9s. 6d. per lb.	
Sandal Wood Oil—		
Mysore	25s. per lb.	
Australian	21s. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted, those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition within two months of the date given; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, 15 days after the date given.

I.—GENERAL; PLANT; MACHINERY

Applications

Brooke, and Woodall-Duckham, Ltd. Centrifugal separators. 4401. Feb. 20.

Dempster and Sons, and Toogood. Regenerator furnaces. 4545. Feb. 22.

English Grains Co., and McConechy. Drying apparatus. 3528. Feb. 11.

Evans (Allgem. Elektrizitäts-Ges.). Furnace. 4704. Feb. 23.

Farbenfabr. vorm. F. Bayer u. Co. Apparatus for producing intimate mixture between gases and liquids. 3782. Feb. 13. (Ger., 6.4.23.)

Fothergill. Evaporators. 3968. Feb. 15.

Green. Refrigeration etc. 3837. Feb. 14.

Hoenan and Leek. Separation of solid matter from gases. 3868. Feb. 14.

Higgins. Apparatus for separating liquids of different specific gravities. 4598. Feb. 22.

Imray (Meister, Lucius, u. Brüning). Expelling volatile substances by means of a stream of vapour. 4281. Feb. 19.

Jackson (Burn and Co.). Kilns. 4145. Feb. 18.

Leach. Refining-apparatus. 4505. Feb. 21. (U.S., 21.2.23.)

McLeod. 3589. *See* II.

Marks (Polysius). Drying sludge. 3534. Feb. 11.

Pfisterer. Apparatus for washing, mixing, and saturating fluids. 4373. Feb. 20.

Pfisterer. Apparatus for mixing etc. 4378. Feb. 20.

Phillips. Apparatus for cooling substances, liquids, or gases. 4521. Feb. 21.

Stehli. Sintering-machines. 3670. Feb. 12.

Thermokept Corp. Vacuumising liquids. 3526. Feb. 11. (U.S., 17.2.23.)

Complete Specifications Accepted

30,318 (1922). Arbuckle. Separating the liquid and solid components of mixtures. (210,855.) Feb. 20.

31,157 (1922). Lamplough and Harper. Retorts or stills. (211,219.) Feb. 27.

33,777 (1922). Appareils et Evaporateurs Kestner. Combined digesting and evaporating process. (204,670.) Feb. 27.

4842 (1923). Akt. de Norske Saltverker. Production of coarse precipitates from solutions. (194,676.) Feb. 20.

8641 (1923). Hunt (Reynolds). Centrifugal decanting or clarifying apparatus. (211,030.) Feb. 20.

10,461 (1923). Imray (Aquazone Corp.). Apparatus for dissolving gases. (211,371.) Feb. 27.
12,271 (1923). Bethune. Apparatus for condensing distilled vapours. (197,341.) Feb. 20.
13,842 (1923). Algem. Norit Maatsch. Treating liquids with purifying and decolorising agents. (198,366.) Feb. 27.
22,703 (9123). Aktiebolaget Separator. Centrifugal separators. (204,046.) Feb. 27.

II.—FUEL; GAS; DESTRUCTIVE DISTILLATION; MINERAL OILS; LIGHTING

Applications

Atkinson, and Stein and Atkinson. Gas-producers. 4367. Feb. 20.
Black. Manufacture of liquid fuel. 4559. Feb. 22.
Boughton. Manufacture of coal gas. 4523. Feb. 22.
Donald. Drying peats etc. 4111. Feb. 18.
Ges. f. Chem. Produktion. Manufacture of highly-active absorption carbon. 4628. Feb. 22. (Czecho-Slov., 22.2.23.)
Humphrey, and Synthetic Ammonia and Nitrates, Ltd. Manufacture of combustible gases. 4649. Feb. 23.
Mackay. 3896. *See* IX.
McLeod. Cylindrical rotating retort. 3589. Feb. 12.
Montgomorie. 4358. *See* IX.
Potts (N. V. Algem. Norit Maatsch.). Manufacture of active carbon. 4529. Feb. 22.
Schwarz. Treatment of hydrocarbons. 3785. Feb. 13. (U.S., 13.2.23.)
Shore. Conversion of heavy to light hydrocarbons. 3742. Feb. 13.

Complete Specifications Accepted

30,678 (1922). Gas Research Co. Gas-generators. (199,695.) Feb. 27.
32,136 (1922). Woodroffe and Scott. *See* XXIII.
32,926 (1922). Dobson, and Sugden and Co. Regenerative furnaces for gas production etc. (211,267.) Feb. 27.
2642 (1923). Kroll. Cracking petroleum products. (210,972.) Feb. 20.
9181 (1923). Dicker (S.E. Co.). Destructive distillation of shale etc. (211,033.) Feb. 20.
9514 (1923). Reitmayer, and Brunner Ges. Continuous distillation of wood. (211,368.) Feb. 27.
18,343 (1923). Gas Light and Coke Co., and Noden. Rotary scrubbers and washers for gas manufacture etc. (211,409.) Feb. 27.
18,365 (1923). Meister, Lucius, u. Brüning. Manufacture of highly-active charcoal. (200,839.) Feb. 27.
21,100 (1923). Ruhr. Apparatus for distilling coal etc. (208,117.) Feb. 27.

III.—TAR AND TAR PRODUCTS

Applications

Schwarz. 3785. *See* II.
Stewart and Walmsley. Purification of cresylic acid. 3702–3. Feb. 13.

Complete Specification Accepted

32,174 (1922). Vivian. Treatment of tar and like liquid hydrocarbons. (210,909.) Feb. 20.

IV.—DYESTUFFS AND INTERMEDIATES

Applications

Bates, Brightmore, and Webber. Manufacture of nitro derivatives of the chlorohydroxytoluenes. 4082. Feb. 18.
British Dyestuffs Corp., Clemo, and Perkin. Manufacture of gamma-tetrahydroquinolone etc. 3642. Feb. 12.
Clayton, Stokes, and Holliday and Co. Colouring matters of the pyrazolone series. 3704, 3710–1. Feb. 13.
Hall, and Silver Springs Bleaching and Dyeing Co. Manufacture and application of dyestuffs. 4542. Feb. 22.
Hereward, Thomas, and Scottish Dyes, Ltd. Production of hydroxyanthraquinones. 4173. Feb. 18.
Imray (Meister, Lucius, u. Brüning). Manufacture of vat dyestuffs. 4281. Feb. 19.
Knecht and Muller. Dyestuffs. 3828. Feb. 14.
Soc. Chem. Industry in Basle. Manufacture of thionaphthisatin etc. 3548. Feb. 11. (Switzerland, 18.7.23.)
Sokal (Kallo u. Co.). Manufacture of vat dyestuffs. 4079. Feb. 16.

Complete Specifications Accepted

21,276 (1922). Davies, Thomson, Thomas, and Scottish Dyes, Ltd. Production of colouring matters. (210,703.) Feb. 20.
30,923 (1922). Imray (Soc. Chem. Industry in Basle). Manufacture of azo dyestuffs and chromium compounds thereof. (210,890.) Feb. 20.
31,254 (1922). Imray (Soc. Chem. Industry in Basle). Manufacture of azo dyestuffs. (211,223.) Feb. 27.
31,595 (1922). Lowcock, Voss, and Gas Light and Coke Co. Manufacture of sulphurised dyes from carbazole-derived indophenols. (211,234.) Feb. 27.
2282 (1923). Marris, and Walker and Sons. *See* XV.
11,985 (1923). Soc. Chim. de la Grande-Paroisse. Manufacture of green dyestuffs dyeing in reduction-baths. (199,706.) Feb. 20.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER

Applications

Barrett, Coward, and Tootall Broadhurst Lee Co. Cellulosic material and manufacture thereof. 3606. Feb. 12.
Harbens, Ltd., Leon, and Sharrat. Manufacture of artificial silk. 3532. Feb. 11.
Marks (Bemberg A.-G.). Manufacture of artificial silk. 3989. Feb. 15.
Moeller. Treating waste paper. 4012. Feb. 16.
Nebrich. Production of paper pulp. 4316. Feb. 19.
Soc. Anon. La Cellophane. Drying cellulose films. 3563. Feb. 11. (Fr., 12.2.23.)
Soc. de Brevets Textiles. Improving vegetable fibres. 3501. Feb. 11. (Ger., 14.2.23.)
Tubize Artificial Silk Co. of America. Manufacture of artificial silk. 4678. Feb. 23. (U.S., 24.2.23.)

Complete Specifications Accepted

2282 (1923). Marris, and Walker and Sons. *See* XV.
10,213 (1923). Heberlein u. Co. Improving vegetable fibrous materials. (196,298.) Feb. 27.
14,503 (1923). Meister, Lucius, u. Brüning. *See* VI.
22,583 (1923). Dobler. Manufacture of paper. (205,793.) Feb. 20.

VI.—BLEACHING; DYEING; PRINTING; FINISHING

Applications

Courtaulds, Ltd., and Whittaker. Dyeing artificial silk. 4604. Feb. 22.
Hall and others. 4542. *See* IV.

Complete Specifications Accepted

24,746 and 29,321 (1922). Plauson's (Parent Co.), Ltd. (Plauson). Dyeing. (211,178.) Feb. 27.
28,139 (1922). Russell. *See* XIV.
30,460 (1922). Grant. Waterproofing processes for fabrics. (210,865.) Feb. 20.
10,017 (1923). Usines de Keukelaere. Apparatus for dyeing bobbins of combed wool. (211,370.) Feb. 27.
14,503 (1923). Meister, Lucius, u. Brüning. Production of colour effects on paper and fabrics. (198,693.) Feb. 20.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS

Applications

Bichowsky and Harthan. Production of cyanogen compounds. 3766. Feb. 13.
Brown. 4175. *See* XIII.
Canada Carbide Co., and Freeman. Manufacture of sodium sulphide. 3800. Feb. 14. (U.S., 14.2.23.)
Carpmael (National Electrolytic Co.). Manufacture of chromates. 3993. Feb. 15.
Chemical Engineering and Wilton's Patent Furnace Co., Wilton, and Wilton. Manufacture of sulphate of ammonia. 4397. Feb. 20.
Crosland. Kiln for calcining lime etc. 4055. Feb. 16.
Fabr. de Prod. Chimiques de Thann et de Mulhouse. Manufacture of cyanides. 3961. Feb. 15.
Johnson (Badische Anilin u. Soda Fabr.). Manufacture of hydrocyanic acid and cyanides. 4284. Feb. 19.
Lande, and N. V. Industrieele Maatsch. Rendering peroxides etc. safer for handling. 3685. Feb. 12.
McDavid, Williams, and Nobel's Explosives Co. Recovery and concentration of nitric acid. 3529. Feb. 11.
N. V. Stikstofbindingsindustrie Nederland. Manufacture of ammonia from products containing cyanides etc. 3763. Feb. 13. (Holland, 21.2.23.)
Soc. Anon. Comp. Gén. des Produits Chimiques de Louvres. Manufacture of salts of chrome. 4086. Feb. 16. (Fr., 16.2.23.)

Complete Specification Accepted

6597 (1923). Henkel et Cie., and Weber. Treating ammonium chloride lyes in iron vessels. (207,142.) Feb. 27.

VIII.—GLASS; CERAMICS

Applications

Cobb. Firebricks, crucibles, etc. 4537. Feb. 22.
Dynamidon-Werk Engelhorn u. Co., Engelhorn, and Schaefer. Manufacture of refractory compositions and bricks. 4388. Feb. 20. (Ger., 20.2.23.)
Priest. Refractory coverings for furnace shafts, flues, etc. 4631. Feb. 22.
Soc. d'Exploit. des Proc. Hidoux. Drying and pulverising clays etc. 4638. Feb. 23. (Fr., 24.2.23.)

Complete Specification Accepted

121 (1924). Riechers. Manufacture of raw plate glass. (209,417.) Feb. 27.

IX.—BUILDING MATERIALS

Applications

Crosland. 4055. *See* VII.
Décolland. Manufacture of aluminium cement in rotary furnaces. 3888. Feb. 14. (Fr., 14.2.23.)
Gayen. Manufacture of binding etc. substances for building materials. 3692. Feb. 12.
Huizer. Preservation and treatment of wood. 3867. Feb. 14.
Mackay. Bituminous emulsions. 3896. Feb. 14.
Marks (Polysius). 3534. *See* I.
Marks (Polysius). Burning raw cement sludge. 3535. Feb. 11.
Marpillero. Construction materials. 3981. Feb. 15.
Montgomorie. Bituminous etc. emulsions. 4358. Feb. 20.
N. V. Bataafsche Petroleum Maatsch. Manufacture of emulsions of asphalt etc. 3781. Feb. 13. (Holland, 30.10.23.) Feb. 13.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY

Applications

Borchers and Stimson. Purification of alloys containing iron and molybdenum, uranium, etc. 3622 and 4570. Feb. 12 and 22.
Evans. Recovery of zinc and copper from alloys. 4553. Feb. 22.
Fischer. Manufacture of ductile metals. 4279. Feb. 19.
Leyser and Nathansohn. Extraction of roasted zinciferous ores etc. 4190. Feb. 18.
Mackay. Electrochemical treatment of copper ores. 3792. Feb. 13.
Nathansohn. Dechlorination of lead products. 4314. Feb. 19. (Ger., 3.10.23.)
Rein. Cupola furnaces. 3841. Feb. 14.
Riemsdijk. Production of refined steel and alloys from titaniferous ironsand. 4428. Feb. 21.
Skappel. Recovery of metals from their compounds. 4518. Feb. 21. (Norway, 26.2.23.)
Stehli. 3670. *See* I.

Complete Specifications Accepted

22,454 (1922). Rosenhain and Grogan. Improving commercial aluminium. (211,027.) Feb. 27.
27,458 (1922). Hennes. Preparation of ores for leaching-process. (210,824.) Feb. 20.
30,562 (1922). Gronqvist. Cementation of iron and steel. (210,870.) Feb. 20.
31,052 (1922). Hamilton and Evans. Manufacture of iron and steel alloys. (211,210.) Feb. 27.
31,127 (1922). Diehl. Preparation and smelting of ores, roaster-residues, slags, etc. (211,215.) Feb. 27.
5719 (1923). Bardt. Precipitating or recovering metals from solutions. (211,005.) Feb. 20.
11,219 (1923). Akt. Ferrolegeringar. Heating metals or alloys in an electric furnace. (211,039.) Feb. 20.
11,616 (1923). Goldschmidt A.-G., Schertel, and Lüty. Refining tin. (196,938.) Feb. 27.
18,660 (1923). Siemens u. Halske A.-G. Lead alloys. (201,176.) Feb. 27.

XI.—ELECTRO-CHEMISTRY

Applications

Croucher and others. 3558. *See* XIX.
Dragonetti. Selenium cells. 3551. Feb. 11. (Ital., 12.2.23.)
Mackay. 3792. *See* X.

Complete Specifications Accepted

32,373 (1922). Rutter. Galvanic batteries or electric accumulators. (211,255.) Feb. 27.
11,219 (1923). Akt. Ferrolegeringar. *See* X.

XII.—FATS; OILS; WAXES

Applications

Holton. Detergent. 4426. Feb. 21.
Kammermann. Extraction of oil from vegetable substances. 4603. Feb. 22. (Belg., 21.1.24.)
Wilhelm. Extraction etc. of fatty acids etc. from oils etc. 3619. Feb. 12. (Ger., 24.12.23.)

Complete Specification Accepted

34,884 (1922). Petroff. Manufacture of detergent compositions. (211,294.) Feb. 27.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS

Applications

Brown. Simultaneous production of iron-oxide pigment and hydrochloric acid. 4175. Feb. 18.
K. D. P. Co. Manufacture of vegetable resins. 4069. Feb. 16. (Ger., 17.7.23.)
Semenza, Semenza, and Welch. Red lead paint. 3550. Feb. 11.

Complete Specification Accepted

31,248 (1922). Goldschmidt A.-G. Production of amorphous, finely subdivided litharge. (189,132.) Feb. 27.

XIV.—INDIA-RUBBER; GUTTA-PERCHA

Applications

K.D.P. Co. Manufacture of caoutchouc etc. 3574-5. Feb. 11. (Ger., 5 and 20.4.23.)

Naugatuck Chemical Co. Compounding rubber etc. 3865. Feb. 14. (U.S., 13.7.23.)

Peachey Process Co., and Peachey. Vulcanisation of rubber. 4658. Feb. 23.

Complete Specification Accepted

28,139 (1922). Russell and Broomfield. Waterproofing by the use of rubber latex. (211,188.) Feb. 27.

XV.—LEATHER; BONE; HORN; GLUE

Applications

Nelson, Dale, and Co. Manufacture of thin sheets of gelatin. 4183. Feb. 18. (Sweden, 3.5.23.)

Schottler, and Turner Tanning Machine Co. Machines for treating hides etc. 3842. Feb. 14.

Complete Specification Accepted

2282 (1923). Marris, and Walker and Sons. Treatment of spent tan, spent dyewoods, straw, and like inert vegetable matter. (211,322.) Feb. 27.

XVI.—SOILS; FERTILISERS

Applications

Carpmael (Chem. Fabr. auf Aktien, vorm. E. Schering). Means for protecting plants and animals against insects etc. 4195. Feb. 18.

Pease. Fertilisers. 4420. Feb. 20.

Redfern (Scheel). Fertilisers. 3564. Feb. 11.

XIX.—FOODS; WATER PURIFICATION; SANITATION

Applications

Carpmael. 4195. *See* XVI.

Croucher, Gush, and Gush. Electrolytic systems for treating water. 3558. Feb. 11.

Milkal, Ltd., and Sierra. Apparatus for making milk etc. powder. 3864. Feb. 14.

Quaker Oats Co. Treatment of seeds etc. with furfural. 3538. Feb. 11. (U.S., 5.7.23.)

Soc. Anon. des Rizières Françaises. Amylaceous flours. 4051. Feb. 16. (Ger., 19.2.23.)

Complete Specifications Accepted

4339 (1923). Lasson, and United Water Softeners, Ltd. Manufacture of water-softening materials. (211,340.) Feb. 27.

8851 (1923). Otteson. Preservation of food substances by cooling. (211,032.) Feb. 20.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS

Applications

University of Toronto. Manufacture of anti-diabetic products. 4252. Feb. 19. (U.S., 2.3.23.)

Wacker Ges. f. Elektrochem. Industrie. Manufacture of acetic anhydride. 3663. Feb. 12. (Ger., 12.2.23.)

Complete Specifications Accepted

22,006 (1922). Imray (Meister, Lucius, u. Brüning). Manufacture of amidos of alkylated acids. (210,809.) Feb. 20.

32,095 (1922). Nobel Industries, Ltd. (Du Pont de Nemours and Co.). Production of urea derivatives. (211,245.) Feb. 27.

24,307 (1923). Meister, Lucius, u. Brüning. Manufacture of diaminodiaryldialkylmethanes. (204,722.) Feb. 20.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES

Applications

Roemmel. Photography. 4540. Feb. 22.

Soc. du Film K.D.B. Manufacture of photographic film. 3780. Feb. 13. (Fr., 16.2.23.)

Complete Specification Accepted

30,451 (1922). Sokal (Kalle u. Co.). Light-sensitive film or layer. (210,862.) Feb. 20.

XXII.—EXPLOSIVES; MATCHES

Complete Specification Accepted

21,946 (1922). Du Pont de Nemours and Co. High explosives. (184,487.) Feb. 20.

XXIII.—ANALYSIS

Complete Specifications Accepted

32,136 (1922). Woodroffe, and Scott, Ltd. Apparatus for determining the volumetric proportion of a gas or gases in gaseous mixtures. (211,240.) Feb. 27.

446 (1923). Simmance. Gas calorimeters. (210,950.) Feb. 20.

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number:—

Baltic States: Tinplate, galvanised sheets, steel (230); *Brazil*: Iron tubes (852/22/F.G./E.C./2); *British India*: Iron and steel (the Director-General, India Store Department, Branch No. 10, Belvedere Road, Lambeth, S.E. 1); *Chile*: Steel, copper, iron, bronze, copper, soap, tin, oil, turpentine, paint, varnish, calcium carbide (9388/F.L./G.C.); *Cuba*: Tinplate, aluminium foil (245); Hardware, paper, heavy chemicals (246); *Finland*: Tinplate, galvanised sheets, steel (230); *Latvia*: Lubricating oil (8842/F.R./C.C./2); *Netherlands*: Leather cloth (233); Silk (234); Brass tubes (235); *New Zealand*: Builders' hardware, wall-paper (226); *Poland*: Tinplate, steel (230); *South Africa*: Iron pipes (13,211/E.D./E.C./2); *Spain*: Chemicals (238); *Switzerland*: Steel (239); *United Kingdom*: Lead-covered cable, zinc, copper, bronze, brass, steel (the Controller, Post Office Stores Department, Studd Street Depot, Islington, N. 1); *United States*: Heavy chemicals (21,940/F.W./C.C./2).

Census of Production for 1924

A census of production in Great Britain during 1924 is to be taken by the Board of Trade in 1925, and schedules will be issued later to all persons and firms who will be required to furnish information. The inquiry will cover not only manufactures, but also agriculture, fishery, mining and building, but, whereas the 1907 census included all undertakings, it is under consideration whether only undertakings employing more than 5 persons (including the employer) will be included. The examination of the second census, in 1912, was interrupted by the war, and when peace came the returns could not be amended or completed. Now that trade is becoming more normal, the need is felt for this periodical review of the facts of industry, so as to provide a sound basis on which to build a reliable estimate of the national income.—(*Bd. of Tr. J.*, *Feb.* 28, 1924.)

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EDITORIAL

THERE comes a period in life, and we are rapidly attaining to it, when leisure and god-like indolence are much desired. An arm-chair before a fire or an aimless stroll through a small garden are the due reward of earlier years of work and study. The activity of younger people is continually postponing our enjoyment of what we rightly consider our due. Our juvenile friend Mr. Woolcock urges us not only to arrange a set of pamphlets which will explain to the visitors to the Wembley Exhibition the importance of chemistry to the nation, but by specious eloquence he has deluded us into writing one of them in what he calls our spare time. In vain have we pointed out to him that quiet meditation and a contemplative mind are necessary for the task; his answer reminded us of the reply received by an Irish king who wrote to a subordinate chieftain, "Pay me the tribute thou owest, or else ——." The chieftain replied, "I owe no tribute, and if I did ——." At any rate, indefinite as were Mr. Woolcock's observations, we were left believing that unless the pamphlet were ready within a week something dire and terrible would befal. To expound the achievements of chemistry to the average visitor to an Exhibition is a vague task; how can we fit our Muse to the powdered flapper, the long-handed miller, the long-haired musician or the pale young curate? When we are lying awake with a dismal headache and repose is tabooed by anxiety, we have to think out some scheme for explaining Bohr's views on spectra or the constitution of Congo Red to a ravenous horde who all got on board at Sloane Square and South Kensington stations.

* * *

We have other grievances. Our youthful President, whose activity we envy and covet, in spite of any number of Commandments, has conceived the erroneous idea that it is time something was actually done about a Chemistry House. Writing about it and talking about it would have sufficed for most people, but like Oliver Twist he asks for more. We were content to have the idea simmering in our minds, but here comes Dr. Armstrong and stirs it round and round and round until he can sniff at the boiling broth. More conferences are to be held, sites are to be inspected, estimates of expenditure are to be considered and calculations about rents, rates and repairs, the three R's which play such an important part in a modern budget. "Give us work or we perish," say some. "Give us nothing to do or we perish," said our Cubian allies. Sometimes we think like Mr. Dooley that we are a bit Cubian ourselves. Well, well, the days are already getting longer, the children will wake earlier and the best way to lengthen your days is to add a piece on at each end. If Dr. Armstrong is succeeded in his Presidency by a man of ripe years—there is a retired Professor at Cambridge who would satisfy us—we shall have a restful time after next July. We can perhaps hold out till then and look forward to a really slothful existence. Even as we write some correspondent puts forward a desire for a universal language. We are in no frame of mind to undertake such a task. Universal quiet will be good enough for us. Every month we receive a chemical journal written in Polish. It gives us less trouble than any other publication which is sent to us. How rapidly and with how little fatigue we skim the pages after a satisfying meal and in a room religiously kept quiet for half an hour on a Sunday afternoon. Hail, Poland!

* * *

It gives us great satisfaction to announce that His Majesty the King has been graciously pleased to extend his patronage to the Annual Meeting of the Society to be held this year in Liverpool. We congratulate the Liverpool Section on this fresh token of the King's appreciation of the Society's work and are confident that this distinction will be greatly valued by the citizens of Liverpool, and by the members of the Society. Formerly, Kings were chosen for their physical strength, or if they were not chosen, they imposed their rule on the community if they were more skilled in the use of the sword and the battle-axe than their competitors. In these modern days the success of a King is judged by his unceasing devotion to the interests of his subjects and our present monarch has been conspicuous for a high standard of duty in all those social and other matters in which his subjects are concerned.

SOME PAGES FROM THE STORY OF INDIGO*

By W. A. DAVIS, B.Sc., A.C.G.I.

In the short time at my disposal I shall be able to turn only a few pages of the "Story of Indigo." This story, like that of linen, with which indigo has always been closely associated, begins in the very earliest periods of man's history. Long before man was able to clothe himself in "purple and fine linen," tradition has it that he ornamented his skin with the extract of woad, one of the plants yielding indigo. Both linen and indigo had their origin in the early civilization of the East and it is interesting that both depend on very similar complex bacterial changes for their production.

The linen fibre and the indigo used to dye it are both of plant origin and both are obtained by leaving the stems of a plant in contact with water, when certain peculiar changes set in spontaneously which in the one case set free the valuable linen fibre and in the other the far more precious blue dye indigo. In the warm climates of the older civilizations—China, Egypt and India—the conditions for the growth and fermentation of the flax and indigo plant were ideal, and until very recently the preparation of both linen and indigo was carried out in almost precisely the same way as was practised in the days of the Pharaohs.

The Importance of the Indigo Industry

The importance of indigo may be realised from the fact that not only was it the most widely used and valuable dye during countless generations of the past, but even at the present day it is by far the most important dyestuff.

Neglecting the smaller indigo-producing countries such as Central America, Brazil, the Philippines, the value of the total world-market for indigo under pre-war conditions considerably exceeded 5 millions sterling. This value falls not far short of that of all *other artificial organic dyes put together* as can be seen from the following table showing the German exports of dyes before the war. It must be remembered that Germany then supplied six-sevenths of the world's requirements of artificial organic dyes.

Table I

	1880	1890	1895	1900	1905	1907	1909
				Tons			
Aniline dyes	2141	7280	15,789	23,781	36,570	43,716	47,777
Alizarin ,,	5588	7906	8928	8591	9359	10,500	34,784

		1907
Values.	Aniline dyes	£5,600,000
	Alizarin ,, ...	£1,200,000

Growth of the Synthetic Indigotin Industry

This is not the occasion to describe in detail the history of one of the greatest and most [illegible]inating achievements of modern chemistry—th[illegible]cation of what only 40 years ago was regard[illegible]ct as a dream—the manufacture on an e[illegible] scale from coal tar of indigotin, the chief [illegible]t of the valuable natural dyestuff indigo. [illegible]gress of modern chemistry indigo has played a supreme part. It was from natural indigo that in 1841 Fritsche obtained aniline—the parent substance of the so called "aniline dyes." In fact the very name *aniline* is derived from the Indian name for indigo—*nil*, which passed into Europe in the Portugese (or Arabic) form *Anil*.† The apparent close relationship of indigo and aniline very early suggested the possibility of preparing indigo synthetically from coal tar, and it was while working with this end in view that W. H. Perkin in 1856 studied the behaviour of aniline with arsenic acid, which led to the discovery of the first aniline dye mauve. Then came the discovery of the diazo reaction by Peter Griess and the wonderful development of the azo-dye industry, which culminated in the synthesis of indigotin itself. The cycle was complete.

So long ago as 1870, indigotin identical with the blue dyeing principle of natural indigo, was synthesised by Engler and Emmerling, but nearly 30 years had to elapse before the manufacture of synthetic indigotin became a commercial success. During this period, in German universities and German works, the problem was pursued persistently and without rest, "Ohne Hast, ohne Rast." The prize was one well worth winning—the capture of an industry representing at that time, when the aniline dye industry was of smaller dimensions than at present, a money value far exceeding that of all other dyes put together. From 1865 to 1880, A. von Baeyer with his numerous pupils worked on the problem and a complete synthesis of indigotin in 1880—1882 firmly established the structure of the indigotin molecule.

Baeyer's processes were patented and purchased by the Badische Company for £20,000 and were worked on a large scale. It was soon found, however, that these processes were an economic impossibility because of the shortage of the world's supply of toluene—the substance which during the great war was used in enormous quantities for the manufacture of the most powerful high explosive, trinitrotoluene (TNT). In spite of the very big increase of production of crude tar which followed the introduction of the modern metallurgical coke-furnaces—especially in Germany—the amount of toluene obtainable from crude benzene would only be enough to produce indigotin sufficient to cover one-fifth or one-sixth of the whole consumption. An increase of the production of crude benzene for the purpose of obtaining more toluene would have led to over-production of unusable (at that period) benzene and hence would have increased the price of toluene and finally, that of synthetic indigotin.

Although the Badische Company had incurred heavy losses by working Baeyer's processes, they did not hesitate to purchase in 1890 the patent of K. Heumann, who had introduced a process starting with naphthalene. This was the turning point of the indigotin industry. Economically, his process was far preferable to the synthesis from toluene.

* A lecture delivered to the chemists of [illegible]. Lever Bros., Ltd., Port Sunlight, on Jan. 28, 1924.

† "*Nil*" (derived from Sanscrit) is the ordinary Hindustani word for "blue." Indigo is thus *the* "blue" dye. "Indigo" is derived from the Greek "Indikon" (Lat. Indicum), the Indian (dye). The word "nil" is also seen in the Egyptian "Nile"—the blue river.

Quite 50,000 tons of naphthalene were produced annually in the distillation of tar and at this time only about 15,000 tons had been utilised—the rest was a "waste product."

But even working this process the output of synthetic indigotin was not much increased until 1897—that is seven years later, as is shown by the following data:—

Table II

	1880	1890	1895	1900
Export of synthetic indigotin from Germany in tons	497	733	653	1873

The obstacle was the fact that the first stage of the process, the oxidation of naphthalene to phthalic anhydride by heating with sulphuric acid, gave a very poor yield. In 1897 a fortunate "accident" made the process ultimately a brilliant commercial success. From the breaking of a thermometer in the vat in which naphthalene was being heated with sulphuric acid and the keen observation of its effect by the chemist in charge dates the downfall of the natural indigo industry. It was noticed that the small quantity of mercury from the thermometer which fell into the sulphuric acid, greatly accelerated the action and that a nearly theoretical yield of phthalic anhydride was obtained. Instead of the action being very prolonged and accompanied by many destructive changes, it was complete in a few hours and its rapidity made it *possible to collect and use over again* the large quantities of sulphur dioxide evolved. This led to the development in Germany of the so-called "contact" process of manufacture of sulphuric acid—a process by the way (like the aniline dye industry) invented and worked in England so far back as 1875 by Rudolph Messel, of Messrs Spencer, Chapman and Messel, though only developed on a very large scale many years later in Germany. So that the fortunate "accident" already alluded to not only made synthetic indigotin an economic possibility but also gave to Germany what is now one of its most important industries. The sulphur dioxide liberated during the action of sulphuric acid on naphthalene was reconverted into sulphuric acid by the contact process, so that the process became a continuous one in which little or nothing was wasted.

The necessity of recovering large quantities of sulphur dioxide thus led the Badische Company entirely to reconstruct its system of manufacturing sulphuric acid. It is difficult fully to estimate the *indirect* influence the synthetic indigotin process has had on other industries (such as other branches of the dyeing industry, the artificial fertiliser industry—sulphate of ammonia, superphosphate), by facilitating and cheapening the production of sulphuric acid. That the processes and plant introduced at this time were an important factor in Germany's military strength is abundantly clear. It was, too, no doubt, the lying idle of the liquid chlorine plant which had formerly been used to supply chlorine in very large quantities for a later stage of the indigotin synthesis (the manufacture of monochloracetic acid) which gave the opportunity for the use of chlorine in the early gas attacks which so nearly changed the whole course of the war at Ypres. The magnitude of the change introduced at this time into German chemical industry by the B.A.S.F. can be gauged by a few data.

In 1888 the Badische produced 18,000 tons of sulphuric acid catalytically and in 1900, 160,000 tons. In 1901 the quantity of sulphur dioxide recovered by this process from the manufacture of phthalic anhydride alone was about 40,000 tons. The first artificial indigotin plant was erected by the Badische at the cost of £480,000. In 1900 two competitors appeared, viz., Meister, Lucius, und Brüning of Höchst-am-Main and Messrs. Geigy of Basle, the latter working Sandmeyer's process. The considerable fall in price of synthetic indigotin which followed this acute competition led to Messrs. Geigy abandoning the field and to the amalgamation of the Badische and Meister Lucius interests with a capital of £1,200,000. Before long this partnership was, however, dissolved. In 1910 the Rathjen Company of Hamburg with a capital of £280,000 started making indigotin, using an improved form of Sandmeyer's process, and von Heyden of Dresden, one of the largest chemical works of Germany, also took up the manufacture, working the so-called phenylglycine process. In Switzerland the Society of Chemical Industry in Basle began making indigotin in 1911—1912.

Although the introduction of the catalytic oxidation of naphthalene and the contact process of manufacturing sulphuric acid were great steps in advance they did not enable synthetic indigotin easily to compete with the natural dye, which as I shall show has certain very real advantages. There is, indeed, good ground to believe that synthetic indigotin was sold at a loss for a long period in the endeavour to capture the market and that for this purpose large subsidies were given by the German Government. It should be emphasised here that the ultimate process adopted by the Badische Company involved the use of information derived neither from Von Baeyer, nor from the works laboratories, but from the Zürich professor Heumann, who had attacked the subject independently and devised methods that were far simpler than any of those discovered by the prime workers. The Heumann process involved fusion with caustic potash in the final stage. In this fusion water was a product; this had an adverse influence on the interaction, and it was necessary in order to maintain control of the operation to carry it out with only small quantities of material. As an economic process the method was therefore unsatisfactory. Success was only made possible by the perseverance and technical skill displayed by the German manufacturers and by their obstinate determination to carry the day against Indian indigo. But this struggle could not well have been successful in the end had not at this time an invention been perfected by a firm having nothing to do with colour making. The invention was that of a process of making sodamide, $NaNH_2$, from metallic sodium and ammonia. Sodamide, it was found, could be used with great advantage instead of caustic soda in the indigotin melt; in place of water it gave ammonia which had no deleterious effect and moreover could be easily recovered and used over and over again. From this moment the process became an economic success.

Natural Indigo

In synthetic indigotin we have an industry in which the resources of modern science have been utilised to the uttermost—in which all that chemical and engineering skill can offer has been called in aid—in the preparation of natural indigo we have the exact opposite—an industry in which the processes were, until quite recently, of a very primitive character, but very much different in fact from those practised in ancient Egypt 3000 years B.C. The plant is cut in the field in the early morning, carted to the indigo factory (often 2 or 3 hours' journey away) in bullock carts and loaded into large cement-lined vats. After loading the plant is "watered"—that is the vats are filled with water warmed if necessary to a temperature of 90° F. The watering takes about half an hour to an hour. The plant is kept down and held in position by means of cross beams fastened across the tops of the vats. The plant is then left to "steep" in the water during about 12 hours; after about 4 hours a bacterial fermentation sets in, the effect of which is that the parent substance of the dye, the so-called *indican*, originally present in the leaves of the plant, passes into solution. The materials originally fermented in the solution consist of protein and carbohydrate material exuded from the cut stems and the gas liberated by the fermentation consists mainly of nitrogen and hydrogen in the early stages. Gradually the process changes, carbon dioxide is evolved in increasing proportion and the vat liquor becomes slightly acid.

Indigo is not originally present in the plant as the blue dye, but as a colourless, beautifully crystalline glucoside, indican, which itself is a compound of the sugar dextrose with *indoxyl*. During the bacterial fermentation as fast as the parent substance indican passes from the leaves into solution, it is hydrolysed by bacteria to *indoxyl*, itself a colourless substance. When the fermentation is complete, that is after 12 hours, a slightly yellow solution, without any blue colour, is obtained. From this process the dye is obtained by the treatment known as "beating." To carry out the "beating," the liquor obtained from the steeping, is run into large vats at a lower level and then thrown up into the air by means of a large paddle-wheel (beating wheel) as a fine spray. In this way the colourless *soluble* substance, indoxyl, is oxidised by atmospheric oxygen to the blue *insoluble* dye indigotin. After about 1½ hours the beating is ended, and the wheel is then stopped and the indigo allowed to settle out during about 4 hours, as a fine blue mud. With a good fermentation the settling is nearly perfect, but with a bad fermentation it is very incomplete and 20 to 30 per cent. of the indigo may be lost in this way. After settling, the supernatant liquid is carefully run off (an operation necessitating skill) by special valves and the thick blue mud remaining, transferred to a boiling tank where water containing a small amount of dilute sulphuric acid is added and the mixture raised to the boil by live steam. This treatment dissolves out a considerable proportion of the impurities (the so-called indigo-gluten) and arrests fermentation. After the boiling the indigo is again allowed to settle out and as much as possible of the clear liquor run off. The residue is then transferred to the "filtering tables,"—large frames across which cotton cloths are stretched—and drained as completely as possible. The residual thick paste is then pressed between cloths in large wooden boxes, slabs of indigo 3 in. thick being obtained. The slabs are then cut up, by wire cutters, into 3 in. cubes, and these are left to dry slowly in the air, until the cakes contain only about 6 per cent. of moisture. This drying usually takes a month to 6 weeks. The small 3 in. cubes are finally brushed and polished and packed into large wooden chests, holding 300 lbs. and sent down to the Calcutta market.

Decline of the Natural Indigo Industry

Up to 1897 the increase in prosperity of the Indian indigo industry during a century had been phenomenal But the introduction of the Badische processes brought about a rapid and steady decline, until in 1914 just before the war, only about 1/20th of the quantity made in 1896, the high-level mark of natural indigo, was being manufactured.

Table III

Exports of indigo from India

Year		Cwt.		Value Rs.
1894-5	..	166,308	..	4,74,59,153
1895-6	..	187,337	..	5,35,45,112
1899-1900	..	85,460	..	2,08,78,848
From 1897 to 1906 there was a steady decline.				
1906-07	..	35,102	..	70,04,773
1911-12	..	19,155	..	37,58,025
1912-13	..	11,857	..	22,01,325
1913-14	..	10,939	..	21,29,070

In 1895, 1,688,042 acres were under indigo; in 1914, the area had fallen to about 200,000 acres. In 1880 excluding the agricultural labourers, who were very numerous, 360,000 persons were employed in the indigo industry. In 1911, the number had fallen to 30,795.

(*To be continued*)

Mons. E. Cuvelette, vice-president of the Etablissements Kuhlmann, has been promoted Commander of the Legion of Honour. Messieurs E. Hures, of the Société de Carbonisation and de Distillation des Combustibles; J. Naud, president of the Denain and Anzin Iron and Steel Works; J. F. Vogt, director of the Ste. Thérése Potash Mines; E. Vielhomme, [illegible]-president of the Cie. Alais Froges et Camargne, [illegible] M. Dumuis, director of the Firminy Iron and [illegible], have been appointed chevaliers of the L[illegible] of Honour. Prof. Joubin, director of the [illegible] and Technical Office of Maritime Fisheries, [illegible] appointed Commander, and Mons. E. Roux, [illegible] of the Sanitary and Scientific Services of the [illegible]istry of Agriculture, has been nominated Grand [illegible] of the Legion of Honour.

THE "PEEBLES" PORTABLE SAND WASHER

(From a Correspondent)

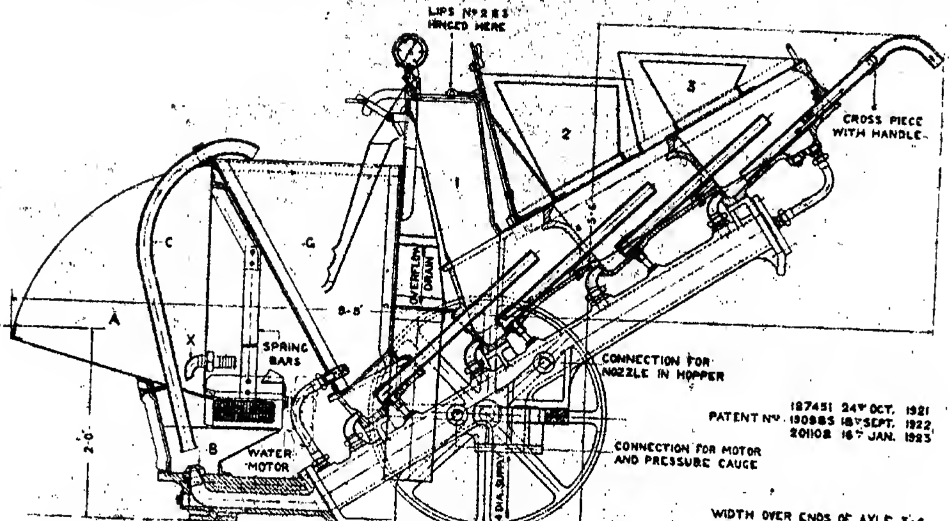
One of the most unsatisfactory operations connected with the use of sand filter-beds for either portable or technical water supply is the washing and cleaning of the dirty sand. This has hitherto generally been carried out by laborious hand methods in large tanks, using a high-pressure water jet, say at 60-80 lb.

Some two years ago Messrs. Glenfield and Kennedy, Ltd., of Kilmarnock, introduced the "Peebles" patent sand washer for carrying out automatically and continuously the washing of dirty sand, using no other power than a very low pressure (say 4-5 lb.) water jet. This machine, which is extremely compact, being contained in a wrought iron tank, 6 ft × 4 ft. × 4 ft., has effected what may be described as a revolution in the washing of sand

There has now been introduced a portable machine on the same general lines, which can be wheeled about by hand from one filter bed to another, so that the sand can be washed on the spot. The apparatus merely requires to be coupled up by flexible connexions to the low-pressure clean water supply, and to a discharge pipe for the dirty water; the sand is thrown into the hopper, the clean sand being discharged continuously from the other end of the machine.

The apparatus, of a total weight of 13 cwt., is extremely neat and easy to handle, well-balanced on two large flat type cast-iron wheels, and has the over-all length of 9 ft., width 5 ft. 4 in., and height, 5 ft. The output depends to some extent on the water pressure available, but at 5 lb. the figure is 4·15 tons (98 cb. ft.) of sand per hour, the time required to wash 1 ton being 14½ minutes, that is about six times the speed of hand methods. Even at only 3 lb. water pressure the figure is 2½ tons (60 cb. ft.) of sand per hour, or 23½ minutes for 1 ton. Further, the machine, although light, is extremely strong, there is practically nothing to get out of order, the wear and tear is infinitesimal, and unskilled labour can be used, all that is being required to shovel the dirty sand into the hopper, whilst the cleaning is much more effective than by the ordinary methods.

The machine is operated by a series of water jets, the total consumption of water at 5 lb. pressure being about 8000 gals. per hour. It consists essentially of a series of 4 small washing chambers one behind the other on an inclined plane connected at the bottom by a cast-iron feeder pipe, the whole resting on a steel axle between the wheels. The sand falls from the hopper through an oscillating strainer,



The "Peebles" Portable Sand Washer

operated by a small water motor, so as to separate all pebbles and similar large particles. The filtered sand then falls into a chamber at the bottom of which is a jet of water which forces the sand upwards and mixes it in the water. The principle depends on the fact that the dirt and impurities are lighter than the sand, and are washed out in a stream of water over a weir to a discharge, whilst only the heavier sand is carried over into a second chamber. Here it meets a second water jet, where the process is repeated, the sand being propelled continuously through the four chambers in succession in this way by a series of clean water jets, thus repeatedly washing and mixing the sand, and separating the lighter dirt and impurities by gravity, the purified sand being finally discharged from the machine in a continuous stream along with clean water. The cleaning action is also intensified by the repeated change of direction of the sand within the machine, and the consequent scrubbing action of each grain of sand on its neighbour, and altogether the whole device is ...

A STUDY OF THE DESTRUCTIVE DISTILLATION OF COAL

The relationship existing between yields of tar and gas obtained by the distillation of coal, was the theme of the second of a series of Cantor Lectures delivered by Mr. E. V. Evans at the Royal Society of Arts on March 3. The dilution of a rich coal gas by the admixture of a small proportion of furnace gases under strict control was described and it was shown how the process enabled a gas of very uniform calorific value to be produced at the inlet to the gas holder. It is found to be more economical to reduce the calorific value of the gas to a desired standard in this way than to raise the temperature of the combustion chamber surrounding the retorts materially above 1300° C. The yield of gaseous therms is about the same whichever method be adopted, but the employment of higher temperatures results in a destruction of tar. The results of many investigations upon carbonisation recorded in technical literature show a lack of appreciation of the part played by tar by reason of the fact that attention has been focussed too closely upon the gaseous product.

When coal was carbonised at different rates in laboratory apparatus it was found that a very low rate of heating favoured the production of an increased yield of coke at the expense of the volatile matter. The greatest yield of volatile therms was obtained with the most rapid heating of the coal up to 1000° C. This condition also allowed of the production of a maximum yield of gas therms. With a decrease in the rate of heating the yield of gas therms fell and then rose slightly, the maximum yield of tar therms being obtained when the yield of gas reached the minimum. For the purpose of ascertaining whether a more careful method of carbonisation would still give a low yield of volatile therms, carbonisation was carried out in two stages, a temperature of 525° C. being taken as the first stage. The process proved to be less drastic in that an abnormally high yield of tar was obtained whilst the yield of gas therms was quite low. These phenomena are explained by supposing that when coal is very slowly distilled there occurs simultaneously a fractional distillation of the tar with the consequent formation of pitch. The tar obtained under these conditions is a limpid brown fluid containing little pitch and practically no free carbon. The gas obtained from rapid carbonisation is characterised by a high proportion of unsaturated hydrocarbons, a fact which points to the decomposition of primary tar. It is significant, however, that the therms lost from the tar were approximately recovered in the gas; thus further proof was obtained that the rapid heating of coal as in normal gasworks practice is not so wasteful of thermal energy as advocates of other methods of distillation have suggested. Very rapid carbonisation is a gas-producing process, slower and more careful distillation is a tar-conserving process, and exceedingly slow distillation a coke-conserving one.

The analyses of tar obtained from the carbonisation of Durham coal at different temperatures showed that there is a limit to the quantity of gas which may be produced from tar without producing such a degree of deterioration that the physical and chemical constitution of the residual tar is altered to an undesirable extent. At the higher temperatures naphthenes, paraffins and phenols are gradually replaced by pitch, and the free-carbon content of the pitch shows a very marked increase.

In order to illustrate the complexity of the chemistry of tar cracking the decomposition of cyclohexane by heat was considered in some detail. A novel feature of the lecture was the introduction of a cinematograph film in order to show the decomposition of cyclohexane to cyclohexene and *n*.hexylene, and the formation of lower olefines from the latter. The decomposition of cyclohexene to hexadiene and the mechanism of the reactions giving rise to the production of butadiene, acetylene and naphthalene were also illustrated in a manner calculated to make a special appeal to those responsible for the teaching of chemistry.

It was concluded that hydrocarbons of the cyclohexane and cyclohexene type are the main gas-yielding constituents of primary tar; they are probably selectively cracked during the carbonisation of coal, leaving a residue of secondary tar less suitable for further cracking. The gas obtained is rich in unsaturated compounds, and has a high calorific value. Higher aromatic compounds are formed by polymerisation and condensation of these unsaturated hydrocarbons. Direct hydrogenation with the formation of benzene and its homologues takes place to an extent insufficient to account for the quantity of these compounds found in high-temperature tar. The relative proportions in which the various decomposition products are produced was shown to be influenced by the temperature at which the cracking takes place. At higher temperatures the proportion of free carbon and gas increases whilst the liquid decomposition products become more aromatic in character.

In another series of experiments high and low-temperature tars were heated to various temperatures, the vapours being cracked in the presence of nitrogen or coal gas. Low temperature or primary tar gave a fair yield of gas at temperatures as low as 600° C., a large proportion of the tar being recovered as a liquid which may be regarded as secondary tar.

Directly a primary tar has been converted by cracking to a secondary tar, it should be removed from the retort as quickly as possible, as the compounds present in high-temperature tar having resulted from the decomposition of less stable bodies, are themselves comparatively stable. They decompose only at the highest temperature of carbonisation, mainly with the elimination of hydrogen, and the formation of compounds of increasing molecular complexity. A very limited yield of gaseous therms is obtained from such a secondary tar by the sacrifice at considerable loss of benzene and its homologues. The nature of the gas obtained during carbonisation is indicative of the nature of the reactions taking place in the retort. The greater the percentage of unsaturated hydrocarbons in the gas the greater the quantity of primary tar which has been decomposed, and a low proportion of these hydrocarbons may

indicate that the gas and tar have been subjected to too long an exposure to heated surfaces.

An analysis of the balance sheets of the London gas companies showed that it was economically sound for a gas undertaking to gasify as much tar as possible so long as working difficulties were not experienced in the retort house, and so long as the residual tar was not so degraded that its value per therm was reduced. In this connexion it was suggested that the free carbon content of the tar should not exceed 15 per cent. Microscope slides were exhibited in order to demonstrate a method of observing the free-carbon content of tar.

The tendency in recent years in the gas industry has been to charge greater weights of coal into retorts and to extend the period of carbonisation. This process conserves tar, and there comes a point at which it is desirable to increase the temperature of the setting so as to permit of the cracking of tar. The most recent tendency is thus to maintain the larger charges of coal and to reduce the period of carbonisation for the purpose of increasing the gaseous thermal yield. It was forecasted that there would arrive a limit at which retort house difficulties would arise due to the production of too viscous a tar, but where precisely was this transition point was unknown. Since the cracking of primary tar as it is produced is such a different process from the cracking of secondary tar in a heated chamber it was argued that the reduction of the free space in horizontal retorts and an increase in the rate of heat transmission within the mass of coal itself were matters demanding careful consideration.

ASBESTOS IN QUEBEC

The output of asbestos, chief of Quebec's mineral products, showed a considerable improvement during 1923, the production reaching the record amount of 205,000 tons, valued at \$7,500,000. In 1922 163,706 tons were produced valued at \$5,552,823. Whilst 1923 is the record year for production in the asbestos industry, it must be noted that when the previous high record was established in 1920 and 199,573 t. was marketed, the receipts from sales reached a total of \$14,792,201 or approximately twice the amount received for the tonnage sold during the year just closed.

An important industrial development in the Province of Quebec is the establishment of a plant for the manufacture of asbestos products. The undertaking is of special interest because it represents a new venture in the manufacture of asbestos products on a large scale in Canada. The plant is being erected at Asbestos, Quebec, where the asbestos is being mined. This will help materially in keeping down costs, since freight charges will be eliminated. The following articles will be produced: asbestos roofings, shingles, packings, building materials of all kinds, insulation, paper and mill board, brake linings and other products.

LOW TEMPERATURE CARBONISATION *

By A. McCULLOCH, A.M.C.T., A.I.C.

The low-temperature carbonisation of bituminous coal may be dealt with under three headings:—(1) The need for a solid *smokeless* fuel, suitable particularly for domestic purposes. (2) The difficulties encountered in producing such a fuel from bituminous coal, and (3) The progress which has, so far, been made in this direction, and the future of a low-temperature carbonisation industry.

The Need for Smokeless Fuel

Lord Macaulay relates that in the year 1307 an Englishman was executed for the burning of raw coal to the detriment of his fellow citizen's health, whilst in 1580 Queen Elizabeth prohibited the use of coal in London whilst Parliament was in session, " because the health of the knights of the shires might suffer during their abode in the Metropolis."

Since these early days we have become inured to the emission of smoke from countless domestic and industrial chimneys, but a consideration of the damage occasioned by such smoke is startling. It has been computed that the extra cost for fuel and materials for washing in Manchester alone, owing to the smoky atmosphere, is nearly £250,000 annually, whilst the extra labour entailed totals 668 years. The annual national " Black Smoke Tax " is approximately £40,000,000. E. D. Simon ("The Smokeless City," Longmans, Green and Co.) states that 75 per cent. of the damage caused by smoke to property and health is due to domestic smoke, and that improved plant and a general desire for fuel economy amongst power producers are responsible for the tendency for the disappearance of air pollution from industrial smoke to disappear. By carbonising coal at the temperature of about 600° C., as distinct from carbonisation at about 1000° C., as in the modern gasworks, it is possible to produce a coke suitable for domestic purposes. Such a coke whilst smokeless on combustion, ignites readily, and can be made sufficiently strong to withstand considerable handling and transport. To replace the 35 million tons of coal consumed annually for domestic purposes, it would be necessary to carbonise 54 million tons of coal at a low temperature, but the by-products recovered would be of the following dimensions:—

Light Spirit	121 million gallons.
Tar	972 " "
Ammonium sulphate ..	337,000 tons.

With some reservations, it can be said that the tar is of such a nature that it will find use as " fuel oil," whilst motor spirit can be manufactured from the light spirit obtained. The fertilising value of ammonium sulphate is well known. The national importance of such a low-temperature carbonisation system at once becomes apparent, and the question naturally arises, " What practical difficulties are encountered in carbonising bituminous coal at a low temperature, and what progress has been made in establishing a low-temperature carbonisation industry ? "

* Lecture before the Manchester College of Technology, Evening Students' Chemical Society, on January 22.

The Manufacture of Smokeless Fuel

Two main difficulties arise in the manufacture of low-temperature coke due to (*a*) the excessive swelling of certain types of bituminous coal on carbonisation at a low temperature, and (*b*) the low thermal conductivity of coal.

(*a*) Bituminous coal may be regarded broadly as consisting of a fusible portion and a non-fusible portion. The fusible portion appears to melt at temperatures of 350° C.—450° C., and acts in this condition as a binding or cementing agent for the non-fusible constituents. On the continued application of heat decomposition takes place, and the gases evolved "blow out" the pasty mass, causing the coal to swell. This swelling is excessive with certain bituminous coals, normally employed for the manufacture of metallurgical coke and as gas-coals, and measures must be taken in low-temperature carbonisation to modify the swelling and prevent the charge "sticking" in the retort. At higher temperatures, such as obtain in a gasworks retort, the coke subsequently shrinks, and this difficulty does not arise. Excessive swelling can be overcome by "blending," which consists in intimately mixing a strongly swelling coal with a non-swelling coal, or with a coke obtained from a previous carbonisation. Another method is that adopted in the Illingworth process. The fusible constituents of bituminous coal decompose over varying ranges of temperature. By a selective preheating a portion of the fusible constituents can be destroyed, and the swelling of the coal can be correspondingly modified. By blending and preheating the strength and nature of the coke can also be modified. In certain processes mechanical means are taken to overcome excessive swelling.

(*b*) In high-temperature carbonisation processes, the charge requires heating about eight hours before carbonisation is complete, owing to the low thermal conductivity of the coal. In low-temperature carbonisation processes, the temperature gradient is in comparison very low, and it has been found necessary to reduce the thickness of the coal charge to four inches, in order that the period of carbonisation shall not be excessive. Alternately, a gaseous heating medium such as superheated steam, coal gas, or producer gas may be employed, or the coal may be passed continuously through the retort during the carbonisation so that each piece of coal comes into intimate contact with the hot wall of the retort.

We may date the beginning of low-temperature carbonisation as a commercial venture from 1906, when Thomas Parker (who originated the term "coalite") patented plant in which the coal was carbonised at a low temperature, in layers of about four inches in thickness. From that date numerous patents have been taken out [illegible] many processes have been worked, although [illegible] has yet justified the high expectations entertain[illegible] the patentees. Definite progress has, howev[illegible] made in the manufacture of low-tempera[illegible]e, and remaining difficulties centre round the [illegible]mic utilisation of the by-products, rather than round the actual manufacture of a satisfactory smokeless domestic fuel. Three typical processes may be described.

(1) The "Coalite" Process (Low-Temperature Carbonisation, Ltd., Barnsley) is typical of processes in which the coal is stationary in the retort during carbonisation, the retort being heated externally. Blending of suitable coals is carried out in a washer of standard type, and after draining, the coal passes to charging bunkers situated over individual retorts. The distance from centre to centre of the retorts is 21 inches, the retorts being built in batteries. Each retort is provided with two manganese cast-iron plates, situated inside, and running the whole depth of the retort. Mechanism is provided whereby the plates can be brought closer to one another. The coal is charged into the free space between the plates and the sides of the retort, being supported on a bridge-piece placed below the plates. The distance between the plates and the sides of the retort is approximately four inches. When carbonisation is complete, the period of carbonisation per charge being eight hours, the plates are brought nearer together, the bridge-piece is rotated and the mass of coalite falls into a specially-designed cooling chamber, situated below the retort. Here it is cooled, the chambers being water-jacketed, the steam generated being used in auxiliary processes. The "Coalite" is obtained in large cakes requiring breaking and sizing prior to sale. It is sufficiently hard to withstand considerable handling and transport and burns readily, giving a pleasant, smokeless fire.

(2) The "Carbocoal" or "Smith" process, of American origin, utilises an externally-heated retort, through which the coal is mechanically propelled during carbonisation. The retort is of an inverted "heart" shape, and is provided with two internal shafts fitted alternately with paddles. The shafts revolve in the retort, and the coal, fed into the retort by a screw conveyer from a charging bunker, is passed through the retort by the paddles. Carbonisation lasts from two to three hours, and the coked residue is discharged from the retort in a pulverulent condition, through a water seal. This coked residue is the true low-temperature product. In order, however, to fit it for sale, it is briquetted, after mixing with pitch, in "roll" presses, and the "ovoid" briquettes so obtained are carbonised at a high temperature giving a product known as "Carbocoal." The "carbocoal" briquettes are exceptionally hard and compact, but are more suitable for use in anthracite stoves and as boiler fuel, than as a smokeless domestic fuel for use in the ordinary grate.

(3) In the Pure Coal Briquette Process the sensible heat of a stream of superheated coal-gas is employed for carbonisation, an internally-heated retort being employed. This process represents the most recent development in low-temperature carbonisation, in so far as the properties of the fuel obtained are dependent upon a preliminary treatment prior to carbonisation, and upon the temperature conditions during carbonisation. The coal, cleaned by passage through a battery of "froth flotation" cells, and dryers of the "static" type, is pulverised to a fineness comparable with that required for powdered fuel for boiler furnaces and cement kilns.

The finely-divided coal is then briquetted under a pressure of about ten tons per sq. in., no pitch binder

being added. Carbonisation of these briquettes under varying temperature conditions yields a fuel suitable either for domestic purposes, boiler fuel, or metallurgical coke, for which remarkable claims are made with regard to consumption per ton of pig iron produced in the blast furnace. Retorts have been designed to carbonise 500 tons of briquettes per retort per 24 hours, and it is hoped that by utilising retorts of such large capacity and by the system of internal heating adopted, the low costs of carbonisation may offset the cost of cleaning, drying, pulverising, and briquetting. The process has yet to be tried out on a large-scale plant, but experimental plant has given encouraging results over a considerable period. The further development of the process will be viewed with much interest by all concerned in fuel economy, marking as it does an entirely new departure in carbonisation processes for the production of smokeless fuel.

The success or failure of many industrial processes centres in the value of the by-products as distinct from the main product. Besides the 15 cwts. of low-temperature coke obtained from every ton of coal carbonised there is obtained :—

(1) 20 to 25 gallons of tar, which is characterised by its liquid nature, its low free carbon content (3 per cent.), and a composition approximating to :—
  (a) 50 to 80 per cent. of hydrocarbons, mainly paraffin, naphthene, and unsaturated hydrocarbons, whilst benzene, toluene and the homologues are either entirely absent or present only in small quantities.
  (b) 20 to 50 per cent. of tar acids—phenol being present only in small quantities, cresols, and xylenols to the extent of 2 to 4 per cent. of the tar, whilst the remainder are mainly higher phenols which are viscous oils or resinous solids.
  (c) Small quantities of nitrogenous and sulphur bodies.
(2) From processes employing externally-heated retorts 3000 to 3500 cb. ft. of gas of 800 to 1000 B.Th.U. per cb. ft. From many processes employing internally-heated retorts 20,000 to 25,000 cb. ft. of gas of approximately 230 B.Th.U. per cb. ft.
(3) Varying yields of ammonium sulphate which may be said to be from 10 to 25 lb.

The processes producing large volumes of low-grade gas (230 B.T.U. per cb. ft.) must find application in industries in which such gas can be economically utilised, as for example the steel industry, whilst the small volumes of high-grade gas (800 to 1000 B.T.U. per cb. ft.) from other processes may find application as an enriching agent for town's gas produced by gasworks processes in which steaming is employed.

The greatest difficulty centres in the economical utilisation of the low-temperature tar. Our knowledge of its composition is far from complete, and although with some reservations with regard to viscosity and flash point it can be employed as fuel oil, we have yet to discover a scheme for its utilisation which is comparable with that in existence for the utilisation of high-temperature tar.

FORTHCOMING EVENTS

Mar. 14.—Society of Chemical Industry, *South Wales Section*, The University College, Chemistry Department, Swansea, at 6.45 p.m. "Suggestions for Spectrum Analysis in Works Laboratories," by J. R. Green.

Mar. 18. Institute of Metals, *Birmingham Section*, the Chamber of Commerce, New Street, Birmingham, at 7 p.m. "Brittle Ranges in the Brasses," by D. Bunting, M.Sc. "The Relation of the Theobromine Content of Cacao to its Fermentation," by A. W. Knapp and R. V. Wadsworth.

Mar. 18. Society of Chemical Industry, *Edinburgh and East of Scotland Section*, the Hall of the Pharmaceutical Society, 36, York Place, Edinburgh, at 7.30 p.m. "Co-ordination and Co-valency," by Dr. N. V. Sidgwick, M.A., F.R.S.

Mar. 19. Society of Chemical Industry, *Newcastle Section*, Chemical Lecture Theatre, Armstrong College, Newcastle, at 7.30 p.m. "East Durham Waters for Boiler and Other Purposes," by W. G. Carey.

Mar. 19. Institution of Civil Engineers, Great George Street, Westminster, S.W. 1, at 6 p.m. *Students' Meeting.* "The Work of a Mechanical Engineer's Office," by A. J. Hill.

Mar. 20. The Chemical Society, Burlington House, Piccadilly, W. 1, at 8 p.m. (Ordinary Scientific Meeting). (1) "Rotatory Dispersion of Derivatives of Tartaric Acid. Part I. Methylene Derivatives," by P. C. Austin and V. A. Carpenter. (2) "The Rotatory Dispersive Power of Organic Compounds. Part XV. The Molecular Weight of Ethyl Tartrate and the Origin of Anomalous Rotatory Dispersion in Tartaric Acid and its Derivatives," by T. M. Lowry and J. O. Cutter.

Mar. 21. Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W. 1, at 6 p.m. General Meeting. Presidential address by W. H. Patchell.

Mar. 21. Society of Chemical Industry, *Liverpool Section*, the Overseas League, 14, Elliot Street, Liverpool, at 6 p.m. "Some Aspects of a City Analyst's Work," by Prof. W. H. Roberts.

Mar. 21. Society of Dyers and Colourists, *Manchester Section*, 36, George Street, Manchester. (1) "Bi-polar Electrode Electrolysers for the Production of Bleaching Liquors," by G. G. Hepburn. (2) "Properties of Cotton Wax in Relation to the Scouring Process," by R. G. Fargher, D.Sc.

Mar. 22. Royal Institution of Great Britain, 21, Albemarle Street, W. 1, at 3 p.m. "Properties of Gases in Vacua," by Prof. Sir E. Rutherford. *Also on March 29, at 3 p.m.*

Mar. 24. Institution of Mechanical Engineers, Storey's Gate, S.W. 1, at 7 p.m. Informal discussion on "Failure in Metals."

Mar. 24. Royal Society of Arts, (Cobb Lecture), John Street, Adelphi, W.C. 2, at 8 p.m. "Certain Fundamental Problems in Photography" Lecture I., by Dr. [illegible]

Mar. 26. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2 (Ordinary Meeting), at 8 p.m. "The Fishing Industry and its By-Products," by N. Green.

Mar. 26. ROYAL MICROSCOPICAL SOCIETY, 20, Hanover Square, London, W. 1. Dr. Stephen Miall will preside. (1) "Methods of Mass-Production in Sectioning Flax Stems," by G. O. Searle. (2) "Microscopical Metallurgy," by Dr. H. Wrighton, D.Met., (3) Lecture Demonstration on "Technical Microscopy." No. 4: The Setting up and Adjustment of a Microscope. The Vital Necessity of Accurate Centration, by J. E. Barnard.

Mar. 28. SOCIETY OF CHEMICAL INDUSTRY, *Chemical Engineering Group*, the Lecture Theatre of the Institution of Civil Engineers, Great George Street, S.W. 1, at 6 p.m. "Kinetic Elutriation," by L. Andrews.

Mar. 28. ROYAL INSTITUTION OF GREAT BRITAIN, 21, Albemarle Street, W. 1, at 9 p.m. "Insulin," by Dr. H. Maclean.

Mar. 28. SOCIETY OF CHEMICAL INDUSTRY, *South Wales Section*, the Technical College, Mount Pleasant, Swansea, at 7.15 p.m. Annual Meeting, addressed by Capt. H. Vivian.

Mar. 28. THE MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, *Chemical Section*, at 7 p.m.

Mar. 28. SOCIETY OF CHEMICAL INDUSTRY, *Glasgow Section*, Engineers' and Shipbuilders' Institute, 39, Elmbank Crescent, at 7.15 p.m. "The Influence on Chemistry of the Recent Knowledge Gained of Atomic Structure," by J. A. Cranston, D.Sc.

Mar. 31. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2 (Cobb Lecture), at 8 p.m. "Certain Fundamental Problems in Photography" (Lecture II.), by Dr. T. Slater Price.

The meeting of the South Wales Section of the Society with the Faraday Society, announced in our last issue for March 14, has been postponed until October next.

The Ordinary Meeting of the Faraday Society that was to be held on March 17 will not take place, but an Ordinary Meeting will be held on Monday, April 14, at 8 p.m., in the Rooms of the Chemical Society, Burlington House, W. 1, when a report on the Examination of Oppau Ammonium Sulphate-Nitrate will be given.

The Physical Society of London is arranging to celebrate its jubilee from March 20 to 22 next. The preliminary programme of the proceedings will be as follows: On Thursday, March 20, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 2, at 2.30 p.m., there will be an Exhibition of Apparatus, followed by a reception at 3.0 p.m., and at 3.45 the Guthrie Lecture on "Photo-electric Effects in the case of High Frequency and Allied Phenomena" will be delivered by M. le Duc de Broglie. On Friday, March 21, from 4.0 to 5.30 p.m., and from 6.0 to 7.30 p.m., reminiscences by Original Fellows and other Follo[illegible]ng standing will be given, and on Saturday, Mar[illegible]e will be a continuation of the Exhibition, and [illegible]m. for 7.30 a banquet will be held for Fellows [illegible] guests only.

The Council of the Physical Society extends to the members of this Society a hearty invitation to be present at these meetings, and, according to present arrangements, no tickets will be required for this purpose.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

Patron: H.M. The King

PRELIMINARY NOTICE

The Annual Meetings of the Society will be held in Liverpool from Wednesday, July 9, 1924, until Saturday, the 12th inclusive.

His Majesty the King has been graciously pleased to grant his Patronage to the Meeting.

The Presidential Address will be delivered by Dr. E. F. Armstrong, F.R.S., and the Messel Lecture will be given by the Rt. Hon. Viscount Leverhulme.

A limited number of technical papers will be read, and there will be visits to at least two large works in the neighbourhood.

A very interesting programme is being arranged by the Local Committee under the Chairmanship of Mr. Edwin Thompson, who was largely responsible for the great success of the British Association meeting in September last.

Whilst the business and technical side will be adequately represented in the programme, arrangements will be made to make the meeting an attractive social event.

It is hoped that many of the Society's overseas members who are coming to this country to visit the British Empire Exhibition will arrange their visit so that it may be possible for them to be present at the Society's Annual gathering.

Further particulars will be intimated as arrangements are completed.

OFFICIAL NOTICES

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

Vol. VIII is now in preparation and will be issued shortly. The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members. Vol. I is out of print, but copies of Vols. II, III, IV, V, VI, and VII may be obtained by members at 4s. 6d., 5s. 6d., 5s. 6d., 8s. 3d., 7s. 6d., and 7s. 6d., and by non-members at 7s. 6d., 10s. 6d., 12s. 6d., 15s., 12s. 6d., and 12s. 6d. respectively. If Vols. II, III, IV, V, VI, and VII are ordered at the same time as Vol. VIII, the set may be obtained by members for £2 2s. 6d., and by non-members for £3 15s. The appropriate remittance must accompany every order. The books are sent to purchasers post free.

DEATHS

Roberts, F. G. Adair (Original Member), of 68, North Gate, Regent's Park, London, N.W. 8. Chemical Manufacturer. On February 11, 1924.

Richards, Edgar (elected 1889), of 60, Ayrault Street, Newport, R.I., U.S.A. Analytical Chemist. On January 21, 1924.

Francis, W. H. (Original Member), of 11, Bramham Gardens, South Kensington, London, S.W. Wholesale Druggist. In May, 1923.

CHEMICAL ENGINEERING GROUP

On March 4 a joint meeting with the Hull Chemical and Engineering Society was held in Hull, and Mr. E. A. Alliott, B.Sc., M.I.Chem.E., read a paper entitled "Centrifugal Dryers, Their Construction and Use."

After a few remarks on the arts of drying and separating Mr. Alliott discussed constructional details of centrifugal dryers, beginning with the basket, that part of the apparatus which has most influence on the design. Various materials, steel, copper, aluminium, nickel, etc., are used to make the baskets, which are discharged by hand or through discharge doors; one type is ifted out. Speeds of running usually vary between 8000 to 12,000 ft. per minute, though small machines of 12 in., and less diameter may be run at 18,000 ft. per minute. After considering the relationships of running speed and size of basket, centrifugals were discussed under the headings of fixed spindle, suspended, and self-balancing machines. The behaviour of material in a centrifugal drier was dealt with and an account was given of various points connected with working practice, *e.g.*, the method of filling, the distribution of moisture in the load, and the effect of heat, size of grain, viscosity, and capillarity on drying. Figures were adduced to show the efficiency of "spinning" under commercial conditions and the question of labour and output was treated at length. The second part of the paper was devoted to centrifugal separators, beginning with a discussion of the chief features of emulsions and suspensions. A detailed account of separators, illustrated by practical data, was then given.

EDINBURGH AND EAST OF SCOTLAND SECTION

Two papers were read at the meeting held on February 12.

I "Factory Plant Records as a Control of Efficiency in Manufacture," by J. Adam Watson. The efficient working of any plant, and particularly of a chemical plant, can be most easily controlled by the use of a series of daily reports drawn from every section of that plant. These reports, which can be drafted so that their filling up by the departmental foreman every day will occupy little time, are then handed to a special Record Department. The duty of this department will be to tabulate the figures handed to it in such a way as to enable a diagram to be prepared at any desired time interval, which will show clearly the efficiencies of the plant in bulk and detail. The diagram which does this is the flow-sheet, which indicates the course of all material required to produce the article or articles being manufactured. It also shows the interdependence of the various departments. From the details so obtained it is readily possible by substituting cost for weight to obtain the price paid for the finished article. Also the labour necessary may be shown by noting against each stage the men-hours required for its production. This scheme provides a basis for issuing instructions to such subsidiary departments as the laboratory, buyers, etc., and at the same time it may be used to calculate a bonus for the workers. The adoption of such a system places in the hands of the management a mass of data which will be invaluable for improving the efficiency of the processes and determining the minimum price of the articles being manufactured.

II. "The Viscosity of Rubber Solutions," by C. L. Abernethy, M.A., B.Sc. The importance of viscosity determinations as a means of factory control has lead to the study of the factors controlling viscosity and of the methods of measuring it. The various methods were examined with reference to their suitability. for rubber solutions, and the falling sphere method was described in detail. By its aid the viscosities of solutions of well-milled smoked plantation sheet in benzene and toluene could be examined from 7½ per cent. up to as high as 30 per cent. or 40 per cent. concentration, the concentration being expressed as grams per 100 c.c. of solution. Curves were obtained for the viscosities of solutions up to 40 per cent., *i.e.*, 40 grams in 56 c.c. of benzene, at a range of temperatures from 10° C. to 60° C. The viscosity concentration curves were found not to obey Arrhenius' logarithmic law, $\eta = ke^{c}$, but to follow the law $\eta = Ke^{k\sqrt{c}}$, where K and k are constants depending on the nature of the rubber and on the temperature. The viscosity of the solid rubber could thus be obtained in absolute units.

MANCHESTER SECTION

A meeting was held on March 7 at the Textile Institute, Dr. Herbert Levinstein presiding. About 70 members and visitors were present, and Prof. F. Gowland Hopkins, D.Sc., F.R.S., read a paper entitled "Some Chemical Qualities of the Living Cell."

Prof. Gowland Hopkins said that as one who was more or less responsible for having introduced the conception of vitamins into science, he had frequently had to speak on that subject to medical and other audiences. The conception of a vitamin had certain encrustations about it which prevented everybody accepting what were really said to be very important scientific facts. He had not attempted to define a vitamin. In an adult community, under good economic conditions, the need for something other than a supply of energy did not seem to assert itself, because the vitamins were always present in all natural foods. Special circumstances were required to make their importance obvious, or they would have been discovered many years ago instead of in the past ten years or so. Being connected with the subject of diet, they naturally attracted the attention of quacks, and therefore a good deal of nonsense had been written about them, whilst, on the other hand, it was equally true what was written about vitamins gave a great opportunity for trade stunts. They had not yet been isolated, so that their chemical composition was unknown. What he wished to

urge was that the facts known about vitamins were important. An animal can be fed upon a diet consisting of the most excellent protein and really superior fat and best carbohydrate on the market, and give it the necessary salts in the right ratio. So long as those materials were pure and not mixed with traces of any other ingredient, the dietary would be eaten, enjoyed, fully digested, thoroughly broken down in the body, and its energy extracted, and yet any animal continuing to eat it would inevitably die. In order to convert that dietary into a perfect one for the maintenance of life, materials must be added which acted in almost infinitesimal concentration within the cellular structure of the living organism. The only present definition of a vitamin of a definite constitution was that it was a substance of extreme nutritive importance which acted in infinitesimal concentration. With Fat-Soluble Vitamin A 0·004 mg. added to a synthetic dietary made just the difference between certain death and excellent life in feeding a rat weighing 100 g. They must not despise the rat; it was, in all essentials, of the same physical constitution as human beings. With a 70 kg. man 2½ mgs. would be required to bridge the difference between health and death. Only under exceptional circumstances, such as a state of war, did the lack of vitamins affect adults, but the feeding of infants must be placed in a different category.

The living cell was pre-eminently a colloidal system, though this factor must not be dwelt upon too much if they were to understand its chemical activities. Its colloidal nature represented the essential apparatus. There were small molecules in solution which were able to undergo high-velocity reactions characteristic of life. The living cell contained 70 per cent. of water, and much of its material was in simple solution. The colloidal apparatus was relatively stable and was largely, if not entirely, protected from the oxidations which yielded a supply of energy to the cell, but, on the other hand, the form of the colloidal apparatus was all-important in determining what precise energy transformation should occur.

Prof. Gowland Hopkins also dealt with the question of food preservatives. It was extremely difficult for a physiologist, biologist or medical man to say whether long continued use of material which apparently produced little or no effect within a short period might not, in the course of years, have a deleterious effect upon health. One manufacturer would point out that the amount of preservative in his particular article was so small that it could not matter; it was far below the medicinal dose, and so on. This would be equally true of another manufacturer's article, and of a third, and perhaps of a fourth, and one individual would partake of all four articles in the same day. Upon going into figures, it was astonishing what a very large dose of boric acid the consumption of various articles of diet might involve. There were, of course, enormous trade interests to be considered in connexion with the supply of foodstuffs. They were all using infinitesimally small quantities of preservatives, and, in some cases, even dyes. The problem was whether there was likely to be any cumulative effect. Neither the manufacturer, the wholesaler, nor the retailer troubled themselves concerning this aspect of the problem. The living organism was at times astonishingly sensitive to small doses, and could also accumulate small doses until they became large. Of course, there was provision, for instance, that a dye should contain neither arsenic nor lead nor other poisonous substance. It was not the fault of anyone concerned in the preparation of foodstuffs that the present position of things was taken for granted, but the time had seemed to arrive when a new profession was required, or else the State should provide special Institutes where tests could be made which did not come under ordinary chemical technique. Drugs should be tested biologically, and foodstuffs for their food content. Living tissues were delicate, nicely balanced organisations and extremely sensitive to maltreatment.

NEWCASTLE SECTION

At the meeting held on February 25, a paper was read by Mr. C. W. H. Holmes, B.Met., on "Some Aspects of the Physical Properties of Moulding Sands for Foundries." Mr. Holmes first described the properties of a well-bonded moulding sand and pointed out the importance of the strength of the bond and the ratio of the various mechanical grades, a factor upon which depends the venting properties of the sand. He described the various methods of sorting out the different sizes of sand and described his modification of Crooke's elutriator for determining the proportions of the finer grades, which are impossible to determine on sieves. An account was also given of the latest method of determining the bonding factor by means of dye adsorption.

On March 3 a joint meeting was held in Middlesbrough with the local section of the Institute of Chemistry and the Cleveland Institute of Engineers. Mr. C. H. Ridsdale, F.I.C., read a paper entitled, "Engineers and the Interpretation of Chemical Specifications for Iron and Steel in Relation to Analytical Accuracy."

Exploration of the work of the British Chemical Standards' Movement had revealed data which should have practical bearing on the interpretation of chemical specifications. The engineer provided exact measurements for section or length as well as the weight, but for composition all that was given was a figure on paper that had no exact meaning; its value was determined arbitrarily after the steel had been made by analytical operations subject to ever varying personal and other factors so that another test of the same sample might yield a different result. So, although the maker's own chemist might find the material right he could never be sure it would not be rejected. Small differences near the border-line—quite within the range of working of good chemists—might be enough to cause rejection. For the same reason exaggerated importance was apt to be attributed both to the influence of small quantities of impurities and to trifling differences in results; no allowance however was officially recog-

nised for differences which analysts usually gave in practice, which were distinct from differences arising during manufacture and recognised as inevitable.

If instead of the maker having to work to and be judged by an unfixed and unascertainable (by him) value, the composition figure was specified in terms of a definite standardised sample the values of which had already been determined, how much more satisfactory for all concerned. This would be tested side by side with the sample of steel made, and, by its agreement with or divergence from its acknowledged standard figure, would at once reveal whether or not the working and results of both were correct. In the preparation of standard analysed samples important factors which tended to differences between chemists in ordinary work were removed. Yet whenever a large number of chemists (10 to 20) tested the same sample the final carefully considered results had shown an appreciable variation. The question thus was whether there was justification for regarding any result by one or even two or three chemists as right, except to within a similar range of variation, and whether it was reasonable that material should be rejected solely for wrong composition, when the variation from the figure specified did not exceed that by which the reference or any chemist might be in error?

These facts and considerations were submitted the General Meeting of the British Chemical ndards' Movement held on February 9, 1923, their views were embodied in a resolution stating he rejection of steel or cast iron is not warranted on chemical analysis alone.

The Committee of the Chemical Standards movement then sent out a circular letter to about 550 co-operators, users of standards, and others, asking for their opinion on a table showing that the tolerances which would seem reasonable for analytical determination of composition were really very small when compared with those actually granted for other properties of material, such for instance, as variation in weight and length.

TOLERANCES OFFICIALLY GRANTED FOR WEIGHT AND LENGTH AND THOSE PROPOSED FOR COMPOSITION.

For	Per Cent. Plus or minus for normal conditions.	
Weight	1·0	granted, see B.E.S.A. specifications.
Length	0·05	

Composition		Actually Found under exceptionally favourable conditions.	suggested
	%	%	%
Carbon, up to ..	0·35	0·025†	0·015
	0·36—0·75	0·033	0·020
	0·76—1·20	0·05	0·025
Silicon up to ..	0·10	0·025	0·015
	0·10—0·20	0·032	0·020
Sulphur up to ..	0·08	0·0077 (0·008)	0·005
Phosphorus up to	0·05	0·0062	0·005
over	0·10	0·012	0·007
Manganese, plain Carbon steels up to	0·45	0·021	0·015
	0·46—1·0	0·048	0·025
Alloy Steels, Cast Iron up to ..	0·7	0·050	0·030

† The percentages of variation found and suggested for composition are (as with weight and length) percentages of the whole 100 units, not of the total of the particular element determined only.

The tolerances tentatively suggested were slightly above one half the range of variation found with work under exceptionally favourable conditions. Out of all the replies, not one objected outright to the principle though several said the tolerances were not sufficiently large, or raised partial objections. Two or three others did not feel disposed to offer any opinion, but the vast majority approved both of the principle and the amounts. The replies were clearly representative of the interests concerned.

The fact of these differences between chemists, even when doing the most careful work, could not be gainsaid, and showed that they caused considerable trouble, and did not improve the status of the chemist in the eyes of engineers and commercial men. Did they really matter in practice? A difference of 0·005 per cent. might look a lot as compared with a total of 0·03 per cent., but it was really only one twenty-thousandth of the unit. A solution would be for chemists not to report to the third decimal place, at any rate by less than 0·005 per cent. at a time, otherwise it would be imperative to allow such differences at the tolerances. If it was contended that figures should be reported to such a degree of fineness, the only way was for chemists still further to improve their working. In that case it was imperative that everything should be done to facilitate the desired exactitude. To this end, engineers should supply, or at least refer to definite standards obtainable by all, just as they stated the composition itself, and both makers and chemists ought to regard these standards not merely as a convenience to be supplied or used at option, but as a necessity for which they had a right to demand. However, these differences and difficulties would ultimately be removed, the more the subject was ventilated and discussed between engineers, managers and chemists, the sooner would this come about. We had as an example, the splendid work of the British Standards Association. True, they only made recommendations, not laws, but these were becoming more and more effective every day, and we could only expect the British Chemical Standards Recommendations to take effect in the same way for chemical specifications.

The Lord President of the Council has appointed Mr. F. S. Sinnatt, M.B.E., M.Sc., to be Assistant Director of Fuel Research as from April 1. Mr. Sinnatt is Lecturer in Fuels in the University of Manchester, Faculty of Technology. He is also Director of Research to the Lancashire and Cheshire Coal Research Association, and has been in charge of the physical and chemical survey of coal seams which the Association is carrying out for the Fuel Research Board in the Lancashire and Cheshire fields.

CHEMICAL SOCIETY

The third Hugo Müller lecture was delivered on Thursday, February 28, by Prof. J. Joly, Professor of Geology in Trinity College, Dublin. The lecturer was introduced by the President, Prof. W. P. Wynne, who briefly referred to the advantages of the application of physical science to geological investigations.

Radioactive studies, said Prof. Joly, were of special interest in that they appeared to throw light on the past history of the elements. Lord Rayleigh's observations, eighteen years ago, that acid rocks contain a larger quantity of radioactive material than the basic rocks, and that the igneous contain more than the sedimentary, had since been confirmed. The precise value of the ratio of the content of uranium to that of thorium, for which an approximate average figure was 0·9 : 2, was not important, or indeed constant, since the rates of decomposition of uranium and thorium are unequal, the former being thrice as great as the latter. The results which he had to communicate were favourable to the view which had been adopted by many geologists, namely, that there is a primary basaltic magma on which the superstructure of the continents floats. It was of importance to note that the first silicates which were formed in the igneous rocks, the zircons, are exceptionally rich in uranium. The lecturer suggested that an explanation might be sought in the isomorphism of zirconium oxide with the oxides of uranium and thorium.

Prof. Joly then proceeded to give an account of the "haloes" to which this concentration of radioactive elements in rocks gives rise. These circles, which have a radius of about 0·003 mm., and could readily be observed with a good microscope, were in fact cross sections of spheres around a zircon centre, and were due to the penetration of the material by α-rays; their existence was at one time erroneously ascribed to the presence of organic matter, since the bands fade when the material is heated. (Their appearance as concentric light and dark bands was illustrated by a number of photomicrographic lantern slides.)

Three kinds of haloes were due, respectively, to uranium and its family, to the thorium family, and to emanation; in the case of the last-named a photograph showed the effect of the passage of emanation through interstices in the material, and the formation of haloes at points where, presumably, the radioactive material became arrested by adsorption. It was possible to distinguish clearly between the haloes due to uranium and those due to thorium by measurement of the radii, and comparison (assuming, however, that the rays are parallel) with the known degree of penetration in air of the α-rays from various sources; in the case of mica, the ranges for air must be divided by 2000. The lecturer hazarded the opinion that the effect was an alteration in the molecular condition of the iron by α-rays, since iron-free materials never exhibit haloes. If it were assumed that a rock contained twenty-five times as much uranium as was present in Lord Rayleigh's richest sample of zircon, calculation demonstrated that the clearly observed haloes originated from an amount of uranium no greater than 3×10^{-18} gram.

In some cases the light and dark areas of the haloes were reversed; the phenomenon was explained by the lecturer as being parallel to the known reversal of photographic images by over-exposure to light. Thus partial or complete bleaching of portions of the mica may result from over-exposure to the ionising α-rays. It is supposed that in the case of new micas (one hundred million years) there has not been time for reversal, whilst in the case of the old micas (two hundred million years) such reversal has taken place. The nature of the halo depends also on the radioactive strength of the nucleus.

Examination of an old mica—Ytterby mica—had led to the detection of the presence of three different varieties of haloes which could not be identified with those due to any known element. Two of these, called respectively X_1 and X_2, of which the smaller corresponded with an α-ray penetration in air of 1 cm., might be produced by any existing element, such as a rare earth, or by an element which has now disappeared by disintegration; the third could only be ascribed to a hitherto unrecognised element, to which the name "hibernium" had provisionally been given.

Prof. Joly concluded by remarking how few of the existing elements are radioactive, but that this comparatively scarce phenomenon was involved in the genesis of the elements. The studies which he had described carried one back to events of two hundred million, possibly even a thousand million, years ago.

Prof. H. B. Dixon, proposing a vote of thanks to the lecturer, said that the discourse to which they had just listened was one of the most delightful, as regards both material and delivery, he had heard. Borrowing a phrase from Mr. Pickwick, he asked them to "surround with a halo of united cheering" the name of Prof. Joly—physicist, chemist, geologist—the Hugo Müller lecturer for 1924.

Seconding, Dr. A. S. Russell expressed thanks for a most interesting and stimulating lecture, dealing with a fascinating area of junction of the sciences. He asked whether one of the haloes might be due to an element of the actinium series, and whether the α-ray of 1 cm. penetration in air might be due to the head member of the polonium group.

The motion for the vote of thanks, when put by the President, was carried with acclamation.

Prof. Joly, after brief acknowledgment, said that he had considered the actinium question, but was unable to endorse the suggestion. He regarded that element as a side branch of the uranium line, and not strong enough to produce a halo by itself.

At an ordinary meeting on Thursday, March 6, 1924, the President, Prof. W. P. Wynne, announced that nominations to vacancies among the Officers and Council had been received as follows: To be one of the Secretaries, Prof. C. S. Gibson; as Vice-Presidents who have filled the office of President, Prof. Sir J. J. Dobbie and Prof. W. H. Perkin; as Vice-Presidents who have not filled the office of President, Mr. A. J. Greenaway and Prof. J. C. Philip; as members of the Council (Town), Dr. O. L. Brady,

Dr. A. E. Dunstan, Prof. T. S. Moore (County), Mr. B. Lambert, Prof. F. L. Pyman, Prof. D. R. Boyd. As the number of nominations did not exceed the number of vacancies, no ballot would be necessary this year.

The President reminded Fellows that the Annual General Meeting would be held at 4 p.m. on Thursday, March 27, and would be followed by an Informal Dinner, tickets for which could be obtained from the Assistant Secretary for the sum of 7s. each. He hoped that, whether they chose to wear evening or morning dress, a large number of Fellows and their guests would be present.

Prof. J. R. Partington gave an account of experiments on :—

The reaction between lime and nitrogen peroxide. J. R. Partington and F. A. Williams.

THE reaction between pure nitrogen dioxide and lime has been investigated, and it has been shown that the products of reaction are calcium nitrite, calcium nitrate, nitric oxide and nitrogen. The proportion of calcium nitrate in the product is more than equivalent to the calcium nitrite. The loss of nitrogen as elementary gas varies, the maximum being about 5%. The existence of the hydrate of calcium nitrite, $Ca(NO_2)_2$, $4H_2O$ has been confirmed. The thermal decomposition of calcium nitrite has been found to commence at 230°, the products below 480° being calcium nitrate, calcium oxide, nitric oxide and nitrogen. Above 480°, nitrogen dioxide is also obtained. It has been proved that calcium nitrite is readily oxidised to calcium nitrate by nitrogen dioxide, which is reduced to nitric oxide and nitrogen. The nitrogen set free during the reaction of nitrogen dioxide and lime is due to this reduction. Calcium nitrite when heated in oxygen below its decomposition point (230°) was found to remain unoxidised, but on admitting nitrogen dioxide oxidation occurred, the dioxide being alternately reduced to nitric oxide and reproduced from this by oxidation with free oxygen.

Prof. F. G. Donnan congratulated the authors on the thorough way in which the reaction had been examined, the President referring also to the interest of a detailed study of the behaviour of nitrogen dioxide in the manufacture of sulphuric acid.

Prof. Partington also described the following confirmatory experiments :—

Tellurium monoxide. By J. J. Doolan and J. R. Partington.

THE experiments of Divers and Shimosé on the production of tellurium monoxide by heating tellurium sulphoxide, $STeO_3$, in a vacuum at 180°, were repeated and confirmed. The product had the properties described by Divers and Shimosé, and the results obtained by Weber are therefore incorrect.

Dr. S. W. Smith agreed that difficulties arose in the assay of tellurium ; fusion with litharge at a low temperature was necessary. He had reason to think that the reaction, $2PbO+Te=Pb_2O+TeO$ took place when the buttons of lead containing tellurium were fused with litharge, for the black substance in the mass was soluble in concentrated sulphuric acid.

Prof. Partington said that although one would not expect the tellurium monoxide to exist at the temperature employed—it decomposes at an undetermined temperature above 180°—it might exist in the presence of litharge. Elementary tellurium requires the use of fuming sulphuric acid for its dissolution.

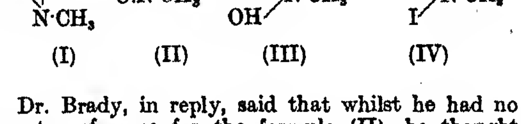
Dr. O. L. Brady discussed :—

The isomerism of the oximes. Part XVII. The action of 1-chloro-2:4-dinitrobenzene on some isomeric aldoximes. By O. L. Brady and R. Truszkowski.

1-CHLORO-2 : 4-DINITROBENZENE reacts with the sodium salts of substituted benz*anti*aldoximes to give dinitrophenylethers which have the *syn*-configuration since they are decomposed, on being warmed for a short time with alcoholic sodium hydroxide, with the formation of sodium dinitrophenoxide and the corresponding nitrile. *o*-Hydroxybenz*anti*aldoxime does not react in this way and in a few other cases the yield of ether is small. With the sodium salts of *syn*-aldoximes a complicated reaction occurs but from the products only sodium dinitrophenoxide and the corresponding aldehyde could be isolated. The binary fusion curves of the *anti*-oximes and chloro dininitrobenzene indicate that in certain cases well defined additive compounds are formed consisting of equimolecular amounts of the two components. That stable additive compounds with chloro dinitrobenzene were characteristic of those oximes which could readily be converted into *syn*-isomerides seems to support the view that the formation of additive compounds is at the base of isomeric change in the oximes.

Prof. T. M. Lowry pointed out that the greater tendency of a reactive compound to form additive products was observed also in other cases.

Prof. J. F. Thorpe considered that the Beckmann change itself was a proof of the Hantzsch-Werner hypothesis. He preferred, however, the ring-formula (I) to the alternative (II) employed by Dr. Brady :—



(I) (II) (III) (IV)

Dr. Brady, in reply, said that whilst he had no great preference for the formula (II), he thought that there was some justification for it, in that the great solubility of the compound in water (III), its ready formation of additive compounds (IV), and the shift in the position of the absorption band might thus be accounted for.

The President doubted whether a sodoxyl group and an iodine atom could be attached to the same nitrogen atom.

Prof. C. S. Gibson described :—

The dimorphism of diphenylarsenious chloride (diphenylchloroarsine). By C. S. Gibson and the late D. C. Vining.

The dimorphism of diphenylarsenious chloride, which has not been previously recorded in the literature, has been definitely established. The unstable form, which melts at 18·2–18·4°, forms colourless, silky needles. The stable form, m.p. 38·7–38·9°, forms rhomb-shaped biaxial doubly refracting crystals. Both forms have a normal molecular weight in benzene solution. The boiling point of pure diphenylarsenious chloride is 178·6°/10 mm.

Prof. Gibson said that his results absolutely confirmed those of Dr. N. V. Sidgwick, of whose work he had only recently been made aware, and to whom he was indebted for some of the material.

Dr. Sidgwick, expressing gratification that the results were identical with those obtained under his direction, said that he believed that in America the material could not be obtained in the solid condition until it could be seeded with that from unexploded German shells. Unlike Prof. Gibson, however, he had experienced no difficulty in obtaining the unstable form. The material was such as to cause the investigator extreme physical discomfort.

Dr. M. A. Whiteley recalled that the first specimen which she received, when sent to another laboratory, arrived in the solid form ; a few hours after the siphon, with solid at the nozzle, had been returned, the whole of the material had solidified.

Prof. Gibson said that no difficulty was experienced in working with the liquid substance, but the solid was unpleasant to manipulate.

ROYAL MICROSCOPICAL SOCIETY

A meeting was held on February 20, Mr. A. Chaston Chapman, F.I.C., president, in the chair, and Mr. W. E. Hall read a paper entitled "A Simple Apparatus for the Extraction of Micro-Organisms from Samples of Water."

The microscopical examination of samples of water is greatly facilitated by means of the following simple apparatus. The sample is collected in a small straining jar through which any quantity of water can be passed and the organisms retained in a quantity of water convenient for carriage.

From this concentrated sample the organisms can be extracted by passing it through a filter paper about 1¾ in. diameter placed over a small funnel attached to a vessel from which the air is extracted by means of an exhauster consisting of a modified form of filter pump.

The organisms are finally washed [illegible] the filter paper by means of a wash bottle with about 2 c.c. of water in which the organisms can readily be examined in a stage trough or placed in small quantities on a compressor slide.

INSTITUTE OF CHEMISTRY

At the 46th Annual Meeting of the Institute c Chemistry on March 3, the Meldola Medal, th gift of the Maccabæans, was presented to Mr. C N. Hinshelwood, B.A. (Oxon). The Medal is awarde for the work of most promise published by a Britis chemist under thirty years of age, brought to th notice of the adjudicators during the year.

Mr. A. Chaston Chapman, F.R.S., the retirin President, in his address referred to the growin activity of the Institute during his three years c office. The roll of membership had increased b 1129, and about 1000 new chemists had bee absorbed into useful professional life. He empha sised that the Institute endeavoured to counterac the modern tendency to turn out narrow and impe fectly educated specialists. He deplored the tendenc on the part of Government Departments to unde value professional scientific and technical servic especially in view of the fact that the public chemica service is becoming every year a more importar part of the machinery of government.

Dealing with the proposals for closer co-operatio amongst chemical societies, which he though should have the warm support of all, he expresse the hope that in any scheme of co-operation th Institute would not sink any of its individualit The general public was coming more and more t recognise in chemistry one of the most powerfu factors in the creation of material wealth, at a tin when it is more important to create wealth than t quarrel about the distribution of what little the wa had left us. He quoted Mr. Baldwin, the late Prim Minister, who, in a recent speech at Glasgow, ha said that under the stimulus of the war we had mac great headway in pure chemistry, and we had schoo of chemistry in this country which compared wit any in the world. We should take care that ou industries absorbed the output of those school and should not be content to run only rule-of-thum industries and leave those more highly organise industries, which depend upon science and bra power, to the foreigner. He felt that those word had a very special significance with reference to th reported negotiations between the British Dyestuf Corporation and the Interessen Gemeinschaft.

The new President, Prof. G. G. Henderson, F.R.S Regius Professor of Chemistry in the University c Glasgow, was formally installed.

The officers, Council and Censors for 1924-2 were elected as follows :—

Vice-Presidents :—Prof. E. C. C. Baly, C.B.E F.R.S., A. Chaston Chapman, F.R.S., A. Mor Dr. T. Slater Price, O.B.E., Prof. A. Smithell C.M.G., F.R.S., and Dr. E. W. Voelcker.

Hon. Treasurer :—Mr. Patrick H. Kirkaldy.

General Members of Council :—L. Archbutt, D E. F. Armstrong, F.R.S., E. R. Bolton, Prof. A. Boon, Dr. F. D. Chattaway, F.R.S., R. Leslie Collet Dr. H. G. Colman, John Evans, Dr. R. H. Greave Prof. A. J. Hale, Mr. G. Nevill Huntly, Prof. W. Lewis, W. McD. Mackey, Dr. H. McCombie, D [illegible]; Dr. R. S. Morrell, G. H. Perry, O.B.E., Pr[illegible]y, Philip, O.B.E., F.R.S., Dr. R. H. Pickard [illegible]

B. D. Porritt, Prof. F. L. Pyman, W. D. Rogers, H. Silvester, Dr. Arthur Slator, Prof. J. F. Thorpe, O.B.E., F.R.S., Dr. J. F. Tocher, Dr. D. F. Twiss, Prof. F. J. Wilson.

District Members of Council:—Dr. L. Dobbin (Edinburgh), H. J. Evans (Liverpool), Dr. W. R. Fearon (Irish Free State), Dr. W. H. Gibson, O.B.E. (Northern Ireland), C. A. F. Hastilow (Birmingham and Midlands), E. M. Hawkins (London and South-Eastern Counties), R. D. Littlefield (Bristol and South-Western Counties), S. E. Melling (Manchester and District), Dr. L. G. Paul (North-East Coast) C. A. Seyler (Wales), and J. H. Young (Glasgow and West of Scotland).

Censors:—Mr. A. Chaston Chapman, F.R.S., Sir Herbert Jackson, K.B.E., F.R.S., Prof. G. T. Morgan, O.B.E., F.R.S., and Sir Robert Robertson, K.B.E., F.R.S.

On March 5, a paper was read before the Leeds Area Section of Chemistry, by Dr. N. M. Comber, entitled "The Fertilisers and Feeding Stuffs Act and the Professional Aspects of Agricultural Analysis." The author said the Fertilisers and Feeding Stuffs Act was only partially successful. The checking by analysis of the guarantees under which fertilisers and feeding stuffs are sold was almost inoperative in some parts of the country. This was largely due to the fact that local authorities and official samplers are under no obligation to take samples except at the request of the purchaser and on payment by him of a prescribed fee. A compulsory and uniform scheme of sampling, as required by the Food and Drugs Act, seemed very desirable. The Act would operate more fairly to the seller if criminal proceedings only arose on the basis of the analysis of samples taken before delivery. At present the analysis of samples taken up to ten days after delivery may be used for criminal proceedings. The contents of the warranty which the Act demands could be usefully revised. All forms of quicklime and carbonate of lime should be included among the fertilisers, and the carbohydrate and maximum fibre content of feeding-stuffs should be included in the guarantee.

In addition to the provisions of the Fertilisers and Feeding Stuffs Act, facilities are offered by some educational authorities for analyses to be carried out for the information of a farmer at nominal fees. This raised an important point of professional etiquette. In general, it seemed obvious that Educational Authorities should only undertake analyses the results of which would have a definite educational value and which would help to elucidate hitherto unsolved problems. The situation, however, was more complicated than it appears to be: no hard and fast rule could be put forward, and the difficulty would probably be most effectually overcome when all chemists concerned in agricultural analysis were members of the Institute of Chemistry.

Soil analysis was at present in the research stage and must be considered separately. It was difficult [illegible] any justification for the analysis of soil samples [illegible] undertaken by consulting analysts, as the [illegible]tical data considered alone were of minor [illegible] for any immediate practical purpose.

SOCIETY OF GLASS TECHNOLOGY

At the meeting in Sheffield on February 20, two sessions were held. In the morning there was an exhibition and demonstration of modern pyrometers at the Department of Glass Technology of the University. The following firms exhibited:—1. The Bowen Instrument Co., Ltd.; 2. The Cambridge and Paul Instrument Co., Ltd.; 3. The Foster Instrument Co.; 4. The Optical Pyrometer Syndicate; 5. Messrs. Booth and Miller also demonstrated their New Temperature Controller.

At the afternoon session the subject under discussion was "The Use of Pyrometers in Glass Works." Five papers were presented.

I. "The Use of Pyrometers in Glass Works," by E. A. Coad-Pryor, B.A. The value of pyrometric equipment in a glass factory depended essentially on three factors:—(1) The reliability of the pyrometer itself, particularly the clock-work; (2) The skill which is expended on its maintenance; and (3) The attitude with which the management, foremen and furnace operators regard the pyrometer. Of these three the last was the most important. The pyrometer in no way displaced the trained eye; its real function was to supply further information in order that a highly skilled operator might be able to get more out of his plant than had hitherto been possible.

The range of temperatures to be measured could conveniently be subdivided into three groups. (1) The range 0° to 700° C., covering lehrs, stack temperature, producer gas, etc. (2) From 700° to 1200° C., regenerator temperature, pot work, and (3) Above 1200° C., the temperature of the melting furnaces.

In the first group the thermo-couple was the most convenient instrument to use. Some sort of a portable thermo-couple should be part of every works equipment. A convenient couple for low temperature work was iron-constantan: the wire to be about 22 gauge.

In the high-temperature ranges an optical or total radiation pyrometer was, as a rule, the most convenient. The tank furnace might be subdivided into three zones; the melting zone, the plaining zone, and the refining end. Two permanent pyrometers should be used on each furnace, one on the refining end, the other sighting through a hole in the end wall at the melting end of the furnace. The use of couples embedded in the wall of the tank or in the crown caused probably more trouble than they were worth.

The optical or radiation pyrometer if used with discretion, was the most reliable and the most easily applied. The author's experience was that the optical instruments gave less variable readings than did the radiation instruments. The all important factor was the training of the staff and operators to use the instruments as an aid to the maximum efficiency in furnace manipulation.

II. "Continuous High-Temperature Measurements in Glass Works," by W. M. Clark, Ph.B. (U.S.A.). There was probably no absolutely accurate method existing for constantly determining glass-house temperatures. We could only approach this desirable

aim by refinements of installation and careful maintenance, and this meant both equipment and maintenance expense. Therefore, in considering a pyrometer installation the glass manufacturer must decide what his demands for accuracy will be worth against the initial and operating costs of various systems. It is always advisable to install both the indicating and recording type of instrument side by side. Experience at a number of modern plants showed that pyrometric measurements were reflected in the costs sheets. The morale of the furnace men was improved by eliminating errors due to guessing at temperatures, and cost per unit of output decreased. The depreciation on pyrometric equipment was not excessive, about ten per cent. per annum being a fair amount, judging from successful installations and improvements could be incorporated into the system, replacing features which became obsolete and thus keeping the installation up to date. A well planned system would reduce overall costs in a year more than sufficient to pay for the investment and often would leave several times this amount if used intelligently. The most forceful argument for the adoption of pyrometer control in a glass works was on the score of economic savings, but the information thereby made available to the management and staff was also important in showing each man a tangible effect of his operation on the thermal conditions.

III. "Recent Advances in the Design of Temperature Measuring Instruments, etc.," by R. W. Whipple. One difficulty of disappearing filament pyrometers was to get two lamps which would be interchangeable. Methods for overcoming this difficulty were indicated. He had been much impressed with what he had seen recently in the United States in the matter of automatic temperature control. Considerable work was being done in glass works, such as those of Messrs. Keuffel and Esser, where lehr temperatures were controlled from 200° C. to 600° C. For every kind of glassware a special cooling curve was followed. In the United Kingdom automatic temperature control was being developed. The main principle in such control was a galvanometer needle which was deflected by some method. Lantern slides were then exhibited showing various forms of controller, including (1) Brown, (2) Bristol, (3) C. Engelhard, (4) Leeds and Northrup, (5) Cambridge, (6) Barr, (7) Althorpe.

IV. "Practical Applications of Pyrometers to Glass Works," by C. E. Foster, F.Inst.P. Both optical and total radiation instruments were calibrated for what were known as "black body" condition and when used on hot bodies which were not technically "black bodies" the reading would be in error by an amount which varied with the actual condition. An ordinary large glass melting tank was by no means a "black body." The author suggested that luminous gas flames might have the power of selective emission, that is, they radiated a light which was not in proportion to their temperature, but might be of an intensity which would correspond to the brightness of a solid hot b[illegible] at a much higher temperature. Considering a [illegible] of molten glass viewed obliquely in a furna[illegible] did not realise "black body" conditions, it obviously had a considerable reflecting power, but its reflecting power as experienced in measuring with a total radiation pyrometer was relatively much less than the unoxidised surface of molten metal. This was reasonable because there was some considerable transparency in the glass so that it would actually emit a greater proportion of the heat from inside. Thus it was actually found that molten glass approached more nearly to a true "black body" than unoxidised molten metal.

V. "Reflections on Pyrometer Design," by W. Bowen. Economy in fuel consumption, long life of furnaces or other heating devices employed, elimination of waste of raw materials and of irreparable losses of finished products all depend upon the raising of the heat-treated materials to no less, and no more, than the requisite temperatures. A few of the standards which a good pyrometer should fulfill were discussed with reference to the new "Pyro" radiation pyrometer, an instrument compact in shape, extremely portable and simple in operation.

ACADÉMIE DES SCIENCES

On February 18, Dr. Roux described the work of M.M. Sergent and Rougebief on the dissemination of grape yeasts by insects. The authors concluded from their experiments that certain insects, particularly *Drosophyla*, play an important part in spreading the yeast. Dr. Roux also communicated a note by Monsieur Mazé, indicating that in the manufacture of Cantal cheese the peptisation of the casein is accompanied by putrefaction if the medium is insufficiently acid. To avoid this phenomenon it is suggested that a suitable lactic ferment should be introduced during manufacture to maintain a sufficient degree of acidity.

Monsieur Perrin described a method worked out by Monsieur Tien for measuring very small quantities of heat, and drew attention to Monsieur Kuhn's work on the action of ultra-violet rays on ammonia.

On February 25, Prof. C. H. Moureu read an account showing how Maurice Barrès, the distinguished French writer who died recently, had foreseen the part that science would play in deciding the future of the country, and recognising the valuable work he did in helping the movement in favour of scientific research. Professor Moureu then communicated a paper by MM. Dufraisse and Gillet on "Curious Stereo-chemical Observations in the Series of Benzalacetophenone." Monsieur Le Chatelier communicated a note by Monsieur Chesneau, showing the similarity in the chemical composition of the glass in ancient windows of ages varying by 100 years. Monsieur Schloesing described work by Monsieur Lebedantshev on the chemical and biological modifications undergone by dried soil, showing that drying reduced to one-third, and even one-tenth, the microbial fauna and flora of the soil. Monsieur D'Arsonval presented a note by Monsieur Villard on a direct-reading actinometer for the measurement of solar ultra-violet.

CORRESPONDENCE

A CORRECTION

SIR,—As I did not see the proof before publication of a short article on the derivation of the word "Mercaptan," which you were good enough to publish in your issue of February 22, perhaps you would allow me here to make a correction in regard to a small point, which, nevertheless, gave me some trouble. The earliest information of Zeise's discovery appeared, as I state (page 197) in Schweigger-Seidel's *Journal für Chemie und Physik*, 1833, Vol. 8, *but of the 3rd series*, which is Vol. 68 of the whole series, and is at the same time also the 8th volume of Schweigger-Seidel's "Neues Jahrbuch der Chemie und Physik."—I am, Sir, etc.,

University of Glasgow
March 7, 1924 T. S. PATTERSON

COLLOID CHEMISTRY

SIR,—Referring to the letter of Mr. A. V. Slater on page 38 of your current volume, I would call the attention of your readers to the fact that about the end of this year I expect to complete a comprehensive international book on "Colloid Chemistry, Theoretical and Applied," to which over 150 of the best men of all nations have already promised contributions. Of these 19 are citizens of the British Empire, and I expect that other Englishmen will also write.

Papers have already been received from R. Zsigmondy, E. F. Armstrong, A. Mary, E. E. Ayres, C. Barus, C. Benedicks, H. J. Creighton, W. P. Davey, A. E. Dunstan, F. Emslander, H. Freundlich, C. I. Fulmer, G. Georgeivics, R. A. Gortner, L. Gurwitsch, W. B. Hardy, A. L. Herrera, H. N. Holmes, S. Leduc, Dorothy Jordan Lloyd, J. Uri Lloyd, R. Lorenz, A. Lumiere, Luppo-Cramer, G. D. McLaughlin, E. J. Mardles, P. H. Prausnitz, H. R. Procter, M. Sameo, H. N. Spencer, W. H. Martin, N. Waterman, T. Hagiwara, S. Utzino, M. Toch, F. Zerban, and H. Schado. Many others are either in the mail (T. Braisford Robertson and P. P. von Weimarn) or else will soon be ready (W. D. Bancroft, H. Bassett, G. Bredig, W. Clayton, H. A. Gardner, E. Hatschek, W. H. Herschel, F. E. Lloyd, R. E. Liesegang, D. T. MacDougal, L. Michaelis, Sven Oden, A. B. Searle, S. E. Sheppard, W. E. S. Turner, and many others).

If any of your readers can send me reprints of papers germane to the subject, or suggestions as to points they would like to have included or discussed, I shall appreciate it and make the best use I can of the information.

Meanwhile, let me say that I hope to see the British Reports continued as heretofore. The University of Wisconsin has just issued as a Monograph the papers read there before the First National Symposium on Colloid Chemistry, and the Second Symposium will be held next June at Northwestern University, Evanston, Ill. The more helpful information published on the subject, the better for industry and for the chemical profession.—I am, Sir, etc.,

JEROME ALEXANDER
New York, Feb. 6, 1924

HYDROGEN PEROXIDE AS A BLEACHING AGENT FOR GELATIN

SIR,—I read with interest your report of a meeting of the Nottingham Section of the Society of Chemical Industry, which appears on page 226 of your *Journal* of February 29, 1924.

I was astonished at Mr. Trotman's reply to Mr. Pentecost on the use of hydrogen peroxide for bleaching and preserving gelatin. His statement that hydrogen peroxide is not being used for this purpose is entirely wrong. He would, no doubt, be surprised to learn that my firm, Messrs. B. Laporte, Ltd., has supplied hydrogen peroxide in large quantities for the bleaching of gelatin for the past twenty years. To-day it is being used more than ever for bleaching gelatin made from either bones or fleshings.

I should like to call Mr. Trotman's attention to the following, which I have taken from page 246 of "Animal Proteins," by Mr. H. G. Bennett, M.Sc., published by Messrs. Bailliere, Tindall and Cox, in the Industrial Chemistry Series. Mr. H. G. Bennett, whom I have the pleasure of knowing personally, has had a large experience in the bleaching of gelatin with hydrogen peroxide, so that his remarks are based on practical experience.

"On account of its freedom from bases, and because its residue is simply water, peroxide of hydrogen has been found of great service in practice, and in most factories it has shown itself superior not only to the other peroxides, but also to all other oxidizing agents. Its application is simple, a concentrated solution being added to the gelatine sol before or after evaporation. It is the most "foolproof" of all the oxidizing agents used in bleaching, and it yields the purest product. Its bleaching action is perfectly satisfactory, but only in a non-acid sol. Hydrogen peroxide is moderately stable in acid solution, and its bleaching action is best in slightly alkaline solution. An acid sol bleaches too slowly, or not at all; an alkaline sol induces evolution of oxygen and consequent waste. The great disadvantage of peroxide of hydrogen is its great expense, which is enhanced by an increasing demand for it in other industries. A minor disadvantage is its instability, which leads to loss in transit and storage. It is sold usually in strengths indicated by the volume of oxygen obtained from unit volume of the solution, when treated with permanganate in a nitrometer (*e.g.*, "15 vols. peroxide,").

It is a fortunate feature of both the oxidising and reducing agents usually employed in bleaching, that they have considerable antiseptic power. This assists materially in preserving the gelatin from putrefaction during the critical period between extraction and concentration"

Mr. Bennett wrote his book in 1921; since then the price of hydrogen peroxide has been reduced considerably, so that its use for bleaching gelatin has become more than ever a sound commercial proposition. In addition, its extended uses in other industries has helped to lower the price, owing to increased production.—I am, Sir, etc.,

Luton
March 6, 1924

I. E. WEBER
Chief Chemist for
B. Laporte, Ltd.

PROF. H. BAKER'S EXPERIMENTS

Sir,—It occurred to me some time ago that a substance which might be used to test the various hypotheses put forward to explain the experiments of H. B. Baker is liquid nitrogen tetroxide. In this the two forms NO_2 and N_2O_4 are known to be present, and the change from one to the other is easily followed by the change in colour. If one takes the liquid at room temperature it is deep orange red; this changes to pale yellow in a freezing mixture. If now the liquid at room temperature is dried, it may change to pale yellow, if polymerisation has occurred, or, if the colour persists it may also persist in a freezing mixture if drying fixes the equilibrium $N_2O_4 \rightleftarrows 2NO_2$ at ordinary temperature. It should therefore be possible, if this is a suitable liquid, to decide between two theories, and I am carrying out experiments on these lines.—I am, Sir, &c.,

J. R. Partington

Chemical Research Laboratory,
East London College

MAGNESIUM OXYCHLORIDE CEMENT

Sir,—With reference to the article by Dr. J. H. Paterson in *Chemistry and Industry* of February 29 1924, it is to be regretted that the article contains many inaccurate statements.

In view of the importance attached to opinions expressed in the *Journal of the Society of Chemical Industry* these mis-statements should not go uncorrected.

Dr. Paterson states :—

I. That in pre-war days the bulk of the magnesia used in this country was imported from Hamburg, and was there made by the calcination of magnesite rock imported from Euboea.

II. During the war a large amount of magnesite was shipped from India and calcinod in this country, but it did not yield a very satisfactory product, and the high cost of carriage has made its use prohibitive since that period.

III. The calcined material is ground in tube or ball mills.

IV. If the temperature of burning is carried above 1000° C., the resulting product will not react with magnesium chloride.

V. The kilns used are frequently of the beehive type.

The facts are :—

I. In pre-war days the caustic burning of magnesite was chiefly carried out in Euboea and India, and the lump calcined material was shipped to Holland, where it was ground and distributed. A small quantity of the lump calcined material went to Hamburg, where it was ground, and and then distributed chiefly to Germany and the United States of America. Hamburg was not a calcining centre.

II. With regard to India—during the war and since—both caustic calcined magnesite and crude magnesite have been and are being shipped to this country.

Indian crude magnesite is recognised as being of exceptionally high grade.

It was not calcined here, however, during the war to produce caustic or plastic material, but to obtain dead-burnt magnesite to be used for making refractory magnesite bricks. It was necessary, during the war, to produce magnesite bricks in this country on a large scale as the Austrian supply had been cut off. Owing to the high degree of purity of both Indian and Grecian magnesite, and the unsuitability of the kilns in this country for calcining at sufficiently high temperatures, there was difficulty i thoroughly dead-burning these magnesites, bu this difficulty was overcome to a large exter by adding oxide of iron or an iron salt to tl magnesite. Dr. Paterson seems to have confused the Indian and Grecian calcined magnesites, which contain only about 0·2 per cent. oxide of iron, with the Austrian magnesite containing about 7 per cent. oxide of iron. The latter is quite unsuitable for cement purposes, but is highly valued as a refractory material.

Indian magnesite has been regularly shipped to this country since the war, but owing to ship-building and other strikes consumption has been curtailed.

During the latter part of 1922 Indian causti calcined magnesite was introduced to America and now commands there, because of its quality, a premium in price over the domestic product. The following statement based on authoritative figures from Washington shows that during the first half of 1923 the total imports of Indian caustic magnesite were almost equal to double the total of all other magnesites imported into the United States during the same period.

Magnesite imported January to June, 1923, inclusive :—

	India.	Greece.	Germany.	Scotland.	Netherlands.	Italy
	Per cent.					
Jan. ..	—	—	—	—	99·9	0·1
Feb.	87·2	—	—	2·6	10·2	—
March	49·4	—	1·2	11·2	38·2	—
April	65·2	—	—	—	34·8	—
May	72·4	6·1	2·7	—	18·8	—
June	60·5	—	1·6	7·7	30·2	—
Total for six months	64·73	1·77	1·24	3·33	28·89	0·0007

The demand for Indian magnesite has since increased.

III. Calcined caustic magnesite is largely ground under millstones.

IV. Indian and Grecian magnesites, even when calcined at a temperature over 1000° C., will re-act with magnesium chloride.

To dead-burn these magnesites, *i.e.*, to carry to the stage when the resulting product will be inert and shrunk, requires a temperature of over 1500° C.

V. The kilns used are *not* frequently of the beehive type. In Euboea, India and the States the kilns used for producing caustic calcined magnesite are generally gas-fired shaft kilns.
—I am, Sir, etc.,

H. H. Dains

The Mining and Metallurgical Club,
London Wall, E.C. 2, March 5, 1924.

CO-OPERATION AMONGST CHEMICAL ASSOCIATIONS

SIR,—On two occasions the Editor has devoted a portion of his particular space in the *Journal* to the subject of the multiplicity of chemical meetings and societies. With all the statements in these articles we are in complete accord, and we feel with him that the time for effective co-ordination of effort is now, not in a few years to come. At the present time even the most cheerful optimist must feel that the condition of the chemical trade and profession could be bettered. Now, to the improvement of the conditions there must be devoted every scrap of information that has any bearing on technical chemistry. When trade is good the necessity is not so great for keeping in close touch with the scientific world, but with high manufacturing costs on the one side and a sluggish market on the other the industrial chemist should study any scientific research which, however remotely, may bear on his special work. This necessitates the reading of current literature; yet under such conditions as the present the expense of subscriptions is most felt and the tendency is to resign rather than to take up membership of societies, although the latter may be the wiser course. This being the case, it would seem to be an opportune time for the various societies to embark on a scheme of co-operation that will make more easy the application of chemical science to the needs of the country. Chemistry is a fundamental branch of science or knowledge, and any attempt to differentiate between the academic and industrial side is not only arbitrary, but tends to lessen the appreciation of those members of the community who are not initiated into its mysteries. And on these very members chemical industry depends for its success. One ideal to be kept in view is a central body which will be able to speak authoritatively for chemistry. We are aware that this is foreshadowed by the scheme for the establishment of a "Chemistry House," and we have confidence in this coming to full fruition. Yet, if chemistry is to do its duty in shortening the present period of depression we cannot wait on this accomplishment. If the two main societies, the Chemical Society and the Society of Chemical Industry, would come together and discuss the means whereby their publications can be combined and issued at an economic rate to the chemical public we feel sure that they would have the support of the bulk of their members. In this discussion let them keep in their minds as an ultimate end the publication of an international journal of chemistry which shall contain abstracts of all chemical work. Thus and thus only will be avoided the duplication of effort to be seen in the publications of the chemical societies throughout the world. It is not now that the individuality of societies should be considered. If one may have a longer and more brilliant history than the others, yet their ultimate objects are the same—the dissemination of useful knowledge, and in the fulness of time the honour of the older society will be enhanced when it is found that by sinking its individuality it has increased the value of the science which gave it birth.

As yet the profession of chemistry has no rules: each member plays a lone hand with no guidance but his own personality. In this we differ from other professions. Conventions, the slow growth of generations, do not yet govern our doings, yet on convention depends the strength of any country or community. Let us, then, proceed to form our rules and laws. To do this, we must come together, we must co-operate, we must work with an eye on the common good of our professional brethren, and, to do this effectively, scientific information must be readily available and this can only be accomplished by the societies who are the trustees for the scientific world.—I am, Sir, etc.,

J. ADAM WATSON

THE STATUS OF CHEMISTS AND CHEMISTRY

SIR,—Mr. Claremont's letter in your issue of March 7 is a most useful contribution to the discussion which has centred recently about the question of the status of chemists and chemistry. As he points out, the fact that the personal services of chemists are not likely to be required by the average member of the public makes it improbable that anything will be done by the Government to lay down a definite professional status for the chemist. We must all share his hope that in future professional chemists will come to regard the qualifications of the Institute as a necessary part of their equipment, for whilst chemistry can never be a closed profession like medicine or law, a really strong and representative Institute could do much to consolidate professional chemists and to secure for chemistry a worthier place in the public status.

When all is said and done, however, we are bound to recognise that a correct public estimation of the importance of chemistry can only arise from an enlightened public knowledge of the functions and services of chemistry, which, in turn, can only develop from a wider education and interest in chemistry and kindred sciences. The lack of acquaintance among educated people with even the most elementary facts concerning chemical processes and raw materials is still remarkable, though an improvement is occurring in this respect. The story is still told of a Minister, a member of the War Cabinet, who, finding the conversation at a certain dinner turning to the sinister menace of the submarine campaign, then at its height, and its effects especially on the Chile communications, turned to his neighbour with the enquiry: "Tell me, what is this nitrate they are all making such a fuss about?"

The analogy which Mr. Claremont brings out between chemistry and engineering does not extend to the public recognition of these professions. In the first place, engineering in its numerous branches is an industry employing a far larger number of work-people, and to that extent bulks more largely in the public eye. Further, the man-in-the-street can comprehend a bridge, a power-station, a battleship, or an aeroplane, as something built up by human agency, but gallic acid might be a synonym for cheap French wine ... [illegible] ...losive

for all he can tell without specific information, and one liquid or powder looks much like another.

We have to look for improvement in our status in the first place to the concerted efforts of professional chemists themselves, acting each in his own sphere, and together through the Institute, and in the second place to a gradual enlightenment of the public through education, exhibitions, lectures, etc., as to the social importance of chemistry.—I am, Sir, etc.,

STANLEY I. LEVY

THE EDITOR IS ADMONISHED

SIR,—I am a very humble individual, a regular Uriah 'Eep, but thank goodness I can always kick an editor. That is the unalienable right of every Scotsman.

I am out to criticise. Why, why, did you compare the profession of chemistry with law? Do you not see that it is the same as a comparison between a thoroughbred racehorse and the vermiform parasite which infests its bowels. Chemistry, the greatest productive science which has in its applications made civilization, and on which with its fellow sciences all the wealth, prosperity and progress of the world have been built, you compare with the pettifogging law founded on the sin, misery, chicanery and errors of humanity. I don't like it, Mr. Editor, and I just feel like "Coffee and pistols for two."

Again, you go into high politics. Now the late trouble on the Continent is outwith our purview. Instead of talking of apologies, why don't you get up some practicable scheme to benefit everyone. For example, preach the doctrine that an international language of science is essential. Take Volapuk or Esperanto, add thereto an efficient, flexible vocabulary suited specially to the needs of scientific description. Get this introduced into the schools instead of French or German, and gradually get all scientific literature printed in this language.

Recently I had to hunt up information on some enzymes, and I had to get translated papers in Japanese, Russian, Italian, French and German, incurring considerable expense and loss of time.

Now there is a job to your hand. It would in time do more for international amity than possibly any other scheme. I believe the time is ripe for a start.

Growth would be gradual, but in time it would arrive at fruition. Consider the advantages. Any book could be sent anywhere and read with exactly the right shades of meaning. Students could go from one country to another independent of language. Doctors, chemists, physicists and biologists all the world over would be bound by the tie of language.

Of course, all we can do is to start it, but posterity might count it as an offset against the awful debt we leave them.

Be higher in your ideals, Mr. Editor. We are the salt of the earth.—I am, Sir, etc.,

CAREY LAW

Paisley

PERSONAL AND OTHER NOTES

His Majesty the King has been graciously pleased to grant his Patronage to the Annual Meeting of the Society of Chemical Industry, which will be held in Liverpool in July.

Mr. W. A. Turner, a founder and the managing director of W. T. Owbridge, Ltd., manufacturing chemists, died recently at Hull.

Monsieur R. Masse, president of the Cie. Francaise d'Éclairage et de Chauffage par le Gaz, and of the Cie. Nationale des Matières Colorantes, has been promoted Commander of the Legion of Honour.

The Gold Medal of the Institution of Mining and Metallurgy has been awarded conjointly to H. W. Gepp, M.Inst.M.M., and Gilbert Rigg, M.Inst.M.M., in recognition of their joint and individual services in the advancement of metallurgical science and practice, with special reference to their achievements in the treatment of complex sulphide ores, and in the development of the electrolytic process for the production of zinc in Australia.

Prof. Sir D. Orme Masson, K.B.E., who has retired from the chair of chemistry in Melbourne University, will shortly pay a visit to England. Prof. J. A. Schofield, of the Chemical Department, Sydney University, is also coming to Europe on a visit this year.

Prof. N. Parravano has been appointed corresponding editor to represent Italy on the Committee for the International Critical Tables published by the International Research Council.

Mr. N. J. T. M. Needham, Gonville and Caius College, Cambridge, has been elected to the Benn W. Levy research studentship in biochemistry.

The eleventh election to Beit Fellowship for Scientific Research will be held in July. Information can be obtained from the Rector, Imperial College of Science and Technology, South Kensington, S.W. 7. Applications must be received by April 19.

Mr. A. F. Wenger, who died recently at Newcastle-under-Lyme, was the founder and principal of Wengers, Ltd., Stoke-on-Trent, manufacturers of ceramic colours.

Oil Discovery in Holland

The Government Mineral Research Department has been drilling in Eastern Holland for a year, where salt and coal have been brought to the surface, and now reports, states the *Times*, a discovery of oil near Winterswyk. In one place a deep bore was made, but as nothing of particular interest was found, it was decided to dismantle the workings, but during the dismantling a weak stream of light petroleum, greenish in colour, suddenly came to the surface. Twelve gallons were collected, and the hole was closed, but on February 26 was reopened, when several barrels were filled. It is not yet known whether the quantities are sufficient for the establishment of a petroleum industry in Holland.

REVIEWS

NICKEL ORES. *Monograph issued by the Imperial Institute. Pp.* 80. *London: John Murray. Price* 5*s*.

"Nickel Ores" commences with a short sketch, historical, mineralogical and metallurgical, and the main part of the work is devoted to the sources of supply of nickel ores in the British Empire and in foreign countries. Statistics for production are given for the eight-year period 1913-1920. The world's production of ore in terms of metal content averaged about 30,000 tons annually for 1913 and 1914, increased to as high as 47,000 tons in 1918. The estimate attributed to the Metallgesellschaft that the production fell quite so low as 5000 tons in 1921 is incorrect; the official Canadian figures alone amounted to 9600 tons. It may be added that the Caledonian production in 1921 was practically nil, but that re-production commenced again in 1922. There are potential supplies of nickel in many countries, but the world's production is almost exclusively derived from Canadian and New Caledonian sources. The monograph is provided with the usual excellent references to the literature of the subject. W. G. WAGNER

SANDS AND CRUSHED ROCKS. *By* ALFRED B. SEARLE. *Vol. I, Their Nature, Properties and Treatment. Pp. xiv*+475. *Vol. II, Their Uses in Industry. Pp. viii*+281. *London: Henry Frowde and Hodder and Stoughton*, 1923. *Price* 52*s*. 6*d*.

In compiling these volumes Mr. Searle has drawn copiously on the publications of H.M. Geological Survey and the Memoirs on Resources of Glass-making and Refractory Sands by Prof. P. G. H. Boswell, but errors have crept in which are not present in the memoirs. The introductory chapters on the geology of sand deposits, etc., are very loosely written, and would not receive the approbation of a geologist.

A very wide interpretation of the subject of the volumes has been made, and it is a little difficult at times to see any connexion between the matter introduced and "Sands and Crushed Rocks." The portions of the book dealing with the mechanical devices used in the quarrying and treatment of sands and rocks contain a good deal of data and illustrations extracted from trade catalogues which may be of use to quarrymasters and managers. W. J. REES

THE CHEMISTRY AND PHYSICS OF CLAYS AND OTHER CERAMIC MATERIALS. *By* ALFRED B. SEARLE. *Pp. xiii*+695. *London: Ernest Benn Limited*, 1924. *Price* 55*s*. *net*.

There is need for a book which critically sums up the modern views on the properties of refractory and ceramic raw materials and products, but that need is certainly not met by the present volume. The contradictions, misconceptions and mistakes in the book are so numerous as to necessitate an unhesitating condemnation of it. As a contribution to the literature of refractory materials the book is of little or no value. W. J. REES

COMPANY NEWS

MAGADI SODA CO., LTD.

On February 13, an extraordinary general meeting was held to consider a resolution to place the company in voluntary liquidation and to appoint a liquidator and an advisory committee to co-operate in the liquidation of the company and its proposed reconstruction. During the discussion, the chairman, Mr. Samuel, M.P., said the fact that he had rendered himself liable for over £250,000 to try to save the company, was sufficient proof that he had confidence in its future. Altogether roughly a half million of fresh capital would be required, but it was estimated that £250,000 would be sufficient to turn the company into a profit-making concern. As the result of a poll the resolution was carried.

At the statutory meeting of creditors, the receiver and liquidator stated that total liabilities were £2,316,244, and there was a debit on the profit and loss account to November 30, 1923, of £693,317. Attempts had heen made to formulate a scheme of reconstruction, and it was possible that shortly a proposal might he made to provide the necessary working capital otherwise than by the shareholders. A creditor opposed these schemes, and asserted that negotiations had been taking place with Brunner Mond and Co. As no resolutions were passed the voluntary liquidation will be continued.

THE BRITISH ALIZARINE CO., LTD.

For two years after 1920 when the capital was considerably increased and a dividend of 10 per cent. was paid, the profits of the British Alizarine Company considerably contracted and no distribution was declared. Last year there was a very pronounced recovery, net profit, after setting aside £20,000 for depreciation, going up from £5,000 to £24,100. This enables the directors to resume the payment of dividends and the shareholders will get 5 per cent. less tax, though in former years the tax has heen paid for them. There then remains to go forward £42,900, as against £36,600 brought in. The directors have therefore treated the avaliable surplus in a very conservative manner. Stocks and open accounts figure for £245,400, as against £188,500. The indehtedness to the bank has increased from £191,700 to £208,600.

INTERNATIONAL PAINT AND COMPOSITIONS CO., LTD.,

At the ordinary general meeting the Chairman said that the profit for 1923, after writing off bad debts, was £55,689, as compared with £37,462 in 1922. It was proposed to place £15,000 to general reserve, to apply £6000 to the payment of a final dividend of 3 per cent. less tax, on the preference shares, making the full 6 per cent. for the year, and to apply £19,000 to the payment of a dividend of 5 per cent. less tax on the ordinary shares for the whole year. Investments stood at £201,736, compared with £187,289. The increase was mainly accounted for by investments in associated companies lately established in Spain and Austria. The

acquisition of the undertaking of the Standard Anti-fouling Composition and Paint Co., Ltd., had brought the company a substantial amount of additional business in the course of the past year. Although there was said to be a slight improvement in the shipping depression, no less than 1,000,000 tons of British shipping was still laid up, and there was no great hope of any marked change in the immediate future. Nevertheless, the directors were assured by experts that trade was improving, and if this opinion proved to be correct, better trade ought before long to bring about more employment of shipping, and consequently a greater demand for the company's goods. They were relieved at last of the incubus of depreciated stocks, and were beginning to reap the fruits of their acquisition of the Standard Co.

UNITED TURKEY RED CO.

Profits during 1923 were £210,263, and deducting the deficit (due to depreciation of stocks) of £54,037 brought forward, £156,226 is available. After paying all arrears and preference dividends for 1923, there is a balance of £81,488, of which £40,000 is placed to reserve. It is proposed to pay 2½ per cent. (tax free) on the ordinary shares for the year, leaving £24,421 to be carried forward.

BRADFORD DYERS' ASSOCIATION, LTD.

In the absence of Sir Milton Sharp, Mr. G. Douglas presided over the annual general meeting on February 28. After reviewing the difficult trading conditions of the past year, Mr. Douglas said that the figures of exports did not bear out the statement that the high price of dyeing had crippled the trade and led to an increased export of grey goods. Dyeing prices were approximately 10 per cent. lower, though this economy was counter-balanced by higher prices for raw cotton and wool. From 70 to 80 per cent. of the Association's requirements in dyes was drawn from British makers, who were making undoubted progress in reliability and quality, though, without question, they could not live under existing conditions without the protection of the Dyestuffs (Import Regulation) Act. The Association, together with all the other colour users, had expressed, both to the directors of the British Dyestuffs' Corporation and to the Board of Trade, disapproval of the terms of the proposed agreement between the Corporation and the German Interessen-gemeinschaft. Profits for 1923 were £546,403, to which was added £448,369, leaving £994,772, of which £125,000 was carried to reserve (now £1,125,000) £271,295 was allocated for the payment of 4s. per ordinary share (making 5s. per share for the year) and £473,477 carried forward.

ELECTRO BLEACH AND BY-PRODUCTS, LTD.

The profit for the year ended December 31, 1923, after deducting all charges, is £52,047, to which is added £1245 brought forward. Final dividends are recommended of 6¼ per cent. on the preference shares (making 10 per cent. for the year) and of 13 per cent. on the ordinary shares (making 20 per cent. for the year), whic[illegible] bsorb £26,000. It is recommended that a [illegible] be carried to reserve (which becomes £55,000 and £3201 carried forward.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Expiring Patents

Mr. Alexander said that Mr. G. Oliver's proposal as to the advisability of inquiring into the practicability and desirability that all expiring patents now in use should become the property of the nation, had already been considered, but was not thought to be in the public interest.—(Feb. 21.)

Census of Production in Trade and Commerce

Mr. Webb, in answer to Mr. Nichol, stated [illegible] steps would be taken to reinstitute the nat[illegible] census of production, suspended during the [illegible] period, and that it had been decided that a Ce[illegible] should be taken next year in respect of the pre[illegible] year.—(Feb. 26.)

Patent Fees

Answering Mr. Smedley Crooke, Mr. Webb said that the average fees received on applications for patents amounted to rather more than £3 per application. The patents maintained in force for the full term of 16 years were about 4 per cent. of the total number granted. Replying to Lieut.-Comm[illegible] Burney and Mr. Crooke, he said he believed the [illegible] of the Patent Office did not do appreciably more than maintain the Patent Office. It was not practicable to reduce the British scale of fees at the present time nor was it possible to establish a fair basis of comparison between British and American fees owing to difference in practice with regard to the permissible scope of a single patent and other consideratio[illegible] —(Feb. 26.)

League of Nations (Scientific Property)

Answering Sir C. Marks, Mr. Ponsonby stated t[illegible] the report on scientific property prepared by [illegible] League of Nation's Committee was under conside[illegible] tion by the Departments concerned, and that [illegible] would not be in a position to state the views of the Government until their reports had been receiv[illegible] —(Feb. 26.)

Reparation Coal and Coke Deliveries

Mr. W. Graham, replying to Mr. Ayles, said [illegible] the average monthly deliveries of coal (includ[illegible] coke expressed in terms of coal) made by Germany [illegible] reparation account were 1,500,000 tons for the y[illegible] 1921 and 1,505,000 t. for 1922. According [illegible] information supplied by the British delegate of t[illegible] Reparation Commission, it was believed that t[illegible] average monthly quantities obtained by the Alli[illegible] concerned, was as follows:—January to Septemb[illegible] 1923 (passive resistance period) (including a monthl[illegible] average of 129,600 t. to Italy on reparation accou[illegible] 547,700 t., and October, 1923, to January, [illegible] (after passive resistance ceased and including up [illegible] December 17, a certain quantity delivered to It[illegible] on reparation account), 996,400 t.—(Feb. 27.)

White Lead (Geneva Convention)

In reply to Lord H. Cavendish-Bentinck, Mr. Shaw said that the Home Secretary hoped to introduce, as soon as possible, a Bill designed to give [illegible] to the provisions of the Convention which [illegible]

[illegible] concerning the prohibition of the use of white lead for interior painting. Should this Bill pass into law without amendments contrary to the provisions of the draft Convention, it was proposed to ratify the Convention.—(Feb. 27.)

British Beet-Sugar

Mr. Graham, answering Mr. Gilbert, said that the amount of Excise Duty that would have been payable on home produced sugar had the duty not been repealed as from July 20, 1922, would have been approximately £140,000 and £250,000 for the output in the 1922-3 and 1923-4 campaigns.—(Feb. 28.)

Chemists under British Dyestuffs Corporation

Mr. Webb informed Mr. Graham White that the number of chemists in the employ of the Corporation engaged on research was 51.

Safeguarding of Industries Act (Amendment)

A motion by Mr. Remer that leave be given to introduce a Bill to amend the Safeguarding of Industries Act in respect of goods made under conditions not allowed by trades unions or by law in Great Britain, was defeated by 228 votes to 157.—(Mar. 4.)

Imports from Germany

Replying to Sir F. Wise, Mr. Lunn furnished figures showing the declared value of articles classed as wholly or mainly manufactured imported into the United Kingdom, and registered as consigned from Germany during 1921, 1922 and 1923:—

	1921	1922	1923
Earthenware, glass, abrasives ..	1272	1292	1541
Iron and steel and manufactures thereof	2600	1951	1819
Non-ferrous metals and manufactures thereof	1489	898	838
Cutlery, hardware, implements, and instruments	1200	1744	1792
Chemicals, drugs, dyes and colours	2122	2399	2558
Oils, fats and resins manufactured	25	125	237
Leather and manufactures thereof	623	1060	1522
Paper and cardboard	872	1154	2513
Rubber manufactures	139	426	482

The figures relating to 1923 include from April 1 of that year the trade of Great Britain and Northern Ireland only with Germany, the direct imports of the Irish Free State from Germany having been excluded from the accounts from that date.—(Mar. 5.)

Nauru Phosphates

Mr. Smith informed Mr. Blundell that trials to test the value of the Nauru phosphate had been conducted in several centres during the past three years. In the first season conditions were unfavourable. The results obtained in the second season were not conclusive, and in the last the results were not yet fully available. In any case the value of raw phosphate could not be satisfactorily determined until after several seasons, but as soon as any conclusive results were obtained these would be published.—(Mar. 6.)

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

In spite of labour troubles the demand for heavy chemicals is well sustained, but there are no fundamental changes in prices to report. The effect of the revision of the German reparation levy is somewhat obscure, and it remains to be seen whether the rebate of the duty will be counterbalanced by the increased cost of manufacture, caused partly by the stabilisation of the currency. The only alteration of note is a reduction in the price of sodium bisulphite by about £1 per ton.

Acetic Acid, 40% tech. ..	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5½d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76% ..	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton carr. paid. In
Sod. Bisulphite Powder 60/62%	Prices reduced to £18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis ..	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included

RUBBER CHEMICALS

Antimony sulphide	Expected to advance in sympathy with the crude metal.
Golden	5½d.—1s. 3d. per lb. according to

Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow 1s. 11d. per lb.
Cadmium Sulphide .. 4s. per lb.
Carbon Bisulphide .. £24—£26 10s. per ton according to quantity.
Carbon Black .. .. Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.
Carbon Tetrachloride .. £56 per ton, drums free.
Chromium Oxide .. 1s. 3d. per lb.
Indiarubber Substitutes, White and Dark } 5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.
Lamp Black .. .. 40s. per cwt., barrels free.
Lead Hyposulphite .. 7½d. per lb.
Lithopone .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. .. £15 10s. per ton f.o.r. London.
Sulphur .. .. .. £10—£12 per ton, according to quality.
Thiocarbanilide .. .. 2s. 9d. per lb.
Vermilion, pale or deep .. 3s. 4d.—3s. 6d. per lb.
Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade, but these are the only products in this section which show any activity.

Acetate of Lime—
Brown .. .. .. £14 10s. per ton d/d. Demand active.
Grey .. .. .. £21 per ton.
Liquor .. .. .. 9d. per gall. 32° Tw.
Charcoal .. .. .. £7 5s.—£9 10s. per ton, according to grade and locality. Market steady.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. " " 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 7d. per gall. Unrefined.
Wood Naphtha—
Miscible .. .. 5s. per gall. 60% O.P. Dull market.
Solvent .. .. 5s. per gall. 40% O.P. Dull market.
Wood Tar .. .. £5—£6 per ton according to grade. Demand not very brisk. Ample supplies.
Brown Sugar of Lead .. £47 per ton. Demand active.

TAR PRODUCTS

Acid Carbolic—
Crystals .. .. 7½d.—8d. per lb. Better demand, and firmer market. London prices reported up to 9d.
Crude 60's .. .. 2s.—2s. 3d. per gall. Firmer, with more inquiry. Tendency to higher values.
Acid Cresylic, 97/99 .. 1s. 11d.—2[illegible] per gall. Demand still good. Market firm.
Pale 95% .. .. 1s. 10d.—2s. per gall. Steady demand.
Dark .. .. 1s. 8d.—1s. 11d. per gall. Steady business.
Anth[illegible] Past[illegible] .. 4d. per unit per cwt. Nominal price. No business.
[illegible]
Strained .. .. 10d.—11d. per gall. Very quiet.
Unstrained .. .. 8½d.—9d. per gall.

Benzole—
Crude 65's .. .. 10½d.—1s. per gall. ex works in tank wagons.
Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure .. .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% .. .. 1s. 4½d.—1s. 7d. per gall.
Pure .. .. 1s. 8d.—1s. 11d. per gall.
Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 11d.—11½d. per gall. Few inquiries
Middle Oil .. .. } 8½d.—9½d. per gall. according to grade and district. Market easier.
Heavy .. .. ..
Standard Specification
Naphtha—
Crude .. .. 8d.—9d. per gall. } Better demand. Prices show upward tendency.
Solvent 90/160 .. 1s. 2d.—1s. 4d.
Solvent 90/190 .. 1s. 1d.—1s. 3d.
Naphthalene Crude—
Drained Creosote Salts £7—£8. Demand still good.
Whizzed or hot pressed £10—£14 per ton. Not much inquiry.
Naphthalene—
Crystals .. .. £16 10s. per ton.
Flaked .. .. .. £17 per ton.
Pitch, medium soft .. 65s.—70s. per ton. Better demand for prompt and forward delivery. Prices hardening.
Pyridine—90/140 .. 16s.—17s. per gall. More demand at higher prices than of late. In the South as much as 17s. 6d. has been quoted.
Heavy .. 11s.—12s. Steady with fair business.

INTERMEDIATES AND DYES

Business in dyestuffs is maintained, but without much improvement. Prices remain firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. 4s. 6d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 11d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 4d.—1s. 5d. per lb. Steady demand.
Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 7¾d.—8½d. per lb. naked at works.
Aniline Salts .. .. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 3d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 29/31° C. .. 5d. per lb. Demand moderate.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethylaniline .. .. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. [illegible]

Diphenylamine ..	.. 3s. 3d. per lb. d/d.
Monochlorbenzol	.. £63 per ton.
α-Naphthol ..	.. 2s. 6d. per lb. d/d.
β-Naphthol ..	.. 1s. 1d. per lb. d/d.
α-Naphthylamine	.. 1s. 5d. per lb. d/d.
β-Naphthylamine	.. 4s. per lb. d/d.
m-Nitraniline ..	.. 5s. 3d. per lb. d/d.
p-Nitraniline ..	.. 2s. 5d. per lb. d/d.
Nitrobenzene ..	.. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. per lb. 100% basis d/d.
Nitronaphthalene	.. 11½d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol..	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 4s. 6d. per lb. d/d.
p-Phenylene Diamine	.. 10s. 6d. per lb. 100% basis d/d.
R. Salt	.. 3s. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 7d. per lb. 100% basis d/d.
o-Toluidine ..	.. 7d.—8d. per lb.
p-Toluidine ..	.. 3s. 10d.—4s. 5d. per lb. d/d.
m-Toluylene Diamine	.. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The principal items are in good demand for home trade and export orders generally show some indication of an improvement, which is expected to continue. In some products, however, weakness is evident and prices fluctuate within comparatively wide limits.

Acid, Acetic 80% B.P. ..	£52 per ton.
Acid, Acetyl Salicylic	.. 3s. 6d.—3s. 8d. per lb. Weaker tendency.
Acid, Benzoic ..	.. Commercial acid 2s. 9d. per lb. B.P. quality remains scarce at 4s. per lb.
Acid, Boric B.P.	.. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric..	.. 18s.—20s. per lb. Business normal.
Acid, Citric ..	.. 1s. 5½d. per lb., less 5% for ton lots. Market firm.
Acid, Gallic ..	.. 3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst...	6s. per lb., for 28 lb. lots.
Acid, Salicylic ..	.. English make, 2s.—2s. 6d. per lb., which is below the price of imported material. Various prices quoted for different brands.
Acid, Tannic ..	.. 3s. 0d. per lb. for B.P. quality
Acid, Tartaric ..	.. 1s. 1d.—1s. 1½d. per lb. less 5%. Firmer with more demand Continental acid offered at 1s. per lb. less 5% c.i.f. U.K. port.
Amidol	.. 9s. per lb. d/d
Acetanilide ..	.. 3s. per lb. Weaker. Offers are being made down to 2s. 10d. to stimulate the demand.
Amidopyrin ..	.. 13s. 3d. per lb. Demand negligible.
Ammon. Benzoate	.. 3s. 9d. per lb. English make.
Ammon. Carbonate B.P.	£37 per ton. Price advanced.
Atropine Sulphate	.. 12s. 6d. per oz. for English make. Market neglected.
Barbitone.. ..	.. 15s. per lb. Weak market.
Benzonaphthol ..	.. 6s. per lb. Firmer.
Bismuth Salts ..	.. A steady market. Prices according to quantity:
Bismuth Carbonate	.. 12s. 9d.—14s. 9d. per lb.
„ Citrate ..	.. 11s. 4d.—13s. 4d. „
„ Salicylate	.. 10s. 2d.—12s. 2d. „
„ Subnitrate	.. 10s. 9d.—12s. 9d. „
Borax B.P. ..	.. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.

Bromides—	Per lb.
Potassium ..	.. 9½d.—10d. English make. No alteration of any moment.
Sodium ..	.. 9½d.—10d.
Ammonium ..	.. 10½d.—11d. Foreign prices are somewhat unsteady. A lot of damp sodium bromide is being offered.
Calcium Lactate	.. 2s. 6d. per lb. for best English make. Prices steady.
Chloral Hydrate ..	.. 3s. 9d. per lb.
Chloroform ..	.. 2s. per lb. for cwt. lots.
Creosote Carbonate	.. 6s 0d. per lb. Little demand.
Guaiacol Carbonate	.. 12s. 6d. per lb. for small stocks available.
Hexamine ..	.. 3s. 9d. per lb. for foreign makes. Weaker. Large supplies available.
Homatropine Hydrobromide	.. 30s. per oz.
Hydroquinone ..	.. 3s. 9d. per lb. Foreign make.
Iron. Ammon. Citrate, B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate— Light Commercial	.. £36 per ton net.
Magnesium Oxide— Light Commercial	.. £75 per ton, less 2½%.
Heavy Commercial	.. £26 per ton, less 2½%.
Heavy Pure ..	.. 2s.—2s. 6d. per lb., according to quantity. Steady market.
Menthol— A.B.R. recryst. B.P.	.. 56s. per lb. Slightly dearer, but market rather erratic.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials ..	.. Prices reduced. Market quiet.
Red oxide ..	.. 4s. 9d.—4s. 10d. per lb.
Corrosive sublimate	.. 3s.—3s. 1d. „
White precip. ..	.. 4s. 1d.—4s. 2d. „
Calomel ..	.. 3s. 5d.—3s. 6d. „
Methyl Acetanilide	.. 20s. per lb.
Methyl Salicylate	.. 2s. 8d.—2s. 10d. per lb. for carboys. Slightly easier.
Methyl Sulphonal	.. 24s. per lb. Scarce.
Methylene di-tannin	.. 7s. 6d. per lb. In good demand.
Paraformaldehyde	.. 3s. 6d. per lb., without much inquiry.
Paraldehyde ..	.. 1s. 5½d.—1s. 8d. per lb. in free bottles and cases.
Phenacetin ..	.. 6s. 6d.—7s. per lb. Dull.
Phenazone ..	.. 7s. 6d. per lb. for cwt. lots. Spot prices much lower than forward offers.
Phenolphthalein ..	.. 7s. 3d.—7s. 6d. per lb. Firm.
Potass. Bitartrate— 99/100% (Cream of Tartar) ..	.. 88s.—90s. per cwt., less 2½%. Firm market. Inquiry good.
Potass. Citrate ..	.. 1s. 8d.—2s. per lb.
Potass. Ferricyanide	.. 3s. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	.. 7½d. lb., 1-cwt. kegs included.
Potass. Permanganate	.. 8½d.—9d. per lb. for B.P. crystal English make.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 6s. 3d. per lb.
Salol	.. 4s. per lb. Price fluctuates.
Silver proteinate	.. 10s. per lb.
Sod. Benzoate, B.P.	.. 3s. 3d. per lb. In more plentiful supply.

Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.	
Sod. Hyposulphite—Photographic ..	.. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.	
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.	
Sod. Nitroprusside	.. 16s. per lb. Less for quantity.	
Sod. Potass. Tartrate (Rochelle Salt)	.. 76s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.	
Sod. Salicylate ..	.. A weak market with various prices quoted. Powder 2s. 7d.—2s. 10d. per lb. Crystal at 2s. 7d.—2s. 11d. per lb. Market weaker.	
Sod. Sulphide—Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.	
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.	
Sulphonal.. ..	.. 18s. 6d. per lb.	
Tartar Emetic ..	.. 1s. 4d. per lb.	
Thymol	.. 13s. 3d.—14s. per lb. for good white crystal from ajowan seed. Somewhat cheaper than of late.	

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d.	per lb.	
Aubepine	.. 13s. 6d.	,,	
Amyl Acetate ..	.. 3s.	,,	
Amyl Butyrate ..	.. 7s. 3d.	,,	
Amyl Salicylate ..	.. 3s. 6d.	,,	
Anethol (M.P. 21/22° C.)	3s. 9d.	,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d.	,,	
Benzyl Alcohol free from Chlorine ..	.. 3s. 3d.	,,	
Benzaldehyde free from Chlorine ..	.. 3s. 6d.	,,	
Benzyl Benzoate..	.. 3s. 9d.	,,	
Cinnamic Aldehyde Natural ..	.. 17s. 6d.	,,	
Coumarin ..	.. 20s.	,,	Cheaper.
Citronellol ..	.. 16s.	,,	
Citral	.. 10s.	,,	
Ethyl Cinnamate	.. 15s.	,,	
Ethyl Phthalate..	.. 3s. 9d.	,,	
Eugenol	.. 10s. 9d.	,,	
Geraniol (Palmarosa)	.. 35s.	,,	
Geraniol	.. 10s.—17s. 6d.	per lb.	
Heliotropine ..	.. 8s. 3d.	per lb.	Cheaper.
Iso Eugenol ..	.. 15s. 9d.	,,	
Linalol ex Bois de Rose..	20s.	,,	
Linalyl Acetate ..	.. 20s.	,,	
Methyl Anthranilate	.. 9s. [illegible]	,,	
Methyl Benzoate	.. 6s.	,,	
Musk Ambrette ..	.. 52s. 6d.	,,	
Musk Xylol ..	.. 19s.	,,	
Nerolin	.. 4s.	,,	
Phenyl Ethyl Acetate	.. 12s. 6d.	,,	Advanced.
Phenyl Ethyl Alcohol	.. 16s.	,,	
Rhodinol ..	.. 57s. 6d.	,,	Cheaper
Safrol ..	.. 1s. 10d.	,,	
Terpineol ..	.. 2s. 9d.	,,	
[illegible] ..	.. 26s.	per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	.. 14s. 6d. per lb.	
Anise Oil	.. Advanced to 2s. per lb. Firmer market forward.	
Bergamot oil ..	.. 15s. 6d. per lb.	
Bourbon Geranium Oil ..	29s. 6d. ,,	
Camphor Oil ..	.. 75s. per cwt.	
Cananga Oil, Java	.. 9s. 3d. per lb.	
Cinnamon Oil, Leaf	.. 6½d. per oz.	Advanced. Market firm.
Cassia Oil, 80/85%	.. 9s. 3d. per lb.	Cheaper.
Citronella Oil—Java 85/90% ..	.. 5s. 3d. ,,	Much firmer.
Ceylon	.. 3s. 9d. ,,	Slightly dearer.
Clove Oil	.. 8s. 6d. ,,	
Eucalyptus Oil 70/75%..	2s. 3d. per lb.	
Lavender Oil—French 38/40% Esters	24s. 6d. per lb.	
Lemon Oil ..	.. 3s. 2d. ,,	
Lemongrass Oil	.. 2½d. per oz.	
Orange Oil, Sweet	.. 12s. 6d. per lb.	
Otto of Rose Oil—Bulgarian ..	.. 30s. per oz.	Market recovered.
Anatolian ..	.. 24s. 6d. per oz.	
Palma Rosa Oil ..	.. 18s. 6d. per lb.	
Peppermint Oil—English ..	.. 70s. per lb.	
Wayne County	.. 18s. 6d. per lb.	Advanced.
Japanese ..	.. None offering on spot. 17s. per lb. offered.	
Petitgrain Oil ..	.. 9s. 6d. per lb.	
Sandal Wood Oil—Mysore	.. 25s. per lb.	
Australian ..	.. 21s. per lb.	

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number.

Canada: Copper sheets (251); *Dominican Republic:* Hollow-ware (1006/8/F.G/E.C/2); *Egypt:* Cement, paint, oils (271); *Iceland:* Sugar (262); *Italy:* Silk (263); *Netherlands:* Leather (264); *Rumania:* Glassware (268); *South Africa:* Leather (253); Steel (13,267/E.D.); *Sweden:* Chemicals (269); *United States:* Rubber, Vegetable oils, copra, tin (272); Iron and steel, brass, tinplate (273).

French Company News

The Société de l'Artois Produits Chimiques et Engrais has now started work in its factories at Feuchy les Arras (Pas de Calais), which includes a sulphuric-acid plant, a nitric-acid plant, and a factory for the manufacture of Phosphazote, a synthetic fertiliser containing 11 to 12 per cent. of nitrogen as urea, and 11 to 12 per cent. of water-soluble phosphoric acid. The urea is manufactured under licence by the process owned by the Société des Produits Azotés, and it is hoped to produce 12,000 tons of Phosphazote annually.

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

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EDITORIAL

THE story which Mr. W. A. Davis tells us about Natural Indigo makes unsatisfactory, even melancholy, reading. The competition between the natural and the synthetic makes a different impression on each individual. We confess that for our part we are not free from prejudice; if the synthetic product is better, more uniform or distinctly cheaper than the natural we adopt it; on the other hand, if, as is the case with indigo, the natural product be as good or even better, as uniform and as cheap, we much prefer it. We dislike, quite unreasonably we know, to distil coal and perform a number of difficult operations in autoclaves and other instruments in a modern factory, and in a place like Huddersfield or Manchester, if the product can be efficiently made in India or Assam by the action of the sun on some living plant. We have sympathy with the planter who says, "I have not toiled, but take what God has made." Natural indigo has traditions, it calls up remembrances of nabobs and ryots, of Quakers in Lamb's Essays, of Clive and Warren Hastings. To waste coal, costing we do not know how many shillings a ton, and involving long and dangerous hours in a coal-mine, is not to be compared to the cultivation of a plantation by dusky natives in the sultry climes of India. And how mortifying is the end of the rivalry! A number of chemists make the synthetic indigo to their satisfaction, others, Mr. Davis being the leader, show how the yield of indigo can be increased, the quality improved, uniformity ensured, a lucrative trade organised and large areas of land maintained in a state of cultivation, even prosperity. And then, just as victory is within their grasp the horrid fates rob them of their reward. If there were some scientific or economic facts which meant that the natural indigo had no prospect of competing successfully with the synthetic we should say but little. But that a rather sentimental, and perhaps an unreasonable, unrest should involve the districts in such social and financial chaos as to end an industry which has flourished for centuries just as the cure for its troubles has been cleverly discovered, is too foolish and unkind. We have no recent news of the indigo plantations of Bihar. Are they now derelict? [illegible]

Virginia we saw many things which interested us deeply, and which we shall long retain in our memories. One of these was an area of many square miles of land once producing cotton, tobacco and maize, but now sparsely inhabited, covered with young and nearly useless trees, underwood and bushes, where here and there the wily negro in secret pursues the nearly equally wily turkey. It is a pity to see cultivation replaced by desolation; this has been the fate of some part of Virginia, and may well be the fate of Bihar.

* * *

The British Empire Exhibition at Wembley is nearing completion, and chemists, we think, will be very much interested in the exhibits of the chemical manufacturers, in the scientific exhibit, and in the book now being prepared to show the present state of chemical knowledge, dealing specially with the important contributions by British chemists during this century. These three pieces of work represent the labours of many chemists during many months. They have devoted valuable time to these projects, and have toiled at them at both convenient and inconvenient hours; they have done this without any hope of reward, cheerfully undertaking and performing the task, partly from a love of the science and partly from a high sense of duty. We owe them a great debt of gratitude. Particulars of the exhibits of chemical manufacturers will very shortly be available. From the preliminary list, which is by no means complete, it seems that the heavy chemicals, dyestuffs, fine chemicals, gas and intermediates, soaps, cosmetics, perfumes, polishes, varnishes, paints, tar products and drugs will be very well represented. It is too early to judge of the enthusiasm of the millions who are expected to visit this Exhibition, but if the other features are organised with the same care and assiduity as the chemical exhibits, the success of the Exhibition is assured.

* * *

The pamphlets which have been prepared for the edification of the non-scientific [illegible]

be made of most fascinating interest to an unscientific body of readers, and that a great deal of it can be explained in very simple language. Easy reading is, of course, hard writing, and our own experience satisfies us that some writers find it a very laborious task to provide matter which is easy reading. What has surprised us somewhat is the extent to which some readers are exasperated by the elementary articles on chemistry which have occasionally appeared in our columns. There is hardly any journal circulating in this country, except our own, which every now and then makes a deliberate effort to publish a chemical article which may be easily read by an accountant or a barrister-at-law whose only chemical knowledge is an association with a chemical company. We have recently received abundant, well-meant and sincere criticism from learned readers, who appear to us to forget that they belong to the distinguished and highly educated minority, and that they are in the possession of much information which a number of less fortunate individuals lack. A journal, so it seems to us, will hardly ever be read through from cover to cover by any one individual. The readers of the *Times* include many to whom fashion notes, company news, racing news, film news and musical news are of entire indifference. They do not complain, they merely turn on to the leading articles, or the foreign news or the golf news. We do not know whether we have misconceived the idea of a scientific weekly journal, but our ambition is that each week every reader will find something of interest. That each week the reader will find a good deal which does not make any appeal we fully expect. The Society of Chemical Industry has an opportunity of doing its small share in bringing chemistry home to the people of this country. It has been of great use in organising, and to some extent financing the British Empire Exhibition publications we have mentioned. Its Annual Meetings make a considerable item in the publicity which chemistry needs; we trust that the patience of our readers will enable a little to be done in this *Journal* to diffuse elementary chemical knowledge.

* * *

At one time or another few can escape the necessity for facing some problem connected with evaporating and drying, often under conditions of great discomfort, conditions that too often resemble, in their unreasonableness, the mediæval request for gowns made out of giant's beards. Mr. Ure, whose interesting article on evaporating we publish in this issue, is troubled with no such limitations, for the problems he discusses are confined to the calmer realms of chemical engineering. We are glad to draw attention to Mr. Ure's article on "Evaporating and Drying Plant," of which the part devoted to Drying Plant will appear in a later issue, and we announce that we have arranged for him to contribute several other articles dealing with various important classes of plant used in the chemical and related industries. Such articles fill a gap in the literature and it is our hope that they will be widely read and commented upon.

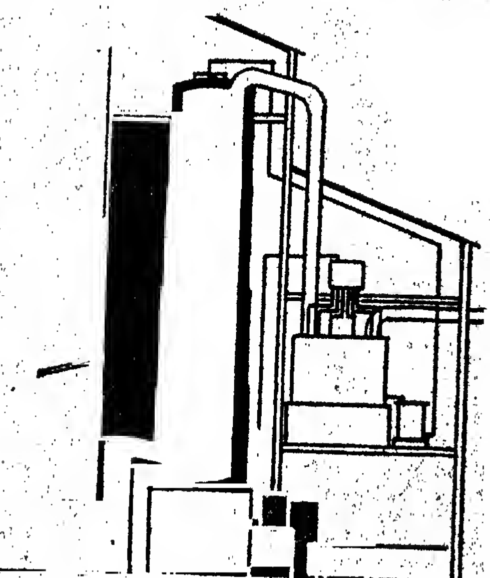
EVAPORATING AND DRYING PLANT

PART I

By S. G. URE, M.A., B.Sc., M.I.Chem.E.

On account of its very extensive employment in the chemical industry, evaporation, the removal by vaporisation of a comparatively valueless non-volatile material from a substance, is of very great importance both to the chemist and to the engineer, and much study has been given to the problem of the development of plant for this purpose.

The heat required for vaporisation may be supplied to the substance directly, or indirectly, through a boundary wall. Brine solution is often concentrated directly by exposure to the sun's rays. Direct heating is also frequently employed in modern sulphuric-acid concentration-plant as represented by the cascade, Kessler and Gaillard types. In the

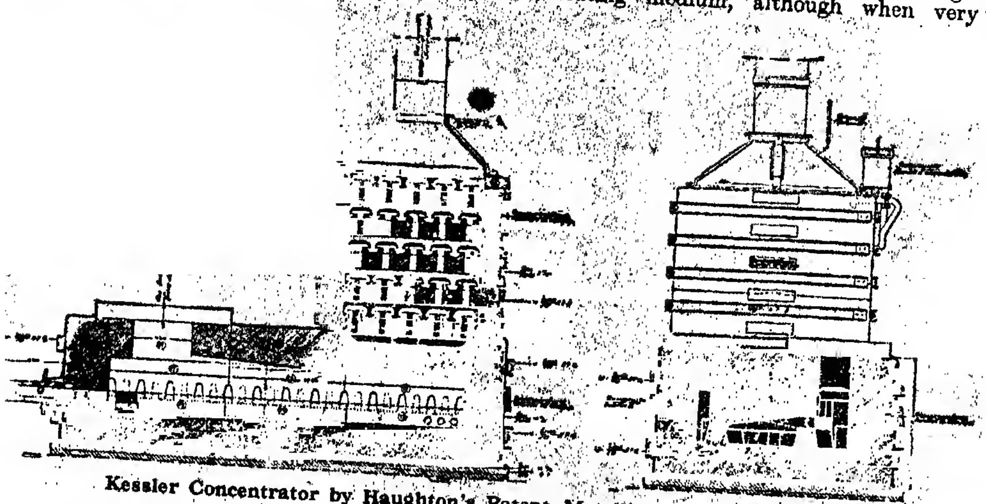


Gaillard Concentrator

FIG. 1

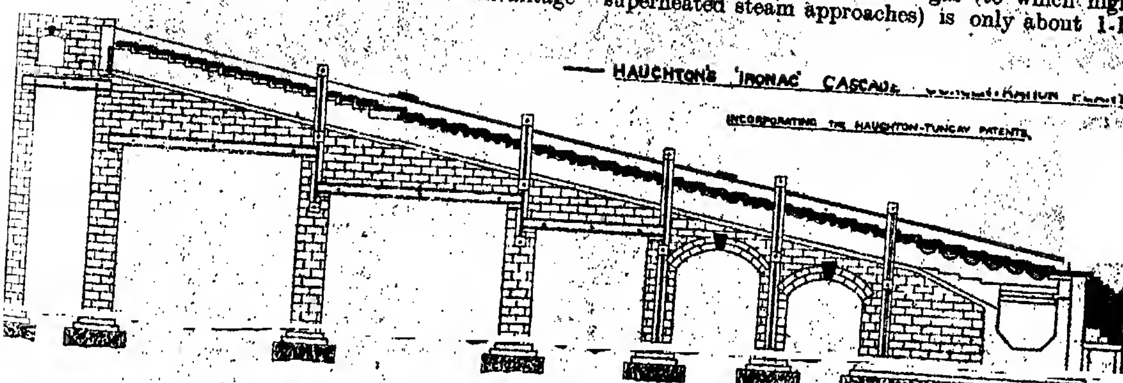
last-named plant, illustrated in Fig. 1, the sulphuric acid is admitted in the form of a fine spray at the top of a large vertical tower, whilst burning gases from a producer enter at the bottom. The concentrated acid collects at the bottom, and the products of combustion, together with the vapour evolved, leave at the top of the tower, and, after passing through a recuperator and scrubber, to remove any sulphuric acid which they may contain, are discharged into the atmosphere. In the Kessler plant, Fig. 2, hot gases from the producer pass over the surface of the concentrated liquor and then ascend a short tower provided with a number of trays of sulphuric acid of gradually increasing [illegible]on,

through which the flue gases bubble. The weak liquor is fed into the top of the tower near the exit pipe for the waste gases, which are again freed of acid before being liberated from the plant. The concentrated liquor outlet is at the bottom of the plant near the entry for hot gas. The cascade plant was one of the earliest forms of acid-concentration



Kessler Concentrator by Haughton's Patent Metallic Packing Co., Ltd.
FIG. 2

plant, and consists of a series of pans placed in échelon formation. The weak acid is admitted to the top pan and flows gradually downwards. The lower pans are heated by radiation and flue gases from a furnace and the upper pans by flue gases only. Although an efficient means of supplying heat to a substance, this method suffers from the disadvantage



Haughton's Cascade Concentrator
FIG. 3

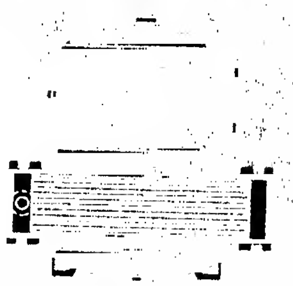
that the resulting product is usually contaminated with dirt obtained from the heating medium.

The supply of heat to the material through a metal wall is the method most commonly adopted in evaporator practice. When the plant is fire-heated, the heat is carried to the metal surface by radiation or convection. Here the main resistance to heat flow through the metal is the thin film of cold gas on the outer surface of the metal. In a very large number of evaporators the heat is brought to the metal container by means of a vapour or hot liquid which flows across one surface of the dividing wall, the liquid to be concentrated being in contact with the other surface. Steam is generally the heating medium, although when very high temperatures are required, and direct firing is impossible on account of the liability to burn the material, oil heating is adopted. High temperatures of evaporation cannot be economically obtained by using superheated steam, as it has been found that the heat transference from a gas (to which highly superheated steam approaches) is only about 1-100 of the heat capable of being transferred by a vapour at or near its saturation point, hence the adoption of oil as a heat-carrying medium when high temperatures are required.

TYPES OF EVAPORATORS

Evaporators using steam as the heating medium

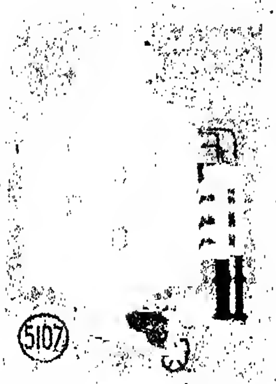
having a submerged heating element and those working on the film principle. Evaporators of the first group may be further subdivided into four types. In the first type, the heating element consists of a number of horizontal tubes placed inside a shell, which may be cylindrical, with axis vertical or



Horizontal Tube Evaporator by J. P. Devine Co.

FIG. 4

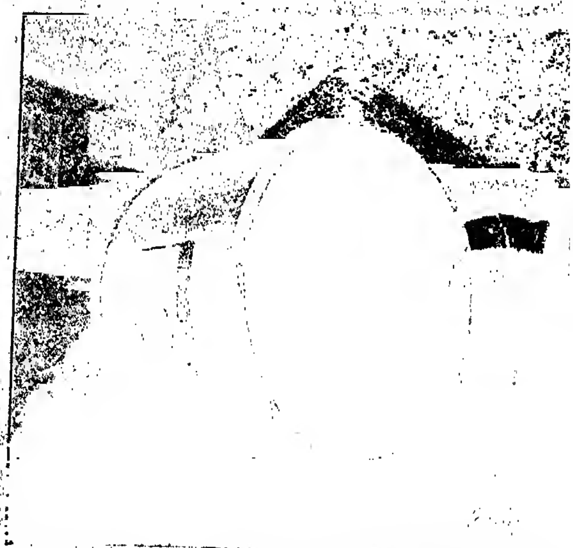
horizontal, or have the form of a rectangular box. The steam passes through the tubes, which are completely submerged in the liquor to be concentrated. It is claimed for this arrangement that it permits of quick cleaning and removal of the tubes when repairs are necessary, and that it gives an efficient steam circulation and allows of provision being made for the removal of condensed steam and non-condensable gases. Sometimes coils are used instead of straight tubes, as illustrated in Fig. 5.



Coil Evaporator by Manlove, Alliott and Co., Ltd.

FIG. 5

Had the next type been realisable in practice it would have consisted of horizontal tubes filled with liquid, the steam surrounding the tubes. The difficulty experienced with this type lies in the removal of the vapour, without the liquid, from the tubes. In the third type the tubes are vertical and contain the steam, whilst submerged in the liquor to be concentrated. The tubes are connected at top and bottom to two headers, which serve for the introduction of the steam and the removal of the condensate, respectively. These headers, however, interfere with the circulation of the liquid being heated, and so reduce the heat transference coefficient. This type is being discarded in favour of the fourth type, which is sometimes referred to as the standard evaporator. Again, the tubes are vertical, but in this case the liquid flows through the tubes and the steam surrounds them. This permits of a neat arrangement in the evaporator, as the heating element is usually formed of the lowest section of the shell, which is fitted with a tube plate at either end into which the tubes are fixed. An illustration of such a heating element is given in Fig. 6. The steam is admitted through an

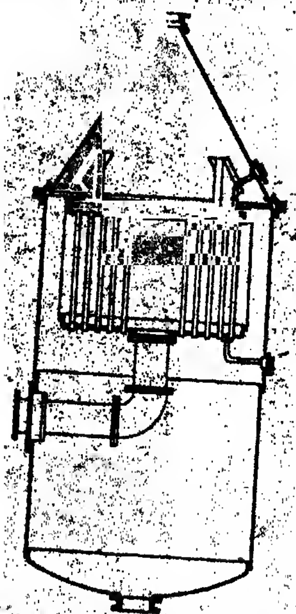


Heating Element used in G. Scott and Son's Evaporator

FIG. 6

opening in the cylindrical portion of the element, and the tubes are specially arranged to ensure equal distribution of the steam over the whole heating surface. To maintain a rapid circulation of the liquid through the tubes, and thus obtain a high rate of heat transference, downcomer tubes are fitted. Sometimes these are placed outside the heating element; in other cases they are situated at regular intervals among the smaller tubes, an arrangement favoured by G. Scott & Son. Devine, as well as Blair, Campbell and McLean, adopts the central tube type of downcomer, sometimes insulated from the heating medium by an air gap, whilst Manlove, Alliott & Co. and Fullerton, Hodgart and Barclay employ a side downcomer, formed by the cylindrical shell and a flat surface on the heating element. A modification of this type of heating element is known as the basket type and is illustrated in Fig. 7. In this case the heating element consists of a number of parallel tubes fixed to the tube plates attached to the ends of a cylinder, which is considerably smaller in diameter than the evaporator shell, and usually rests on a series of lugs attached thereto. The steam is introduced to the

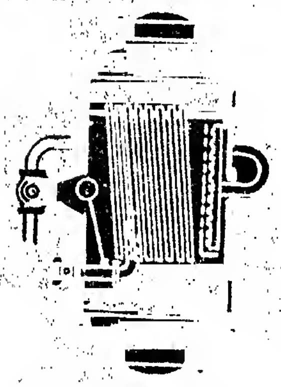
which is fixed to the centre of the upper tube plate, and passes out, either through the top or the side of the outer shell, whilst a smaller tube attached to the outer wall of the heater at its lowest point, and passing through the shell of the evaporator, serves to remove the condensed steam. With this



Basket Type Evaporator by J. P. Devine Co.
FIG. 7

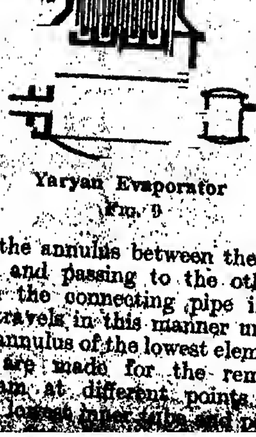
type of heater the annulus formed between the heater and the outer shell acts as the downcomer. Advantages of this type of heater are that it can be removed bodily from the evaporator for cleaning and repair, and that all the heat liberated by the condensation of the steam is transferred to the liquid. All these types of evaporators are provided with a large vapour space above the heating element; it is stated that in large evaporators this space can be considerably increased without materially affecting the radiation losses from the outer surfaces.

M. Paul Kestner, of Paris, invented the film type of evaporator, and many evaporators have since been designed working on this principle. In such plants the liquid being heated is maintained as a thin film on the heating surface. Evaporators of this group can also be subdivided into four types. In the first of these, the tubes are horizontal, the liquor to be concentrated forming a thin film on the outside. The only modern representative of this type is the Lillie evaporator, shown diagrammatically in Fig. 8. The steam is admitted to a steam chest at one end of the evaporator from which it enters a series of parallel horizontal tubes, closed at one end, except for small holes through which the non-condensable gases may escape into the surrounding chamber, whilst the condensed steam runs back to, and is drained away from, the bottom of the steam chest. The liquor to be concentrated is sprayed over these tubes and the concentrate is collected at the bottom of the chamber surrounding them.



Lillie Evaporator
FIG. 8

Several firms manufacture evaporators belonging to the second type, in which horizontal tubes are surrounded by the heating medium, and the liquid to be concentrated passes inside. The Kestner horizontal evaporator belonging to this class is made up of a number of pairs of concentric tubes, placed one above the other, the inner tubes being held in position by stuffing boxes attached to the ends of the outer tubes, whilst the outer end of the inner tube is coupled to the one immediately below it by a U bend. The alternate ends of the outer tubes are connected together by T pieces.



Yaryan Evaporator
FIG. 9

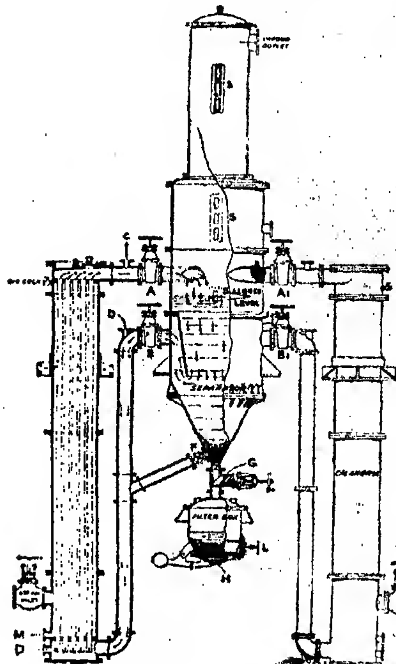
Steam enters the annulus between the top two concentric tubes, and passing to the other end flows down through the connecting pipe into the next annulus, and travels in this manner until it reaches the end of the annulus of the lowest element. Suitable arrangements are made for the removal of the condensed steam at different points. The liquor flows along the lowest inner tube and passes through

the U bend to the one immediately above, thus producing counter-flow to the steam. During its passage through the tubes some of the liquor flashes into vapour and passes through as little pistons of liquid with vapour between.

In the Yaryan evaporator, shown in Fig. 9, the horizontal tubes for carrying the liquor are coupled at the end so as to form a sinuous passage of considerable length. Several of these nests of tubes are contained in an outer shell, to which the heating vapour is admitted, the condensed vapour being drained off at the lowest point. In this plant the liquor enters at the top of he nest of tubes, and flowing downwards is discharged into a separate chamber, where the removal of the vapour from the concentrated liquor takes place.

An approximation to the next type is obtained when in type 3 of the first group the liquid level is lowered so that a considerable portion of the tubes extend into the tube space. Then the uncovered portion of the tubes become coated with a thin film of liquid obtained from the froth.

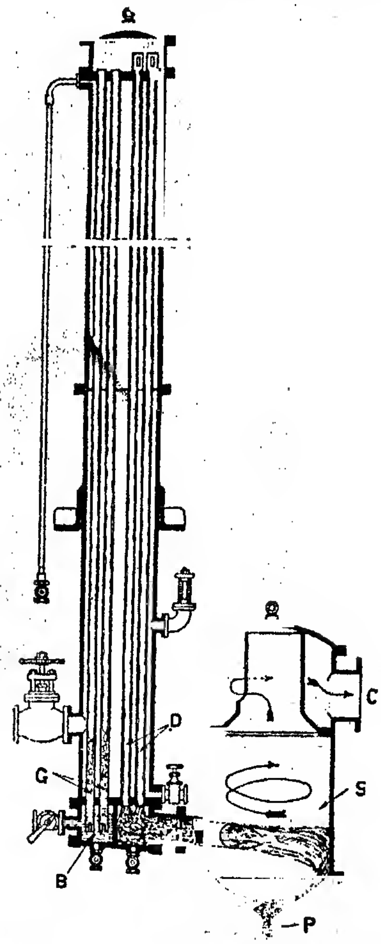
A recent patent described an evaporator consisting of a number of hollow steam-heated cylinders mounted with their axes vertical. The liquor was applied to the outer surface of one cylinder as a thin layer, and was transferred from one cylinder to another by the



Kestner Evaporator—Salting Type

FIG. 10

rotation of one cylinder against another, the final concentrate being removed by a scraper. This might be classified as an evaporator of the vertical outside film type, although its action is analogous to that of a drum dryer. The Kestner vertical climbing film evaporator is a typical example of the last type of this group. In this the liquid ascends inside a series of vertical tubes, which are surrounded by the heating medium. M. Kestner



Kestner Patent Falling Film Evaporator

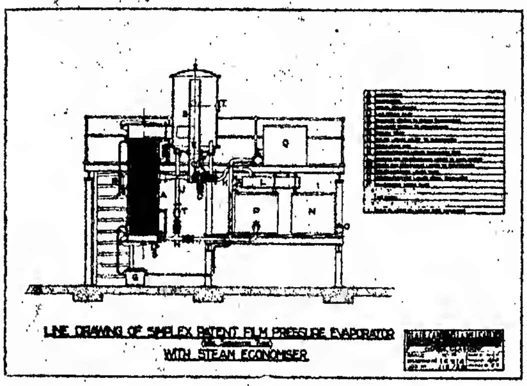
FIG. 11

claims that with this type of evaporator the vaporisation of the liquid at the bottom of the tube produces a column of rapidly moving vapour within the tube, which draws up a thin film of the liquid being concentrated over the surface of the tube. Other writers on the subject maintain that the action is analogous to that of an air-lift pump, namely, a series of vapour spaces alternating with pistons of the liquor. In this plant tubes of 7 m. in length and 5 cm. in diameter are used, whereas the firm of Blair, Campbell and McLean, which also manufactures a vertical film evaporator does not employ very long tubes.

HEAT TRANSFERENCE

To deal with entrainment or frothing in evaporators of the first group a large vapour space i

provided above the free surface of the liquid, but in evaporators of the film variety the separation of the vapour from the liquor is generally effected in another vessel termed the separator. In this vessel advantage is taken of the high velocity of the liquid, usually about 10 feet per second, to produce separation by centrifugal action, and to cause this the liquor is usually discharged into the separator tangentially to the surface of the vessel. The coefficient of heat transfer in the case of a condensing vapour transmitting its heat through a boundary wall to a boiling liquid is influenced by the temperature difference between the vapour and the liquid, the density of the liquid and its viscosity, and the cleanliness of the boundary surfaces. Now, with a steam supply at a given pressure, the only way to increase the temperature difference between the vapour and the liquid is to lower the boiling point of the latter, and as the boiling point is a function of the pressure existing at the surface of the liquid this has led to the employment of evaporators working under vacuum. During evaporation, as the concentration rises, so will the boiling point of the liquid, and therefore the rate of



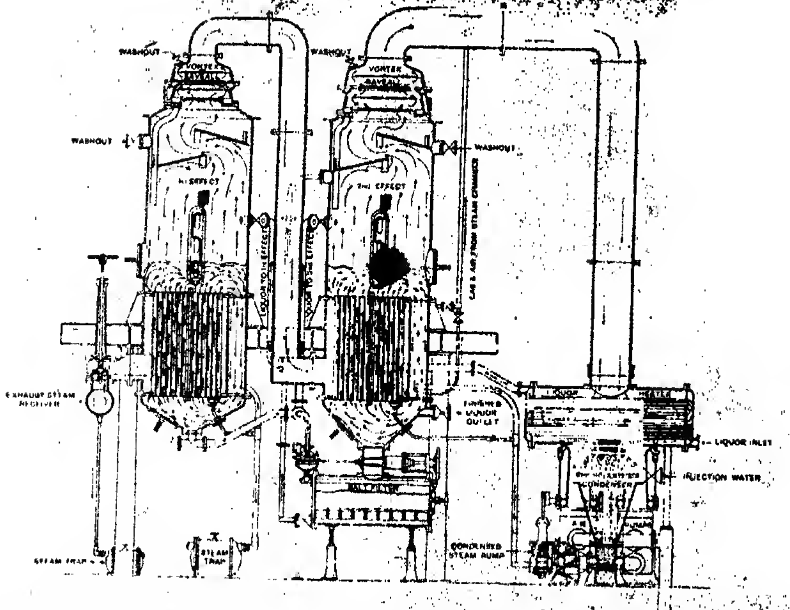
Simplex Film Pressure Evaporator by Blair, Campbell & McLean, Ltd.

FIG. 12

heat transfer will fall off. The reduction of the boiling point is also advantageous and even compulsory when evaporators are required to handle delicate liquids. In determining the vacuum to be applied in an evaporator of the first group, when dealing with a delicate substance it must be remembered that the pressure at a point will increase with its depth below the free surface, and therefore such a vacuum will be required as will prevent destruction of the material in contact with the lowest point of the heating element. The velocities of the vapour and liquid over the surfaces of the tubes affect inversely the thickness of the films covering these surfaces and therefore the rate of heat transfer. Also the greater the velocity of the liquid the shorter is its time of contact with the heating surface, and there is less likelihood of its being damaged by being raised to too high a temperature. With rapid circulation, such as is obtained in the film type of evaporator, delicate liquids can be concentrated at atmospheric pressure without injury. The rapid movement of the liquor inside the tube tends to prevent the formation of scale, and thus maintains the high coefficient of heat transfer, which may amount to 3000 calories per square metre per hour per degree C., a figure very difficult to exceed in general practice. When solids are liable to be deposited upon the heating surface by the liquor being concentrated, many devices are resorted to to maintain the heat transmission efficiency of the plant. In addition to the employment of high velocities sharp gritty material is added to the liquor which, being carried round by the stream, tends to remove any scale which may be deposited. The basket type of evaporator has the advantage that the basket can be removed to clean off the scale. When badly scaling material is being treated, two baskets are frequently employed, one in operation in the plant and the other undergoing cleaning and repair, thus minimising the delay caused through cleaning. In other cases an extra evaporator, or calandra, is installed and connexions are so arranged that any of the evaporators or calandras in the set can be easily isolated for cleaning or repairs.

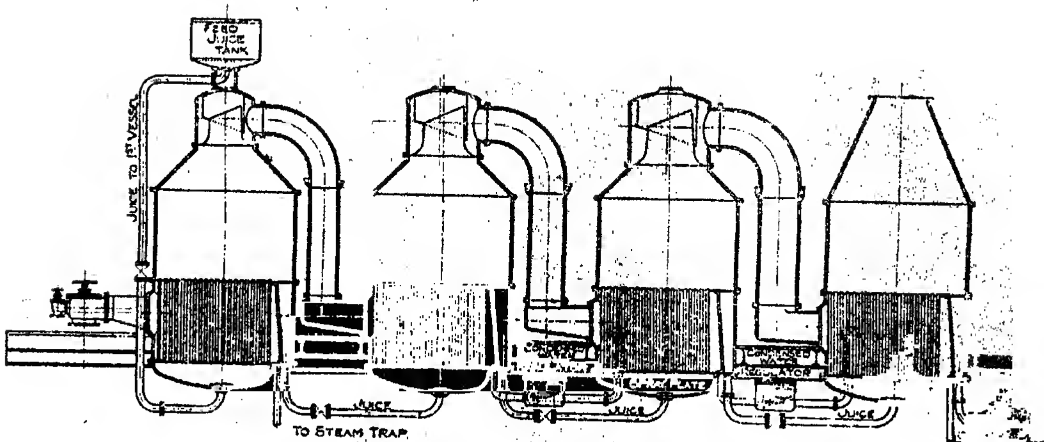
The evaporation per square metre per hour from the free surface of the liquid is another important factor, especially in plants of the submerged heating element type, for upon this factor depends to a large extent the vapour space required. This factor is a very variable one, and depends largely upon the nature of the material, and the conditions under which concentration is effected. From figures derived by Professor Hinchley from data supplied by G. Scott and Sons, Ltd., one finds such rates of evaporation as 43 kg. per sq. metre per hour for malt extracts, 78 kg. per sq. metre per hour for caustic soda liquors, etc., although an evaporation of 2700 kg. per hour per sq. metre has been attained in certain instances. Generally the higher the rate, the greater the trouble likely to be experienced from entrainment and frothing. Some liquors when heated foam or froth freely, and various devices have been adopted to overcome this trouble. With the submerged heater type of plant, the customary procedure when handling a foam-forming liquid is to lower the liquid level until part of the heating element projects above the free surface into the vapour space. In this way the froth rising from the liquid is further heated, thus bursting the bubbles, and forming drops of liquid which fall back into the original mass.

Sometimes this trouble is overcome by reducing the rate of evaporation from the free surface of the liquid, but this is not an infallible remedy for foaming, as certain liquids have been found to "boil off" even under gentle boiling. A crude device and one never recommended by evaporator manufacturers, is to cover the free surface with a thin film of oil, but such a method has decided limitations. Other factors which affect the foaming propensities of liquids include their concentration, the working pressure inside the plant, and the pressure of the steam admitted to the heating element. When concentrating a solution of sodium tungstate and



Caustic-Soda Soap Lye Evaporator by Fullerton, Hodgart & Barclay, Ltd.

FIG. 13.



Quadruple Effect Evaporator by G. Fletcher & Co., Ltd.

FIG. 14.

sodium carbonate which frothed badly, even under gentle boiling, Manlove, Alliott and Co., Ltd., found that when a certain concentration had been attained this trouble completely disappeared and did not return. The small quantity of liquid actually in contact with the heating surface and its rapid rate of circulation tend to eliminate foaming troubles in evaporators of the film type, nevertheless makers of both types of evaporators fit saveall devices at the entrance to the outlet pipes of the plant to remove any liquid which may be brought to the outlet either by entrainment or foaming.

Materials used in the construction of evaporators largely depend upon the chemical properties of the substances to be concentrated. The tubes of evaporators are commonly made of mild steel, but in cases where this has proved unsuitable, cast iron, copper, phosphor bronze or lead tubes have been installed. The casings of evaporators and separators are usually made of cast iron, mild steel or copper. Where [illegible]

of product is of first consideration as in the production of distilled water, it is customary to cover with a thick coating of tin, generally deposited electrolytically, all internal surfaces which come in contact with the liquor and the finished product.

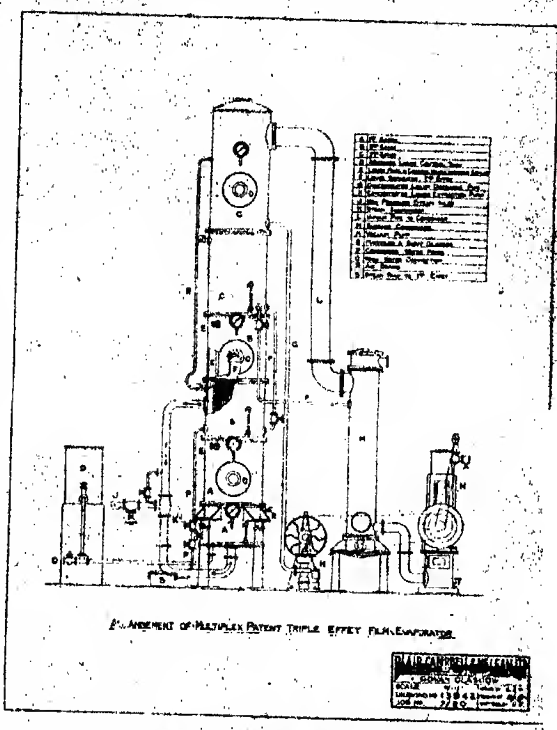
Single and Multiple Effect Evaporators

If waste steam at suitable pressure is available, the waste steam at suitable pressure is available, the custom is to install single effect evaporators, as here the heat is obtained at the minimum cost and the plant involves the minimum capital outlay. In factories where it is necessary to concentrate two different solutions having different boiling points, such as caustic soda and soap lye, it is customary to arrange the plant in the following manner. Two single effect evaporators are used, in the first of which the weak caustic soda solution is concentrated by heat obtained from live steam. The vapour evolved during this process, instead of going to a pre-heater or condenser, is passed into the steam space of the second evaporator which is fed with weak soap lye. This system is illustrated in Fig. 13, and provided one had a number of substances having a suitable series of gradually diminishing boiling points, the principle could be equally well applied, so that each substance would be concentrated in its own evaporator, the heat required for its concentration being obtained from the vapour evolved from the substance having the next higher boiling temperature. This is really a combination of simple and multiple effect evaporation, the steam being used as in the multiple effect plant and the liquors as in the single effect evaporator.

Fig. 12 gives a sectional elevation of a quadruple effect evaporator working on the purely multiple effect principle. As will be seen the steam and the liquor are admitted to their respective compartments in the first effect. The vapour generated by the passage of the liquid through the tubes collects in the vapour space and after passing through the saveall is led into the heating space of the second effect. The liquor rising through the tubes of the first effect flows into the side down-take, which is sealed, and is carried into the liquor space of the second effect. Here the pressure in the vapour space is less than that existing in the vapour space of the first effect, and therefore steam will be flashed off from this hot liquor, and a further heat transference will take place between the vapour in the heating element and the liquor, which will generate more steam from the latter.

This steam passes into the heating space of the third effect whilst the hot liquor flows in a similar manner into the corresponding liquor space. Here, due to a further pressure reduction, more steam is generated in a similar manner to that described above, and then both vapour and hot liquor pass to the heating and liquor spaces of the fourth effect. The steam evolved in this effect by a repetition of the process is withdrawn through a pre-heater or condenser by a pump which maintains the requisite vacuum in the last effect. The liquor at the required concentration leaves the last effect for the next stage in the process. It will be observed that the condensed steam from the second and third effects is led into steam traps fitted with steam spaces connected to the heating chambers of the third and fourth effects respectively, thus permitting steam flashed off by reduction in pressure to be utilised in those heaters. Multiple effect evaporation is resorted to in plants of the submerged heater and film types. In the plant described it will be observed that the flow of liquid takes place in the same direction as the flow of the heat-supplying medium, and such plants are said to work on the parallel current system. If the weak liquor entered the plant at the last effect, the concentrated liquor being discharged from the first, whilst the steam flow remained as before, the plant would operate on the counter-current system.

Should each effect be fed independently, as in plants handling different liquids, the operation would be termed parallel feed. An analysis by Weber of these three methods of working, shows that if the liquor is fed into the evaporators below a critical temperature the steam consumption is greatest in the case of parallel current and least in the counter-current type, but with a feed above the critical temperature the steam consumption is greatest with counter-current operation and least in parallel flow. The ratio of the evaporation per lb. of steam used is greatest with the parallel current, and least with the counter current, with a feed below the critical temperature and least in the parallel current flow



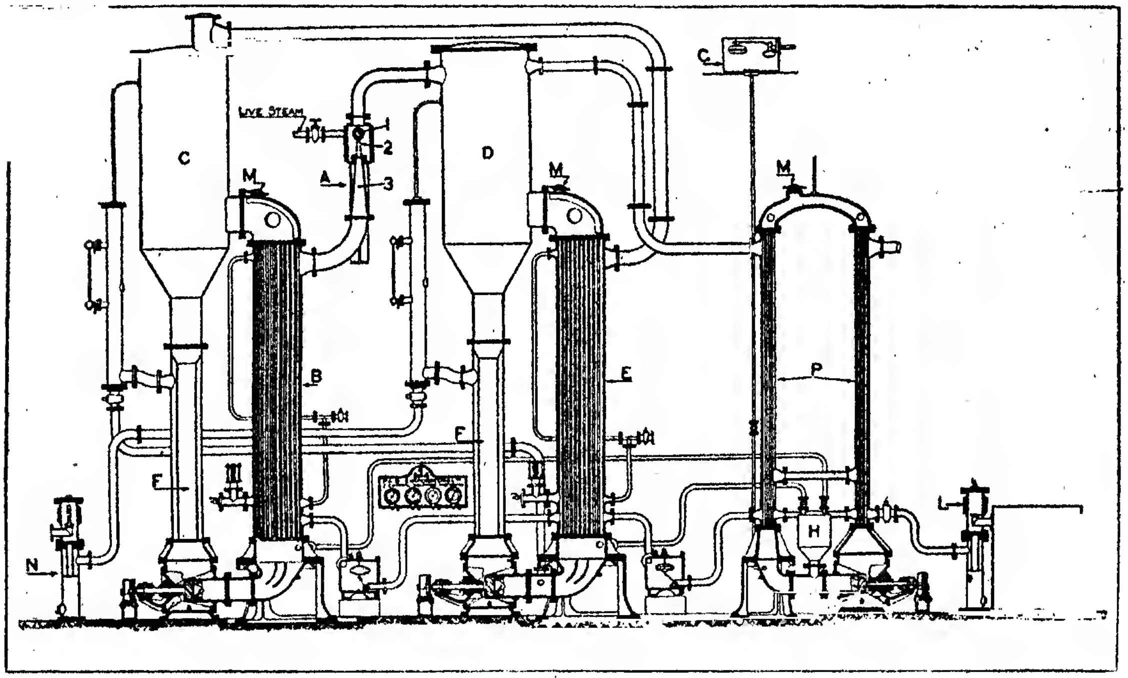
Multiplex Evaporator by Blair, Campbell and McLean, Ltd.

Fig. 15

and greatest in the counter current flow when the feed is above the critical temperature. As one would expect, the amount of vapour to be condensed from the last effect gradually rises in the counter-current and parallel feed types as the temperature of the feed is raised. Under a critical temperature, the amount is least in the case of a counter current flow, but above a critical temperature it ultimately becomes the greatest of all the types. Parallel current places a constant load on the condensing plant irrespective of the feed temperature. Another method of passing the liquor through the evaporators, adopted by G. Scott and Sons, Ltd., especially when the concentrated liquor has for various reasons to leave the plant at a higher temperature than the boiling temperature, consists in feeding the weak liquor into the first effect, passing it from this effect into the third and then into the second, from which it is discharged from the plant.

In Blair Campbell and McLean's multiplex film evaporator, shown in Fig. 15, the liquor is fed by gravity into the first effect which is heated by live steam, which may consist of exhaust steam at a pressure from zero to 5 lb. per square inch. The liquor and the vapour generated therefrom by its passage through the heater tubes, is projected against a baffle plate and then passes through an opening into a separator. After separation the liquid collects on the upper surface of the baffle, whilst the vapour passes into the [illegible] space of the next effect. A pipe descending from the liquor space of the second effect to the baffle plate of the first, serves to convey the liquor to the liquor space of the second effect, where the pressure is less than in the separator chamber of the first effect. Rising through the tubes of this effect more vapour is produced. Again, the liquid and vapour are projected against the baffle plate on the top of this effect, and then enters the second separating chamber. After separation the vapour enters the heating space, and the liquid enters the liquor space of the third effect in the manner described above. When the vapour and concentrated liquor, after impinging on the third baffle plate, enter the third separating chamber, the vapour is removed through a suitable preheater and condensing plant, and the concentrated liquor is withdrawn from the top of the third baffle plate. Sufficient vacuum is maintained in the separator of the third effect to ensure successful working of the plant. The separating chambers are so dimensioned that the short tubes of the heaters can be easily cleaned or removed if repairs are required. The whole plant is compact, requiring little floor space and presenting a minimum surface through which heat may be lost by radiation.

Multiple effect evaporators are generally used when only high-pressure steam is available, and plants of this type have been manufactured having 12 effects. With such a plant usually engaged on water distillation, the initial steam pressure requires to be generally in the neighbourhood of 150 lb. per square inch for successful working. Multiple effect evaporators, however, usually consist of triple and quadruple effect plants, and it is stated that with



Prache Bouillon Evaporator

FIG. 16

certain types of plant every 1 lb. of steam supplied will evaporate 1·66 lb. of water in a double effect, 2·75 lb. of water in a triple effect, and 3·33 lb. of water in a quadruple effect. The actual cost of evaporation taking the cost in a single effect plant as unity works out at 0·552 for a double effect, 0·406 for a triple effect, and 0·276 for a quadruple effect. At first sight, therefore, it would appear that multiple effect evaporation is an economy, but one has to remember that such plants involve a much larger capital outlay than in the single effect plant, and also necessitate a higher initial steam pressure to ensure the requisite temperature drop between each effect.

Thermo-compression

Recently considerable attention has been directed to rendering the low-pressure steam evolved from the liquor suitable for re-admission to the heating space. The method by which this can be carried out consists in removing the low-pressure steam from the ebullition chamber, and compressing it to such a pressure that it can be again admitted to the heating space. When this is done evaporation will take place with an expenditure of energy equal to that supplied by the compressor, the latent heat present in the initial steam having been transferred to the low pressure steam which it has produced. This seems to point to an economical method of evaporation, provided a suitable method of compression is available. Two types of compressors have been tried, the pump compressor and the injector compressor. Of these compressors the latter is the type adopted by Prache Bouillon, Kestner and Blair Campbell and McLean in their evaporators working on this system. In this type the steam consumption required to operate the compressor is largely increased, the greater the difference in temperature to be maintained between the steam and the liquor. This necessitates that evaporators working on this system should only have a small temperature difference between the steam and the liquor, usually about 6°. With such a small temperature drop, special attention must be given to the prevention of scale on the tubes, as this causes the heat transference to fall off rapidly. In the Prache Bouillon Evaporator, illustrated in Fig. 16, the heating element consists of a series of vertical or inclined tubes through which the liquor is circulated mechanically by a pump. Sufficient pressure is maintained in the tubes to prevent the formation of large bubbles of steam, until the liquor is discharged into the separator, when, on the reduction of this pressure the steam is flashed off. A portion of the steam from the second effect is carried to the preheater, and the remainder passes through the compressor, and is then discharged into the heating space of the first effect, the vapour produced in the first effect being admitted to the heating space of the second. In this plant there is a three degree temperature drop in each effect. To keep the tubes clean, finely ground quartz is introduced into the evaporator and circulated with the liquor. The makers claim an evaporation of 6½ lb. of distilled water per lb. of live steam used.

(To be continued)

SOME PAGES FROM THE STORY OF INDIGO

By W. A. DAVIS, B.Sc., A.C.G.I.

The Decline of the Natural Indigo Industry

(Continued)

When war broke out, the supplies of synthetic indigotin from Germany being cut off, a serious shortage of indigo was felt which led to an enormous rise in the price of indigo. Indian indigo which had been selling at Rs. 250-260 per cwt. jumped to about 1000 Rs., this level being maintained during the first two years of war. In India arrangements were immediately made to increase the area under indigo, and in 1916-1917 the acreage was 756,400—nearly a four-fold increase.

Whilst on his way home from a meeting of the British Association in Australia, Prof. H. E. Armstrong, who had always been keenly interested in the struggle between natural and synthetic indigo, sent a letter to the leading Calcutta paper, the *Statesman*, urging the necessity of renewed research. Considerable interest was aroused and in 1915 an official conference was held at Delhi and the matter was referred to the India Office. After giving full consideration to the issues, the India Office made certain recommendations and eventually an understanding was arrived at with the Bihar planters. Prof. Armstrong acted as scientific adviser to the India Office, and as a result of his invitation the author went out to India in May, 1916. A small cess was levied on all indigo exported from India to pay the costs of research, so that the indigo producers largely paid the costs of the investigation.

Feeling very doubtful, like most chemists at the time, of the future of natural indigo, Prof. Armstrong stipulated that at first my engagement should be for one year, during which time I could more fully look into the question. In the course of this year many rather surprising facts emerged which led me to consider that, providing certain conditions were realised, natural indigo could still put up a good fight. I, therefore, recommended the extension of the work for a period of five years. In the first place, after a careful examination of all the facts available, it appeared clear that the issue was pre-eminently an agricultural one and that the main problem was to ensure the satisfactory growth of the indigo plant. Some years earlier a greatly improved type of indigo plant had been introduced into India from Java, where it had been developed by the Dutch indigo research station. The Java variety, *Indigofera arrecta*, when introduced into India gave such phenomenal returns as compared with the old *Sumatrana* plant, that the planters, who had been going through a very thin time, thought their salvation had come.* The old plant had given about 5 seers (10 lb.) of cake indigo per acre, but with the new plant yields of 20 to 40 seers were obtained for several successive years on many

* See especially D. J. Reid, "Ten Years' Practical Experience with Java Indigo in Bihar" (*Ag. J. India*, 1917, 12, Part I), and Indigo Publications Nos. 1, 2, 4 and 6; also Prof. H. E. Armstrong's paper, "Soil Deficiencies in India," read before the Royal Society of Arts in May, 1919.

estates. Several planters who had taken up the Java plant on the large scale had made very substantial fortunes in spite of the competition of synthetic indigotin. The very low yield of indigo per acre with the old *Sumatrana* plant had meant that the costs of sowing, cultivation, manufacture and overhead charges were unduly high in proportion to the return. From an examination of actual working expenses at several factories it became clear that by increasing the yield of indigo per acre the cost of production could be so greatly diminished as to make it possible to compete easily with syntheti[illegible] indigotin. The following table shows this :—

Yield of indigo per acre Seers		Cost of production of 1 maund* of indigo with charges Rs. 40 per acre
5	..	320
10	..	160
20	..	80
30	..	53
40	..	40

1 Factory maund = ⅔ cwt. = 74·66 lb.
1 Seer = 1/40 maund = nearly 2 lb.

As was stated by Bernard Coventry, C.I.E., a large indigo planter who was largely responsible for the introduction of Java indigo and subsequently became agricultural adviser to the Government of India, "If we could grow the plant properly it would give at least 20 seers of indigo per bigha (0·87 acre), and with such a yield I would undertake to undersell synthetic indigo at practically any price."

The trouble was, when I arrived in India, that the Java plant which at first had given such extraordinary yields had largely ceased to do so, and the high hopes originally formed had in many cases been disappointed. On some estates big yields had been maintained for a few years, but in many cases after three or four years the yield rapidly fell off, and, what was even more serious, the plant failed to give seed. A mysterious disease, the so-called "wilt" disease of indigo, had appeared, neither fungal nor bacterial in origin, which was accompanied by a great falling-off in plant. Whereas the Java plant at first had given two, sometimes three, magnificent cuttings with a total yield of 200-300 maunds of plant of high quality in the season, in 1916 the yield had fallen to 50-70 maunds per acre. Only a single cutting, often a poor one at that, was obtained, and the yield of cake indigo had fallen from 30 to 40 seers to about 5 to 7 seers per acre.

Yield of indigo per acre

		Acres		Yield per acre cake indigo
1916-1917	..	80,600	..	15 [illegible] = 7½ seers
1917-1918	..	86,700	..	1[illegible] 6½ „
1918-1919	..	64,200	..	1[illegible] 5½ „

One of my first tasks, therefor[illegible] to make a thorough examination of the plant[illegible]tates : some 600 samples of soil were taken fro[illegible]any different estates and analysed. The resul[illegible] convinced me that the so-called "wilt" disc[illegible] was in reality due to soil starvation ; the soi[illegible] had become so impoverished by continuous stripping without any suitable manurial treatment that the plant could no longer obtain sufficient nutriment for proper growth.

The soils were very variable from place to place—as is usual in areas subject to annual flooding during the rains. In practically all places where the plant had failed badly there was a great deficiency of either phosphate or organic matter, often both, in the soil.

Systematic manurial trials were instituted and maintained during six years, both at the Agricultural Research Institute at Pusa and on numerous planters' estates. In many cases extraordinary increases of crop—both of indigo and the cold weather crops (oats, wheat)—were obtained by proper manurial treatment—either superphosphate alone or combined with green manure (sannai). In several cases poor soils which were practically useless for cropping gave yields of 15 maunds of oats per acre, whilst others gave a yield of 30 maunds after manuring as compared with 13 without. This side of the question has been dealt with in detail in my *Indigo Publications* issued by the Agricultural Department of India, and the story has been told in two papers read by Prof. Armstrong at the Royal Society of Arts in 1919 and 1922.

In my final report to the Government of India in 1922, I stated : "In my opinion the importance of proper manuring in N. Bihar cannot be over-estimated—it is the keynote to the prosperity of the indigo industry and ultimately of the ryots on small holdings who depend largely on special crops such as tobacco, chillies, grown on lands manured with indigo seet (the refuse plant obtained after steeping the indigo). Most planters' estates have been greatly impoverished by lack of proper manurial treatment, especially since the advent of the high-yielding Java variety of indigo which more rapidly strips the soil than other crops. The effect of proper manurial treatment is cumulative. By improving the yield of indigo from the present 50–75 maunds of green plant per acre up to 150–200 maunds (which actual planters' trials have shown to be possible) the output of indigo seet is doubled, and so a far more efficient manuring of *rabi* (cold weather) crops (cereals, tobacco, chillies, etc.) with correspondingly higher yields becomes possible. The value of the lands let out to the ryots for growing tobacco is also greatly increased. Lands which ordinarily would be let unmanured only for Rs. 20 per acre, are gladly taken after seeting, by ryots at a rental of Rs. 100 to 120 per acre. Increased profits from good yields of cold weather crops such as oats, wheat, mustard, tobacco, and the rental derived from lands let out to ryots, would go far towards bearing the expenses of indigo cultivation and increasing the possibility of competing with synthetic.

Thus, in one of the best worked and largest indigo concerns, after allowing for the profits from rabi crops, the actual cost of production of indigo has worked out recently at only Rs. 6 per maund, whilst it has been selling at Rs. 400 per maund or more. In fact, success in the future in competing with synthetic indigotin will depend as much on the increase in the profit from other crops by manurial treatment as from an increased yield of indigo itself."

Indigo Paste

One of the main reasons for the rapid success of synthetic indigotin was that the Germans made special efforts to meet the wants of the consumer. Natural indigo is a mixed product of ever varying composition, containing 40–70 per cent. of indigotin; it was necessary to have an analysis made of every chest at the time of sale, and it was sold in hard lumps which required a long and tedious grinding—often occupying a fortnight—to bring it to the necessary condition for use. Long before the manufacture of German indigotin, artificial alizarin had entirely superseded natural madder owing to the fact that whereas madder was a vegetable product of entirely inconstant value, alizarin could be supplied in paste form of definite guaranteed strength. The same principle was applied by the Germans to "Synthetic." It was sent out as a standardised paste containing 20 per cent. of indigotin, all ready for use; no grinding or mechanical preparation was necessary. Had the planters, when competition first began, put indigo on the market as a paste of standard strength natural indigo would probably not have been ruined. Prof. Armstrong had specially emphasised this point in his letter to the *Statesman*, and my first problem in India was to put on the market a stable paste of fixed composition comparable with the German.

Within a few weeks it was possible to send home a stabilised and standardised indigo paste. At this time, however, great difficulty was experienced in India in procuring suitable casks or drums, and the high shipping rate made it uneconomical to send home a material containing so much water—80 per cent. The inquiry was, therefore, continued in England and Mr. Reginald Brown undertook the task of grinding the cake indigo to paste, and stabilising the product. For the grinding, special machinery was soon found which enabled the cake to be reduced to a very fine paste form in a couple of hours, and stabilisation (the prevention of putrefactive changes) was ensured by the addition of a very small quantity of paranitraniline, which prevented the growth of fermentation organisms.

Natural indigo, in this form, possessed considerable advantages over the synthetic indigotin, particularly for woollen goods and heavy shades—it went much further than the synthetic material, and gave more agreeable tones and a fine bloom. The colour produced by the synthetic product has always lacked "soul." Natural indigo found a ready sale in this country, the quantity being limited only by the supplies of cake indigo which the planters were willing to send home; they were obtaining high prices in Japan.

The Attempt to Capture the Chinese Trade

It is a curious commentary on the old indigo industry that during 100 years' prosperity no attempt was made to capture the huge China market. In fact the existence of this market appeared generally unknown. Every man, woman and child in China wears an indigo-dyed garment. The Germans very soon realised the importance of this, and before the war China and Japan together took three-fifths of the whole of the synthetic indigo produced. The mass production so obtained by cheapening the product was undoubtedly the last nail in the coffin of Indian indigo. In January, 1918, I emphasised, in an article on the situation, the great importance of this, and wrote: "The prosperity of the Indian industry and its ability to compete with synthetic in the future will depend largely upon its being able to supply the Eastern markets. The British and American consumption is small by comparison."

Nothing was done, however, for nearly two years, although there was a good deal of talk. Towards the end of 1919, however, the newly formed Assam Indigo Company, of which I shall speak later, asked me to visit China and Japan on their behalf whilst I was returning home on short leave. I found that China and Japan wanted paste and paste only, and I ascertained their exact requirements. In 1920 and 1921 arrangements were made by Mr. Geoffrey Watson, of Moran and Co., the chief Indian indigo brokers, and the "Indian Marketing Agency, Ltd.," representing the Indigo planters of Bihar, to start making paste indigo in Calcutta for the Chinese market. A technical chemist was engaged by this organisation to direct the operations and the necessary machinery was obtained from home through Mr. Reginald Brown, for the purpose. This was the condition of affairs when I left India.

Development of the Business Organisation in India

In the old days one of the greatest difficulties the industry had to face was that the indigo sales were badly organised: in their endeavour to dispose of their indigo rapidly, so as to finance the next season's working, the planters cut each other's throats and sold their indigo in such a way that the market rapidly fell against them. A great step in advance was made by Mr. Geoffrey Watson in 1918-1919, when after many difficulties he was able to organise the majority of planters into a pool, by which the indigo sales were controlled and a fair selling price maintained. This pool of Bihar planters was known as the Indian Indigo Association, which in 1921 for trading purposes formed a separate company, the Indian Marketing Agency, Ltd. It was this company which undertook to prepare paste indigo in Calcutta.

The Introduction of Indigo Cultivation into Assam in Conjunction with Tea

When war broke out in 1914 and steps were taken to extend the cultivation in Bihar, the main difficulty was to obtain sufficient Java indigo seed. As already stated, soil deterioration in Bihar had reached such a pitch, that the plant, which had at first given seed abundantly, refused to give any on most estates or only a very small yield. Mr. Tunstall, Mycologist of the Tea Associati n, happened to be at Pusa in 1914. Hearing of the difficulty and having noticed that *wild indigo* grew most luxuriously in Assam, he obtained a small supply of seed and started growing indigo for seed. He found t at the Java indigo grew most luxuriantly,

and, what was then most important, gave extraordinary yields of very high quality seed—10·15 maunds per acre instead of $\frac{1}{2}$-2 maunds as in Bihar. He took up the cultivation of seed on the large scale, and other tea planters followed suit, and a very profitable indigo seed industry was developed which met all the wants of Bihar.

It was found that extraordinary yields of green plant were obtained—200·300 maunds an acre—as compared with 50-70 maunds at most Bihar factories—and the plant was unusually rich in indigotin. Encouraged by these results a small experimental factory was started at the Panchnoi Tea Estate in 1919, and this was shortly followed by the Assam Indigo Co., Ltd., a company formed to develop indigo on a larger scale. One of the assets of the natural indigo industry is that it gives a very large quantity of the highly valuable manure—seet—and this indigo seet has been found to be an ideal manure for tea (as it had been found to be for tobacco in Bihar). In this way a supply of manure for the tea crop—a very important question in Assam—could be very cheaply obtained and heavy outlay on artificial fertilisers avoided.

In my opinion the main hope of Indian indigo to combat synthetic indigotin lies in developing the production in unusually favourable yielding areas such as Assam. Bihar at the present time supplies only $\frac{1}{20}$th of the requirements of China and Japan and $\frac{1}{10}$th of the world's requirements. A sufficient increase in the production from Bihar seriously to stem the tide of the synthetic material is not to be anticipated even if suitable manuring were generally adopted, and progress in this direction is greatly handicapped by the present shortage and high cost of phosphatic manures, although the supply of these to Bihar planters has been organised by the Indian Marketing Agency. The area under indigo in Bihar has recently been diminished by agrarian difficulties in Champaran, and the spread of the more profitable sugar-cane cultivation. With a good extraction, the very high yields of fine plant in Assam should enable indigo to be produced at a price which could easily compete under natural conditions with synthetic.

The Débacle

I have dealt in this paper on very general issues only, and have neglected the many points of special interest to the scientific worker. These questions are fully dealt with in other papers, and a general review was given by Professor Armstrong at the Royal Society of Arts in 1922.

Up to a point everything appeared full of rosy promise, but in 1920 and 1921 the storm clouds which had been looming over India burst with all the violence of the typhoon. It is interesting that this storm had its origin in Bihar, the home of the indigo planter. In 1916 Mr. Gandhi first began operating in Bihar. When he first appeared on the scene, Mr. Morshead, the Commissioner of Tirhoot, realising the danger, issued an order excluding him from the province. Mr. Gandhi appealed to the Lieutenant-Governor, who revoked the Commissioner's decision. Mr. Gandhi was allowed to tour through the indigo districts of Bihar, where he—and more particularly his unscrupulous satellites—stirred up racial hatred and unrest. The Champaran inquiry followed which gave to Mr. Gandhi great prestige among his fellow Indians. Then came the massacre of Europeans in the Punjab, the Jallianwallahbagh incident, the cashiering of General Dyer (who, in the opinion of most Europeans, saved India from wholesale insurrection and massacre), and the introduction of the so-called "Reforms." We then saw all the disastrous effects of "putting new wine into old bottles"—the non-co-operation movement and its consequences.

The Government adopted the unprofitable and undignified course of attempting to placate the implacables. During 1920 and 1921 Bihar and Assam were in a very troubled state. In Bihar it became very difficult to obtain supplies of indigo plant and to work the factories; at many factories during the indigo season daily strikes occurred. Plant could not be grown or carted. Several factories were burned down by incendiaries and everything was in a state of uncertainty—even terror. Disaffection was stirred up in Assam also, and thousands of ignorant coolies were induced to desert the tea estates and return to their distant homes—often to perish miserably from starvation and disease on the way. The loss of the Russian market and the over-production of tea following the coarse-plucking introduced during the war led to a great slump in price, and the tea-planters for a year or two were selling their tea at a heavy loss.

The net result of all this was that in 1922—the year my agreement terminated—the Government of India was faced with a deficit which exceeded that of the previous year—which itself had constituted a record in the financial history of British India. Retrenchment became necessary; and not only was the indigo research abandoned but grants to the Indian Tea Association, to the Institute for Tropical Diseases, and other organisations were cut.

Before my agreement came to an end I had strongly recommended that the work be continued, as much still remained to be done; but in spite of this the Standing Finance Committee* stated that "it was the opinion of the Committee that sufficiently satisfactory results had been obtained by research in the past, and it was felt that the financial situation would not justify further retention of the officer." Strangest of all, the Hon. Member for Agriculture, in the Legislative Assembly,† after expressing thanks to me, announced: "We gave him notice the moment we found that his services were no longer required, and he himself informed the Government of India that he thought there was no necessity for any further research in that particular line. Therefore the House will note that officers are not anxious to continue a day longer than they think it necessary for their particular purposes, especially when they are engaged for special periods. (Hear, hear.)"

The statement here made that "I thought there was no necessity for any further research" is completely false. In my final report to the Government

* Report in the *Statesman*, February 1, 1922.

† Reports of the Debate of the Legislative Assembly held March 17, 1922.

of India I had strongly recommended continuance of the work in the following concluding words: "Much, however, still remains to be done. I would therefore recommend the continuance of the scientific work on indigo for a period of at least another five years. I feel sure that such extension will give an ample return to the country for the outlay incurred. Much of the spade work has been done, the benefit of which will be lost unless the work be carried through to completion."

How these words can be interpreted in the sense given above can be understood only by those acquainted with the subtleties of the Eastern mind.

When the news of the proposed abandonment of the indigo work was cabled home a vigorous attempt was made—without success—to move the Indian Government to reconsider its decision. On March 24 Prof. H. E. Armstrong put forward a powerful plea in a paper read at the Society of Arts, at which Sir Thomas Holland, who presided, stated that he "believed there were even good financial reasons for continuing the research work, at any rate for some years to come. To stop the work at its present stage, when the foundation facts had been established and results of direct commercial value were beginning to be available, would mean the waste of money already well spent. . . . The expenditure involved seemed to him almost negligible compared with that required for, say, a new University for the small city of Delhi, for which the Government had just placed a bill before the Central Legislature.

"On the facts it appeared that there had been a misunderstanding of a kind that proper representation should remove, and it would be for the benefit of India if the discussion of the meeting that evening helped the Government to reopen the question afresh."

Prof. H. E. Armstrong, in an eloquent appeal, after summarising all the facts, stated as his opinion: "Now I am prepared to affirm with far greater emphasis my belief in a secure future for indigo. My object has been to make clear the immensity and importance of the problems before us in agriculture, especially in connexion with leguminous crops. In view of their magnitude, it is the most serious reflection possible upon our intelligence that an industry, peculiar to the East, and particularly to India, undoubtedly in principle the root industry of its agriculture, of a lineage than which none is more ancient, should have no proper recognition and support. Agriculture is the chief industry of the country, yet it is to be deprived of scientific aid when it is in sorest need of help. . . . Opportunities lost are not regained. To interrupt the investigation at the present stage is an act nothing short of madness."

Nothing that could be done, however, had any effect in leading to a change of view on the part of the Government of India. The indigo work was abandoned, and the industry cut adrift. In concluding this brief account—one chapter only of the big story of indigo—I cannot do better than quote the words with which Prof. Armstrong opened his address at the Royal Society of Arts in 1922:—

"When the task was undertaken I had in mind the composition of a triumphal march, not of a dirge. Now I am overwhelmed by it, and have difficulty in joining a just measure of joy with my grief. The pen of a Gibbon alone could write the oration proper to the funeral at which we are met—for such it is. The work is to be discontinued, though the inquiry has been most fruitful from the beginning and is of the greatest public consequence.

"I would that the disease to which the patient succumbs could be diagnosed as the mere impecuniosity of the times; I fear it is far more grave and deep-seated—nothing short of general apathy and inability to appreciate the issues at stake, the need and value of acumen and understanding in agriculture. Yet agriculture, of all Indian industries, is beyond compare the most important; that in which considered, constant attention is most required. Indigo does not concern a few British planters alone; the problems underlying the successful cultivation of the plant are those of agriculture generally."

A STUDY OF THE DESTRUCTIVE DISTILLATION OF COAL

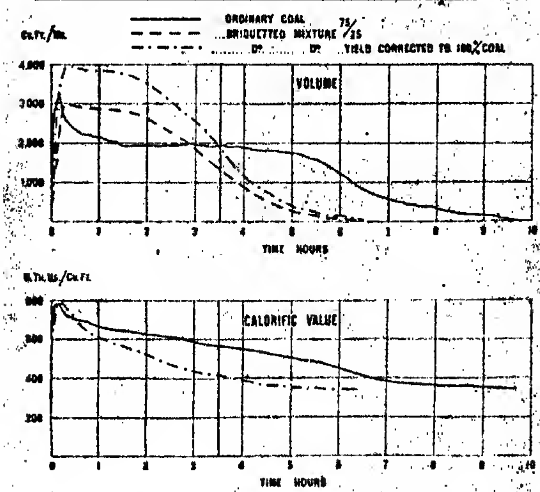
In the last of the series of Cantor Lectures delivered at the Royal Society of Arts on March 10 Mr. E. V. Evans described his ideas of what may take place when ordinary coal is undergoing carbonisation. It is conceived that the outer crust of the coal charge is rapidly transformed into coke even while some of the pieces of coal in the centre of the charge retain their identity. The slow transmission of heat into the centre of the charge is due to the cellular nature of the carbonised mass which results from the fusion of the resinous constituents of the coal. The way in which the plastic zone, which is indicative of this fusion, may gradually converge upon the centre of the charge, was depicted by means of a series of lantern slides. The formation of the plastic layer may be avoided, or at least very materially reduced, by admixing an inert absorbent material such as coke with the coal, and it was demonstrated experimentally that such a procedure enables a large increase in the rate of gas evolution from coal undergoing carbonisation to be obtained. The curves reproduced show the volume and calorific value of the gas obtained in the carbonisation of ordinary coal and of the same coal mixed with coke and briquetted without a binder. The carbonising process is accelerated to such an extent that the whole of the gas is expelled from the briquettes in 6½ hours as compared with 9½ hours for untreated coal. Thus even after allowing for the inert matter introduced into the retort there is an increase in the throughput of coal.

The laboratory investigations described in the previous lecture indicated that the yield of volatile products should be enhanced by such a process which involved more rapid carbonisation, and results of tests upon some 30 tons of briquettes were given to show that this was realised. Whilst an ordinary Durham coal gave 74·7 therms of gas and 10·1 therms of tar per ton, the same coal after being

briquetted with coke gave from 68·2 to 71·1 therms of gas and from 31·0 to 27·5 therms of tar per ton of coal.

After demonstrating the different nature of the solid residue resulting from the carbonisation of briquettes and that the formation of a plastic layer was in fact avoided, the lecturer put forward a hypothesis to explain why the enhanced yields of

VOLUME & CALORIFIC VALUE CURVES OBTAINED IN THE CARBONISATION OF ORDINARY COAL & BRIQUETTED COAL COKE MIXTURE 75/25



tar were obtained. The larger cells of normal coke require a considerable amount of binding material which is not required by the small-celled coke resulting from the carbonisation of briquettes. It is conceived that the pa ent substance from which the binding material originates is distilled away under the influence of more rapid heating and is the source of the higher yield of volatile products. Herein may lie the explanation of why many laboratory tests, such, for example, as the determination of volatile matter in a platinum crucible, fail to indicate the suitability of coals for carbonisation.

Briquette carbonisation makes possible the blending of coal prior to its being charged into the retorts, and the gas industry may in future put on the market a solid as well as a gaseous fuel of constant quality. Furthermore, there is the advantage that if a charge of briquettes is withdrawn from the retort after 3½ hours of normal high-temperature carbonisation there remains 5·6 per cent. of volatile matter in the coke and this is distributed uniformly throughout the mass. There is no central core of friable material such as results from the partial carbonisation of ordinary coal. The business of the gas industry may thus expand in the direction of providing a smokeless fuel suitable for general domestic use. In this connexion the removal of ash from the coal becomes a question of some importance, and the several types of process for [illegible]

FORTHCOMING EVENTS

Mar. 22. Royal Institution of Great Britain, 21, Albemarle Street, W. 1, at 3 p.m. "Properties of Gases in Vacua," by Prof. Sir E. Rutherford. *Also on March 29, at 3 p.m.*

Mar. 24. Institution of Mechanical Engineers, Storey's Gate, S.W. 1, at 7 p.m. Informal discussion on "Failure in Metals."

Mar. 24. Royal Society of Arts, (Cobb Lecture), John Street, Adelphi, W.C. 2, at 8 p.m. "Certain Fundamental Problems in Photography" (Lecture I.), by Dr. T. Slater Price.

Mar. 26. Society of Chemical Industry, *Nottingham Section.* Annual Meeting, followed by an ordinary meeting, at which papers will be read by the late J. M. Wilkie and collaborators.

Mar. 26. Royal Society of Arts, at 8 p.m. "The Fishing Industry and its By-Products," by N. Green.

Mar. 26. Royal Microscopical Society, 20, Hanover Square, London, W. 1. Dr. Stephen Miall will preside. (1) "Methods of Mass-Production in Sectioning Flax Stems," by G. O. Searle. (2) "Microscopical Metallurgy," by Dr. H. Wrighton, D.Met., (3) Lecture Demonstration on "Technical Microscopy." No. 4, by J. E. Barnard.

Mar. 27. The Chemical Society. Annual General Meeting, Burlington House, Piccadilly, W. 1, at 4 p.m. Address by Prof. W. P. Wynne, D.Sc., F.R.S. An Informal Dinner will be held at the Hotel Cecil, Strand, W.C. 2, the same evening, at 7 for 7.30 p.m.

Mar. 28. Society of Chemical Industry, *Chemical Engineering Group*, the Lecture Theatre of the Institution of Civil Engineers, Great George Street, S.W. 1, at 6 p.m. "Kinetic Elutriation," by L. Andrews.

Mar. 28. Royal Institution of Great Britain, 21, Albemarle Street, W. 1, at 9 p.m. "Insulin," by Dr. H. Maclean.

Mar. 28. Society of Chemical Industry, *South Wales Section*, the Technical College, Mount Pleasant, Swansea, at 7.15 p.m. Annual Meeting, addressed by Capt. H. Vivian. "Notes on the History of Copper Smelting in Swansea."

Mar. 28. Society of Chemical Industry (*Newcastle Section*), Newcastle Chemical Industry Club, and Institute of Chemistry (*Newcastle and N.E Coast Section*). Joint Dinner to be held at Tilley's, Blackett Street, Newcastle, at 7.30 p.m. Chair to be taken by Prof. Henry Louis.

Apr. 7. London Section, at Royal Institution, 21, Albemarle Street, W. 1, at 8. Prof. H. E. Armstrong, F.R.S., will deliver an address on "Sir James Dewar as an Experimentalist," with demonstrations.

Note.—Owing to an error in setting up the type of the meeting of the Birmingham Section of the Society of Chemical Industry, held on March 18, the paper read at that meeting on "The Relation of the Theobromine Content of Cacao to its Fermentation," was included under the notice of the Birmingham Section of the Institute of Metals.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

PATRON: H.M. THE KING

PRELIMINARY NOTICE

The Annual Meetings of the Society will be held in Liverpool from Wednesday, July 9, 1924, until Saturday, the 12th inclusive.

His Majesty the King has been graciously pleased to grant his Patronage to the Meeting.

The Presidential Address will be delivered by Dr. E. F. Armstrong, F.R.S., and the Messel Lecture will be given by the Rt. Hon. Viscount Leverhulme.

A limited number of technical papers will be read, and there will be visits to at least two large works in the neighbourhood.

A very interesting programme is being arranged by the Local Committee under the Chairmanship of Mr. Edwin Thompson, who was largely responsible for the great success of the British Association meeting in September last.

Whilst the business and technical side will be adequately represented in the programme, arrangements will be made to make the meeting an attractive social event.

It is hoped that many of the Society's overseas members who are coming to this country to visit the British Empire Exhibition will arrange their visit so that it may be possible for them to be present at the Society's Annual gathering.

Further particulars will be intimated shortly.

MEETING OF COUNCIL

The monthly meeting of Council was held on March 14, 1924, the President, Dr. E. F. Armstrong, F.R.S., in the chair.

The President brought forward consideration of the proposed arrangement between the British Dyestuffs Corporation and the Interessen Gemeinschaft, and after some discussion it was agreed to leave it to the Federal Council for Pure and Applied Chemistry to take any action in the matter.

A second grant of £250 was made towards the cost of the Scientific Exhibit at the British Empire Exhibition, 1924.

A preliminary programme of the Annual General Meeting to be held in Liverpool on July 9 to 12 next, was submitted.

It was reported that Mr. F. E. Dickie has resigned the Honorary Secretaryship of the Shawinigan Falls Section of the Society, but the name of his successor has not yet been received.

Mr. Charles E. Munroe, Chairman of the National Research Council, Washington, D.C., and Mr. W. Alan Gibbings, of Cheltenham, will attend the Annual Meeting of the American Chemical Society, to be held in Washington in April, as delegates from the Society of Chemical Industry.

Mr. W. F. Reid was nominated as delegate from the Society to the Kelvin Centenary Celebrations, which will be held in London on July 10 and 11; and Mr. E. V. Evans was nominated the Society's representative at the Jubilee Celebrations of the Physical Society, which will take place in London on March 2[illegible] to 22. It was decided to send an Address of Congratulation to the Physical Society.

Reports of various Committees of the Council were submitted, and 27 new members were elected: Home, 20; Overseas, 7.

The next meeting will be held on Friday, April 1[illegible], 1924, at 2.30 p.m.

OFFICIAL NOTICE

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The eighth volume of these Reports, covering the year 1923, is now ready. The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members. Vol. I is out of print, but copies of Vols. II, III, IV, V, VI, and VII may be obtained by members at 4s. 6d., 5s. 6d., 5s. 6d., 8s. 3d., 7s. 6d., and 7s. 6d., and by non-members at 7s. 6d., 10s. 6d., 12s. 6d., 15s., 12s. 6d., and 12s. 6d. respectively.

If Vols. II, III, IV, V, VI, and VII are ordered at the same time as Vol. VIII, the set may be obtained by members for £2 2s. 6d., and by non-members for £3 15s.

The appropriate remittance must accompany every order. The books are sent to purchasers post free.

LIST OF MEMBERS ELECTED, March 14, 1924

Beeson, John B., 121, City Road, Chester Green, Derby. Chemical Plant Draughtsman.

Bennett, Miss Hilda, 423, Addison House, Grove End Road, London, N.W. 8. Analytical Chemist.

Benton, William A., 91, Allen Road, Wolverhampton. Technical Adviser.

Brierley, John P., Heath Cottage, Daryl Road, Heswall, Cheshire. Analytical Chemist.

Butterfield, Henry H., 95, King's Avenue, Watford, Herts. Analytical and Manufacturing Chemist.

Carson, Samuel D., 184, Main Road, Handsworth, Sheffield. Chemist.

Dutton, Charles F., Powell Duffryn Buildings, Cardiff. Salesman.

Flett, Thomas, Anchor Cottage, Kirkwall, Orkney. Chemist.

Gabriel, Charles L., Commercial Solvents Corpn., Terre Haute, Ind., U.S.A. Chemical Engineer.

Galley, John V., c/o Imperial Trading Co., 275, Craig Street W., Montreal, Canada. Chemical Importer.

Gracie, David S., School of Agriculture, Reaseheath, Nantwich. Lecturer.

Jones, Walter B., The United Steel Cos., Ltd., Rother Vale Collieries Branch, Treeton, nr. Rotherham. Director.

Kieser, Miss Margaret E., 42, Ravenswood Road, Redland, Bristol. Technical Chemist.

McConnachie, William, Coltness Iron Works, Newmains, Lanarkshire. Chemist.

Morgan, Harold M., 48, Spelman Street, London, E. 1. Pharmaceutical Chemist.

Murphy, Harold N., 57, Palmerston Road, Sheen, London, S.W. 14. Manufacturing Chemist.

(To be continued.)

SOUTH WALES SECTION

At the meeting at Swansea on February 15 a joint paper on "The Increasing Use of Physical Methods for Purposes of Control," by Messrs. L. Taverner and H. J. Williams, was read by the latter.

Until comparatively recently analytical methods of control only had been used in the production of finished metals for various purposes. Such methods enabled the production of metal of chemical composition, fitting it for the desired use, and the composition thus obtained would persist. Subsequent alterations would be of physical, not chemical, nature, necessitating physical methods of control during manufacture. Earlier attempts at this—bend, drift and welding tests for wrought iron and steel—with the more modern mechanical tests called for by engineers—were applied to finished metals to ensure that these had the desired properties, and were in no sense "control methods." Other methods had to be sought, originally to explain failures, the microscope being the first aid in this direction. Accurate temperature measurement was necessary for the work carried out by Roberts-Austen for the Institution of Mechanical Engineers, and this led finally to the adoption of Le Chatelier's thermocouple, which, combined with a recording device, rendered accurate temperature measurements, and records, possible. Previously, other forms of pyrometer—Wedgwood's, Siemens, Carnelly's—had been used; almost every physical property had been utilised for high-temperature measurement.

Workers turned first to iron and steel, and Hadfield's observation that 1·16 per cent. carbon steel could not be hardened below Barrett's "recalescence point," but, hardened from 15° C. higher, was glass hard—a difference no worker, however skilled, could detect without instrumental aid—led to a demand for pyrometers, which had persisted, until now these instruments were almost universally used. Instances were quoted of the detection of causes of failure by means of the microscope, which also indicated the remedy, for the application of which pyrometers were necessary. Examples of the application of "macrography" were also dealt with, and the various methods of determining hardness discussed, together with the modern methods of fatigue test, and the application of X rays.

At the conclusion a number of lantern-slides was shown, exhibiting, among other things, the extreme ease with which the change in properties of steel with increasing temperature can be followed by the aid of the microscope, and also some typical cases of failures in steel, the cause of which was, at once evident on microscopical examination.

At the meeting at University College, Swansea, on March 14, Mr. J. R. Green read a paper on "Suggestions for Spectrum Analysis in Works Laboratories." Prof. J. E. Coates, O.B.E., D.Sc., who was in the chair, explained that owing to the inability of another member to give his expected paper Mr. Green had made up the deficiency at short notice.

The lecturer gave a short summary of the work of W. N. Hartley, and of Pollok and Leonard, on spark spectra of metallic solutions. They found that spectra of dilute solutions were always much simpler (containing fewer lines) than those of concentrated ones, but the fact that they used solutions and worked with spark spectra limited the usefulness of their results. A. de Gramont had greatly extended this work, and had found that as the relative proportion of an element (usually metallic) in a substance decreased, there were always certain definite lines which were the last to disappear. These he had called the "raies ultimes," and they lay usually in the ultra-violet, so that they could not be photographed by attaching a camera to the usual spectroscope with glass lenses and prism.

There were usually, however, a number of sensitive lines in the visible spectrum of a metal, and the copper arc was used to show those of the copper spectrum; this fact rendered it possible to use a direct-vision spectroscope, in conjunction with a camera, as a spectrograph. It was preferable to use a replica diffraction grating to obtain the spectrum, as it gave much higher dispersion, and the wave-length scale was more even. The construction of a simple spectrograph, using a grating replica, was shortly described, and a number of lantern slides of spectrograms taken on it were projected to show the sensitive lines of iron, tin, lead, zinc, copper, nickel, and sodium.

Very fair quantitative results could be obtained by comparing the intensities of lines with the intensities of the same lines in spectrograms, taken under the same conditions, of similar substances (*e.g.*, alloys) of known composition. The rapid estimation of traces of impurities in this manner was often of the greatest value in a works laboratory. Hill and Luckey had shown that lead could be estimated in a couple of minutes or so in copper, by measuring the time for the violet line (4058 Å.U.) to vanish or to be reduced to a given intensity, using a button of copper, 0·4 g. in weight, in the positive crater of a carbon arc. The lecture concluded with a demonstration of the taking of a spectrogram of some tin of unknown purity, using the grating spectrograph described, and pure tin as comparison substance. The sample was found to contain iron, estimated at 0·25 per cent.

There was a short discussion, and the meeting terminated with a vote of thanks to Mr. Green.

NOTTINGHAM SECTION

At a meeting on March 12, Mr. G. J. Ward, of the Stanton Iron Works, read a paper entitled "The Effect of Centrifugal Action on Concrete."

If a concrete mixture be put into a cylindrical mould and the mould be rapidly rotated about its axis, the concrete will be forced towards the periphery of the mould and will form a lining to it. If the spinning be continued long enough the concrete will retain its form after the mould is brought to rest. Hence the use of this process in the manufacture of pipes. A speed of about two feet per second is maintained during filling of the mould, but an increased speed causes the larger and heavier particles to move outwards. This movement obeys the same laws as those governing the settling of particles in

water. The limiting velocity of large and small particles settling together is given by $K\sqrt{D(d-1)}$ where D is the diameter of the particle in inches. d its specific gravity, and K a constant of value 0·16. At the end of three minutes' spinning, the aggregate was well packed and the inner lining was solidified. Excess water is swept out from the bottom, and a polishing bar passed through while the mould is revolving again for another minute. The pipe is then left for 10 hours in an atmosphere of steam at 90° F. and is then removed to the stockyard for further maturing. The author considers that the spinning set is almost entirely a physical and not a chemical effect. Methods were then given for the determination of the right proportions of aggregate, sand and cement, and also for measuring the strength of the resultant concrete. A number of slides were shown illustrating both the theoretical and practical sides of the process.

During the discussion Mr. Droop Richmond asked if the sole object of the aggregate (granite) was for hardening the outside surface, and also if the formula $\sqrt[3]{D(d-1)}$ would not be more approximate. Mr. Burford enquired as to the composition of the framework for the original mould. With respect to the chemical change involved in the setting of the concrete, would not heat be generated giving rise to expansion? Was it necessary to have an approximate chemical formula for the concrete at the finish? Mr. Gray asked if there was any relationship between the bursting strengths of spun and ordinary concrete. Mr. Pentecost enquired as to the method of introduction of the concrete into the mould; was it weighed or measured?

In reply Mr. Ward stated that the outside surface of the pipe was hard even without granite; the chief use of the aggregate, however, was to fill the interstices, and thus economise in the amount of cement necessary. With reference to the formula $K=\sqrt{D(d-1)}$, although this was empirical, it was approximately correct, and was found to give good results when used in connexion with coal washing. There would possibly be a slight increase in the temperature on setting of the concrete, but any expansion caused thereby would hardly be noticeable owing to the same amount of expansion in the mould, as steel and concrete possessed about the same coefficient of expansion. In resistance to external stresses, spun concrete was certainly stronger than ordinary concrete. The concrete was shovelled into the revolving mould, and the amount was gauged fairly accurately by noticing the thickness. A chemical formula was not involved in the setting of the concrete.

GLASGOW SECTION

The meeting held in the Institute of Engineers and Shipbuilders, on March 11, was presided over by Mr. W. E. Moodie, Chairman of the Section, and two papers were read.

The first paper was on "Modifications of Laboratory Apparatus," by Prof. T. S. Patterson, D.Sc., Ph.D., in which a descriptive account was given of (1) an extractor; (2) a receiver for distillation under reduced pressure for very small quantities of distillate; (3) a modified internal condenser which allowed of substances being introduced into the flask without removal; (4) an absorber; (5) an improved type of sodium press with increased number of holes; and (6) a convenient form of reaction chamber and pressure-equalising dropping funnel. The speaker said that these various forms had been evolved from time to time to replace or modify forms at that time in use which had been found in many ways to be lacking: he had thought that as they had proved so useful, many members might possibly find them of use also.

Prof. Patterson was warmly thanked, on the motion of the Chairman, for his paper and for the trouble of exhibiting the forms described.

Mr. T. C. Mitchell then read a summary of a paper on "The Electrical Conductivity of Solutions of Double-Salts," which had gained the award for him of the Student Associate Prize of the Glasgow Section; he showed how this was a logical continuation in its way of the work of Caven and Ferguson; they had examined in solid form the resistance to dissociation of various double-salts to heat: he himself had examined their resistance to dissociation in fluid medium to dilution. Pure salts were used and the following types were examined:—

I. The electrical conductivity of solutions of $CuSO_4$, $CoSO_4$, $ZnSO_4$, $NiSO_4$, K_2SO_4 and $(NH_4)_2SO_4$.

II. The conductivity of equimolar solutions of $CuSO_4$ and $ZnSO_4$ mixed. This was found to approximate within experimental error to the mean of those observed in the simple systems. This was taken as the type of non-double-salt-forming system.

III. The conductivity of solutions of salts RSO_4, $M_2SO_4.xH_2O$, where R=Cu, Co, Zn, or Ni, and M=K or (NH_4).

In conclusion, Mr. Mitchell said that it was very difficult to generalise from the results obtained, but, if anything could be said, he might state that in every case examined the observed conductivity of the double salt was less than that calculated by taking the mean of those of the equimolar solutions, and this difference he had expressed in percentages on the basis of the mean calculated result: he called this the percentage difference. This indicated that the salts had not been completely dissociated at the dilutions examined. With the Cu and Co salts, this percentage difference, at any given dilution, was greater in the case of complexes with K than with NH_4, but this was reversed in the case of Ni and Zn salts. Further investigation was therefore desirable. The Cu salts showed a unique lack of dissociation with dilution, adding one more interesting example of the curious behaviour of this radicle in this series.

Mr. Mitchell was complimented on his paper and cordially thanked for his summary of it.

A discussion was then opened by Mr. Gilbert Gunn on "The Use of Pulverised Fuel for Boiler Heating." A short historical account was given by the speaker, who then described the modern construction of suitable furnaces. He described difficulties he had

encountered, and hoped that the discussion would clear up some of these difficulties. An exceedingly vigorous discussion followed, in which several members took part. Mr. Gunn was thanked for his contribution to the discussion.

ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS

The monthly meeting of the Council was held on March 13, Sir William Pearce presiding in the absence of the Chairman through illness. The Council considered a request from the Chemical Society for financial support towards the upkeep of the Library, and after receiving a report on the working during the past year agreed to give a donation of £250. The Society must not take this as a precedent, and the donation is made on the understanding that members of the Association are at liberty to make use of the Library through their accredited representatives.

The General Manager presented a report dealing with the arrangements in connexion with the Chemical Section of the British Empire Exhibition and with regard to the scientific exhibit said that already £4206 10s. had been subscribed towards the cost thereof. A further £1800 is still required. The arrangements for the publication of the technical volume entitled "Chemistry in the XXth Century" are well in hand.

A letter was received from the New Zealand and South Seas Exhibition Company, Ltd., giving notice that an Exhibition of the World's Arts, Products and Manufactures will be held in the City of Dunedin, New Zealand, during 1925-1926, the opening date being approximately November 1, 1925. The Council decided that the Association as such could not participate in the Exhibition.

Various routine matters were also dealt with.

SOCIETY OF PUBLIC ANALYSTS

An ordinary meeting was held in the Chemical Society's Rooms on March 5, Mr. G. Rudd Thompson in the chair, and five papers were read.

I—"The Composition of Beef and Malt Wine" was discussed by G. D. Elsdon, B.Sc., who described a recent case of adulteration of beef and malt wine. He gave the composition of various extracts of beef and malt, including those taken from previously published works, and those obtained under ordinary commercial conditions, and examined by himself. A number of analyses of wine likely to be used in the preparation of beef and malt wines were also given, and a standard was suggested which all commercial samples of such tonic wines should reach. Finally, fairly complete analyses of a number of commercial tonic wines were detailed.

II—A paper on the "Effect of Fatty Diet on the Composition of Butter Fat" was presented by Prof. J. C. Drummond, D.Sc., and H. J. Channon, B.A., B.Sc. Cows were given, as a supplement to a fixed basal ration of a very low fat content, coconut, arachis and cod-liver oils in amounts varying from 2 to 8 oz. per day for periods up to 35 days. At intervals samples of butter fat from the milk of individual cows, were examined for Reichert-Wollney, saponification and iodine values, refractive index and vitamin A content. Curves showing the rise and fall in these values show marked similarity in the different cows, and would appear to indicate definite passage of the oils to the butter. The percentage of total fat showed a distinct fall during the cod-liver oil feeding, but whether this is due to a specific effect of the oil or to the advancement of the period of lactation, is uncertain. The vitamin A value rose markedly during this period. Attempts to make a quantitative study of the effect of the oil feeding on the composition of the butter fat, by fractional distillation of the methyl esters of the fatty acids, failed. The technical difficulties of fractionating esters of a series of acids so closely related, appears too great for the method to be of any use in quantitative work. The majority of recorded analyses of butter fat, particularly those in which the percentage of each fatty acid is given to one or more places of decimals, are regarded as of doubtful value.

III—Mr. G. D. Elsdon, B.Sc., read a paper entitled, "What is Bondon Cheese?", in which he reviewed the evidence with regard to the composition of Bondon cheese. The opinion was stated that a Bondon cheese should be a whole milk cheese, and should therefore contain at least 20 per cent. of fat. Objection was taken to the pleading of "Trade Custom" in prosecutions under the Sale of Food and Drugs Act, merely because possible adulteration has been carried on unchecked for a number of years.

IV—"Cream Cheese" was the title of a paper by T. R. Hodgson, M.A., who objected to the standard of 20 per cent. of fat in cream cheese proposed to be set up in the recent legal proceedings instituted by the Holborn Borough Council because it did not take into account the composition of the original milk from which the cream cheese was made; the suggestion was made that in any similar prosecution, the vendor should be charged with selling cream cheese made from a milk partially deprived of its fat; an appeal from such an information would have to be taken to the High Court of Justice instead of to the Quarter Sessions, and the decision of the High Court would, of course, be binding on the whole country, whereas the decision of the London Quarter Sessions is binding on London only.

V—"Some Facts on the Composition and Decomposition of Eggs" were detailed by R. J. Thomson, F.I.C., and James Sorley, F.I.C. Contrary to Jean's statement, the fat could be completely extracted from dried egg yolk by any of the three solvents—petroleum spirit, ether or chloroform. A small proportion of any boric acid present was simultaneously extracted by petroleum spirit or ether. Repeated extraction with ether, in a separator, of yolk diluted with water removed all the fat, but petroleum spirit extracted only a small fraction of it. The yolk of a recently lai hen's egg contained 0·59 per cent. of free fatty aci (1·72 per cent. of the fat) and 4·28 per cent. of ur saponifiable matter. It was shown that extractio with petroleum spirit removed only a small percentag

of the unsaponifiable matter from the yolk. The constants of the fat from the yolks of hen's and duck's eggs, and from preserved Chinese hen's egg yolks were given, the last being characterised by high acid values. Decomposition of egg yolk was accompanied by a gradual rise in the acid value of the fat.

BIOCHEMICAL SOCIETY

The Annual General Meeting was held at the Lister Institute on March 10, and the following papers were read :—

"Studies in Phosphorus Metabolism. I. The Effect of Insulin on the Phosphoric Esters in Blood and Muscle," by H. D. Kay and R. Robison. During an investigation of the "acid-soluble" phosphorus in blood, muscle and other tissues, it was found that the amount of readily hydrolysable organically bound phosphate contained in muscle was markedly increased (15 per cent. to 25 per cent. increase on the normal amount) when insulin had been given to a rabbit, if the animal was killed at, or just before, the onset of convulsions. Two methods have been employed. The first entails the use of a preparation of an enzyme present in bone which readily hydrolyses phosphoric esters; the second consists in a modification of Embden's "lactacidogen" determination. Results by both methods agree. Accepting the statement made some years ago by Embden and his collaborators that the main phosphoric ester present in muscle is a hexose phosphoric ester, the discovery of a definite increase in this substance after insulin affords a probable explanation of the fate of the sugar which disappears from the blood, and which, it is known, is neither transformed into glycogen nor fat. The increase in organically bound phosphorus ("lactacidogen") actually found accounts for about three times the amount of sugar which disappears from the blood. This does not take into account any mobilisation of sugar from glycogen or other reserves. These results agree with those just published in abstract by Wagner and Andova who, using a slightly different method, find about the same increase in "lactacidogen" after insulin.

"A Method for Investigating Calcium and Phosphorus Metabolism in Rats" was described by A. Boas. In determining retention of calcium and phosphorus the metabolism cages of Hopkins and Ackroyd were used. The calcium and phosphorus were estimated in (1) the total food offered, (2) the uneaten food and urine and faeces, the difference being the amount retained. Estimations of calcium were made by McCrudden's method, the phosphorus by Neumann's method, after calcining the material in a porcelain crucible in a small furnace specially designed for the purpose by Prof. C. J. Martin.

M. A. Boas and H. Chick read a paper on the "Influence of Diet and Management of the Cow upon the Calcium and Phosphorus Retention of Rats fed upon the Milk." The samples of milk tested by Luce were also investigated for value in inducing retention of calcium and phosphorus in young growing rats by metabolic experiments lasting four-six weeks. The results were in accordance with those obtained by Luce. The milk was fed in daily doses of 15 c.c. as supplement to a diet lacking in fat-soluble vitamins. Rats receiving milk taken from the cow when in the dark stall on dry fodder or on fresh green fodder showed retention of calcium markedly below normal, the phosphorus retention being less affected. Rats receiving the same dose of milk from the same cow when pasture fed in summer showed normal retention of calcium and phosphorus.

Mr. E. M. Luce discussed the "Variations in Growth-promoting and Anti-rachitic Value of Milk from the same Cow kept under varying Conditions of Light and Diet." A cow was maintained for a period of about 18 months under strictly controlled conditions of diet and light, following upon several months of pasture-feeding.

(1.) July-October, 1922. Dry fodder, poor in fat-soluble vitamin (maize and gluten meal, crushed oats and barley, mangolds, chaff, and barley-straw), the cow remaining out-of-doors on a ploughed paddock.

(2.) November, 1922-May, 1923. Cow placed in a completely dark stall, diet being unaltered.

(3.) May, 1923-July, 1923. Diet of fresh meadow grass and clover, the cow remaining in a dark stall.

(4.) August, 1923-October, 1923. Pasture feeding.

The milk given at the end of Periods 1-4 respectively was tested for :—(1) Growth-promoting value (using rats); (2) power of inducing calcium deposition; (3) anti-rachitic value, by determining the daily dose required to prevent rickets in young rats receiving McCollum's rickets-producing diet, deficient in fat-soluble vitamin and in phosphorus.

The milk from Period 4 was found to possess all three properties in a high degree, a daily dose of 3-5 c.c. restoring growth and also preventing rickets; that from Period 3 was intermediate, whilst milk taken from the end of Period 2 was most deficient in all respects, doses up to 20 c.c. proving less efficient than pasture-fed milk. The results showed conclusively that summer milk from a pasture-fed cow possesses specific value for prevention of rickets in a high degree, also that wide variations in the growth-promoting and anti-rachitic power of milk from the same cow can be induced by alterations in diet and management of the animal.

PARLIAMENTARY NEWS

Nitrogen Fixation

Mr. S. Walsh, replying to Mr. Hayday and Major Moulton, said he was aware that the French Government had recently concluded an agreement with the Badische Anilin und Soda Fabrik for the exploitation of methods of manufacturing synthetic ammonia. His attention had also been called to the acquisition by the French Government of the patents and technical information necessary for the production of nitrates by the Haber-Bosch process with a view to the production of nitrates on a large scale in France. Similar steps had been taken by the British Government in conjunction with a British firm.—(May 11.)

CORRESPONDENCE

THE ENGLISH LANGUAGE

SIR,—The importance of the correct and effective use of our own language is being more and more recognised by most professional men in this country, especially by chemists and engineers. Hence I may perhaps be allowed to make a few comments on this subject, supplementary to the excellent editorial paragraph that appeared on p. 1225 in the December issue of this Journal last year. It seems to me somewhat of an inversion of the natural order of things that Englishmen should consult the book of an American author in order to learn how to write our common language correctly. The important task of producing a work of this kind was taken in hand many years ago by the Rev. Dr. E. A. Abbott, the well-known headmaster for several years of the City of London School, whose little two-shilling book, *How to Write Clearly* (Seeley) reduces the subject to short rules, followed by excellent examples and exercises. (Old City of London boys will be pleased to note that Dr. Abbott is still alive.) In the preface to the book the author observes: "Speeches in Parliament, newspaper narratives and articles, and, above all, resolutions at public meetings, furnish abundant instances of obscurity arising from the monotonous neglect of some dozen rules." Whether this strong indictment still holds good, I must leave present-day Members of Parliament, etc. to answer for themselves. One of the rules is as follows: "Do not introduce literal statement immediately after metaphor."

The first example given of neglect of this rule is of special interest to chemists. It runs thus: "He was the father of Chemistry, and brother to the Earl of Cork."

The gentleman here referred to is doubtless the Hon. Robert Boyle, who was the fourteenth child and youngest son of the first (the "great") Earl of Cork, and is known to all of us as the discoverer of the fundamental law connecting the volume and pressure of a gas. He was also the founder of the "Boyle Lectures." The Hon. Robert Boyle was buried in the Church of St. Martin's-in-the-Fields, Trafalgar Square, but whether the above formed part of an epitaph I have not been able to discover.—I am, Sir, etc., A. E. JOHNSON

24 Parkdale,
Wolverhampton

THE EPILATION OF SKINS

SIR,—In reply to Dr. Ross's letter in your issue of March 7, I propose to leave the question as to what are "howlers" to your readers.

With regard to my remarks about tanning, Dr. Ross ought to know that when we speak of tanning, we mean all the processes from the raw skin onwards, and as is well known, the preparatory processes are the most important part of the work. To quote a saying of the late Lord Allerton, "good leather is made before ever the skins go into the tan liquor."

I have not said that epilate is incorrect, but the use of the word by Dr. Ross is pedantic. The word depilate is in common use, as is also the word depilatory. As to the *direction* in which the hair is pulled out, I say nothing.

The reasons why I stated that Dr. Ross's results are not true are:—

(1) Thrombin, or thrombase, is not a proteoclastic enzyme, but a coagulating enzyme. See Hammarsten, "Physiological Chemistry," p. 299 *et seq.* Also Effront, 'Biochemical Catalysts," p. 33 *et seq.* There is no evidence that thrombin "digests the rigid insoluble protein fibrin," as stated by Dr. Ross.

(2) "Saproprotease" or bacterial trypsin, or bacterial tryptase, whichever term you prefer, exists in the soaks, but is not found in the limes, except in very small quantities. The reason for this is now evident from Collet's work, which I quoted, in which it is shown that the bacteria from the soaks are killed by the lime, and that the organisms which are always found in old limes are merely surviving.

In answer to Dr. Ross's request for the methods used in examining the limes for tryptic enzymes, I used Fermi's method ("Alte und neue Methode zum Nachweis der proteolytischen Enzyme, Centr. Blatt f. r Bakt." Bd. XVI., p. 176). See also Wood and Law, "Some Notes on the Enzymes concerned in the Bating and Puering Process" (*J.S.C.I.*, 1912, p. 1105), in which details of the method are described. The limes were tested both in their original condition, and also after careful neutralisation. No tryptic enzymes were found.

Dr. Ross's description of blood as a "chemical" will be new to most of us. In the tannery in which I am occupied we get rid of all the blood as thoroughly as possible, and yet the skins unhair.

Dr. Ross refers me to his experiments. In his paper he twice states that salt is an inhibitor, and having replaced a guinea pig's blood by saline solution, and so prevented unhairing action, he concludes that thrombin is the unhairing agent, because no unhairing occurred when the blood was replaced by the saline solution. I confess I cannot follow the logic of this deduction.—I am, Sir, etc.,

Nottingham JOSEPH T. WOOD

March 15, 1924

THE PROJECTED ANGLO-GERMAN DYE AGREEMENT

SIR,—By inadvertence the name of Mr. E. Ford Morris, M.I.Chem.E., Chairman of Council, was omitted from the list of members of the recent deputation to the Board of Trade on the British Dyestuffs Corporation and Interessen Gemeinschaft agreement.

I shall be extremely obliged if you will be so good as to inform your readers of the fact.—Yours faithfully, A. STEWART MILLS,

Assistant Secretary, the British Association of Chemists

London,
March 8, 1924

QUALIFICATION OF CHEMISTS

SIR,—May I be allowed to draw attention to an aspect of this question which is apt to be lost sight of. It has been the practice of public analysts generally (all Fellows of the Institute of Chemistry) to take youths in to be trained as analytical chemists. Sometimes a fee may be charged and in other cases a small wage may be paid, but this point is immaterial. At least one well known firm of public analysts, to my knowledge, makes no attempt to teach these students or apprentices any theory. Nor is it suggested that a youth on entering such an apprenticeship should endeavour to take a degree. Consequently they acquire a certain amount of skill in performing analytical operations, but the knowledge of chemistry which they possess depends on their own independent study, which must necessarily be done in their spare time. Under such circumstances I admit it is possible to take a degree, but it is extremely difficult. At least it was not done very often 15 or 20 years ago. Many men, however, did become qualified, both by study and practice, to hold the title chemist, yet hold no academic qualification.

Now the point I wish to make is this. The Institute of Chemistry, through its members, has trained hundreds, probably thousands of men in the above system. Many of the men so trained have held good positions and have done useful work as "Works Chemists." Now the Institute wants to turn its back on those men and deny them the right to call themselves chemists, and, as a consequence, prevent them from holding positions as such. Also, it is becoming increasingly difficult to obtain a good post, or a post of any kind, unless the applicant holds some academic qualification, or is an A.I.C. Experience comes second to other qualifications in many cases. I agree that the movement in this direction is inevitable and is also right; but what of the large body of "Unqualified Chemists" who have no hope now of obtaining the necessary qualification and who are greatly handicapped thereby?

Mr. Claremont in your issue of March 7 says:—"The Institute of Chemistry has already done much to open its portals to all *bona fide* chemists." How? I was not aware that one could enter the Institute except by examination. Continuing, he says:—"In the near future it may be hoped that all chemists worthy of the name will take these qualifications." Again I ask how is the man or 35 or 40 going to take these qualifications? Is the Institute going to let him in by the back door, or has he to turn to and spend several years' hard work to pass the necessary examinations, a task well nigh impossible to many quite experienced chemists? I agree that it is desirable that chemistry should be a closed profession, but before it is made so provision should be made for those who entered the profession before a degree was considered necessary.—I am, Sir, yours faithfully, "AN UNQUALIFIED CHEMIST"

Sir A. Duckham, who has been visiting the United States in connexion with questions of low-temperature carbonisation, has now returned to England.

PERSONAL AND OTHER NOTES

Duke M. de Broglie, the eminent physicist, who has done such valuable work on X-rays, molecular physics, etc., has been elected a member of the Académie des Sciences in the Section of Free Academicians by 36 out of 66 votes. The other candidate was the well-known chemist, Prof. A. Desgrez, who received 29 votes.

Sir Max Muspratt, Bart., has been appointed by the Association of British Chemical Manufacturers as one of its representatives on the Federal Council.

Dr. James Kenner, Senior Lecturer in Chemistry at Sheffield University, has been appointed Professor of Organic Chemistry at the University of Sydney. During the war Dr. Kenner was in charge of the big gas station at Calais, being responsible for almost the whole of the phosgene gas used by the British Army in France. He has been at Sheffield University for 14 years, and has carried out many researches in organic chemistry.

Count L. M. H. de Chardonnet, who has died at the age of 84 years, was the first to develop a commercial process for the preparation of artificial silk, his patent being dated 1884. Count Chardonnet, who was a member of the Institut, also carried out interesting work on ultra-violet rays. An extended notice will be published later.

Chemical Society

The annual general meeting of the Chemical Society will be held at Burlington House on Thursday, March 27, at 4 p.m., when the President will deliver his address, and the Longstaff medal for 1924 will be presented to Prof. F. G. Donnan, F.R.S. The informal dinner will be held the same evening at the Hotel Cecil at 7 for 7.30.

FRANCE

Output of Iron Ore

The production of iron ore in 1923 was 23,225,564 metric tons, compared with 21,032,000 t. in 1922. Stocks at the mines at the end of December were 4,473,749 t.

Alcohol

The total output of alcohol during the first four months of the 1923-24 season was 1,114,756 hectolitres, of which 632,368 were reserved for the State, and the rest placed on the market. Imports were 90,997 hl., exports were 73,358 hl., and stocks on January 31 were 1,177,137 hl.

Industry in the Ruhr

At present 33 blast furnaces are alight in the Ruhr, compared with 45 before the Occupation. Those steel works which are in the vicinity of waterways and supplies of coal, are producing 50 per cent. of their normal output, the others producing from 35 to 30 per cent. Complaint is made of lack of orders. The average production of the coal mines not included under the French Regie, is 237,980 t. per day, compared with 369,445 t. in 1913.

REVIEW

SECOND YEAR BOOK OF THE INSTITUTION OF THE RUBBER INDUSTRY, 1923. *Pp. xxiv+448. London*: 10, *Charing Cross Road*, 1924. *Price 5s.*

The second number of the "Year Book of the Institution of the Rubber Industry" contains much interesting material and provides evidence of the growth in membership and utility of the Institution. Altogether 23 papers are printed in the Year Book, which opens with Mr. F. Kaye's paper on the use of rubber latex-making and includes scientific contributions from workers such as Messrs. H. P. Stevens, B. D. Porritt, W. A. Williams, D. F. Twiss, P. Schidrowitz, and others. There are also papers devoted to the commercial side of the industry, a feature which well illustrates the aim of the Institution: "To promote a better understanding and closer relationship between all sides of the rubber industry." A warm welcome can be given to this second volume, with its promise of still better things for the future.

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Dyestuffs (Imports)

Replying to Mr. Hogge's enquiry as to imports of dyes and dyestuff materials during 1921, 1922 and 1923, and what proportion came from Germany, Mr. Lunn gave the following particulars :—

		Total imports Cwts.		Amount consigned from Germany Cwts.
Coal-tar dye intermediates	1921	4465	..	1721
including aniline oil and	1922	41	..	10
salt, and phenyl glycine)	1923	1349	..	267
Finished coal-tar dyestuffs	1922	57,5[illegible]	..	33,960
	1923	56,157	..	41,651
	1921	97,068	..	218
Dyeing extracts	1922	147,860	..	258
	1923	121,299	..	301
	1921	293	..	—
Indigo, natural	1922	1305	..	—
	1923	757	..	—
	1921	6428	..	—
Raw dyeing substances,	1922	10,450	..	—
other than dyewoods	1923	16,480	..	—

Gas Mantles

Answering Mr. Foot, Mr. Webb said that an application for the appointment of a committee under the Safeguarding of Industries Act (Depreciated Currency) to consider the removal of the 33⅓ per cent. duty imposed on imported gas mantles, had been received, but that he was awaiting further information for which the applicants had been asked.—(Mar. 11.)

Empire Production of Sugar

Mr. Webb said that the output of sugar in 1923-24 within the British Empire, estimated by Messrs. Willett and Grey at approximately 4,000,000 tons was produced in the following areas:—British India, 3,025,000 tons; Australia, 279,700 t.; Mauritius, 200,[illegible]00 t.; Natal, 180,350 t.; British West Indies, [illegible]8,000 t.; British Guiana, 90,000 t.; and the Fiji Islands, 35,000 t.—(Mar. 11.)

Sulphuric Ether

In a written answer to Mr. Lorimer, Mr. Webb gave the total quantity of sulphuric ether imported into the United Kingdom during 1923 as 16 gallons. This quantity was inclusive of direct imports, if any, into the Irish Free State up to March 31 of the year in question.—(Mar. 11.)

Scottish Shale Oil Industry

Replying to Mr. Clark, Mr. Webb said that he had arranged for the Anglo-Persian Oil Co. to be consulted on some of the questions raised by the deputation on February 26, concerning the future position of the Scottish shale and oil industry, but that the company had not yet had time to reply. He would like, however, to say that any danger of an early stoppage of the industry was no longer imminent.—(Mar. 11.)

Anglo-Persian Oil

Replying to Sir F. Wise, Mr. Alexander stated that during the year ending December 31, 1923, 5·4 per cent. of the imports of petroleum spirit into this country were imported direct from Persia. In addition, 320,433,790 gallons of crude oil were imported from Persia to be refined in this country.—(Mar. 12.)

COMPANY NEWS

THE BRITON FERRY CHEMICAL AND MANURE CO.

A big improvement in manufacturing profits is shown by the report of the Briton Ferry Chemical and Manure Company for the year 1923, the gross figure being £45,191, after providing for depreciation, compared with only £3014 for 1922, struck before providing for depreciation, which on that occasion required £5000. With interest and transfer fees the total available is £46,921, against £31,336 previously, when £25,677 was transferred from income-tax account. After allowing for debenture interest and redemption, placing £5000 to plant renewal account, £5000 to reserve and providing for corporation tax, there remains, including £4603 brought in, £20,212. Provision has been made for the preference dividend, including arrears, up to January 31, 1924, and the directors have recommended a dividend of 1s. per share (less tax) on the ordinary capital, being the first distribution to the ordinary shareholders since the 7½ per cent. paid for 1920.

UNITED ALKALI CO., LTD.

The profit for 1923 amounted to £352,332, and the year has been so good that although a scrip bonus of 50 per cent., requiring £300,000 from the reserve, was given in April, 1923, the ordinary dividend is to be maintained at 10 per cent.; £100,000 will be put to the reserve, and £16,000 will be added to the balance forward. Demand for the company's products has been generally satisfactory, and thus the company's works have been fairly well employed and costs have, in consequence, been further reduced. The plant and machinery have, as usual, been well maintained and all necessary repairs effected.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech.	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5¼d. per lb.
Potass. Chlorate	3d.—3¼d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17— 19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid. In
Sod. Bisulphite Powder 60/62%	Prices reduced to £18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included

RUBBER CHEMICALS

Antimony sulphide	Expected to advance in sympathy with the crude metal.
Golden	5¼d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide	4s per lb.
Carbon Bisulphide	£24—£28 10s. per ton according to quantity.
Carbon Black	Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 5d per lb. c.i.f.
Carbon Tetrachloride	£58 per ton, drums free.
Chromium Oxide	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.
Lamp Black	40s. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	3s. 4d.—3s. 6d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade, but these are the only products in this section which show any activity.

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£21 per ton.
Liquor	9d per gall. 32° Tw.
Charcoal	£7 5s.—£9 10s. per ton, according to grade and locality. Market steady.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. per gall. 60% O.P. Dull market.
Solvent	5s. per gall. 40% O.P. Dull market.
Wood Tar	£5—£6 per ton according to grade. Demand not very brisk. Ample supplies.
Brown Sugar of Lead	£47 per ton. Demand active.

TAR PRODUCTS

Acid Carbolic—	
Crystals	7½d.—8d. per lb. Better demand, and firmer market. London prices reported up to 9d.
Crude 60's	2s.—2s. 3d. per gall. Market stronger; better demand; limited supplies.
Acid Cresylic, 97/99	1s. 11d.—2s. 1d. per gall. Demand still good. Market firm.
Pale 95%	1s. 10d.—2s. per gall. Steady demand.
Dark	1s. 8d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	10d.—11d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons.
Standard Motor	1s. 4½d.—1s. 8d. per gall. ex works

Benzole, Pure .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% .. .. 1s. 4½d.—1s. 7d. per gall.
Pure .. .. 1s. 8d.—1s. 11d. per gall.
Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d per gall.
Creosote—
Cresylic 20/24% .. 11d.—11½d. per gall. Few inquiries
Middle Oil .. .. }
Heavy .. .. .. } 8d.—9d. per gall. according to grade and district. Market
Standard Specification } easier.
Naphtha—
Crude .. .. 8d.—9d. per gall. } Better demand.
Solvent 90/160 .. 1s. 2d.—1s. 4d. } Prices show up-
Solvent 90/190 .. 1s. 1d.—1s. 3d. } ward tendency.
Naphthalene Crude—
Drained Creosote Salts £6—£8. Demand still good.
Whizzed or hot pressed £9 10s.—£12 per ton. Not much inquiry.
Naphthalene—
Crystals .. .. £14 5s. per ton. Prices reduced.
Flaked .. .. .. £14 5s. per ton. Prices reduced.
Pitch, medium soft .. 65s.—70s. per ton. Better demand for prompt and forward delivery. Prices hardening.
Pyridine—90/140 .. 17s.—17s. 6d. per gall. More demand at still higher prices.
Heavy .. 11s.—12s. Fewer inquiries.

INTERMEDIATES AND DYES

Business in dyestuffs is maintained, but without much improvement. Prices remain firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. .. 4s. 4½d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 10d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 4d. per lb. Steady demand.
Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 7¾d.—8½d. per lb. naked at works.
Aniline Salts .. .. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 3d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 19/31° C. .. 4¾d.—5½d. per lb. Demand moderate.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethyaniline .. .. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 3s. 3d. per lb. d/d.
Monochlorbenzol .. £63 per ton.
α Naphthol .. .. 2s. 5d. per lb. d/d.
β Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. 1s. 4½d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 5s. 3d. per lb. d/d.
p-Nitraniline .. .. 2s. 4d. per lb. d/d.
Nitrobenzene .. .. 5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol .. 2s. per lb. 100% basis d/d.
Nitronaphthalene .. 11¾d. per lb. d/d.
p-Nitrophenol .. .. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol .. 4s. 6d. per lb. 100% basis.
m-Phenylene Diamine .. 4s. 2d. per lb. d/d.
p-Phenylene Diamine .. 10s. 6d. per lb. 100% basis d/d.
R. Salt .. .. 3s. per lb. 100% basis d/d.
Sodium Naphthionate .. 2s. 6d. per lb. 100% basis d/d.
o-Toluidine .. .. 7d.—8d. per lb.
p-Toluidine .. .. 3s. 10d.—4s. 3d. per lb. d/d.
m-Toluylene Diamine .. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The market is dull and values generally lower.

Acid, Acetic 80% B.P. .. £52 per ton.
Acid, Acetyl Salicylic .. 3s. 6d.—3s. 7d. per lb. Weaker tendency continues on a quiet market.
Acid, Benzoic .. .. Commercial acid, 2s. 6d. per lb. B.P. quality is being sold in small lots at 4s. 6d. lb.
Acid, Boric B.P. .. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric .. .. 18s.—20s. per lb. Business normal.
Acid, Citric .. .. 1s. 6d. per lb., less 5% for ten lots. Market extremely firm. Upward tendency.
Acid, Gallic .. .. 3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst... 6s. per lb., for 28 lb. lots.
Acid, Salicylic .. .. Market uncertain. Prices quoted from 2s. 6d. per lb. down to 1s. 10d. for ton lots.
Acid, Tannic .. .. 3s. 0d. per lb. for B.P. quality.
Acid, Tartaric .. .. 1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol .. .. .. 9s. per lb. d/d
Acetanilide .. .. 3s. per lb. Weaker. Offers are being made down to 2s. 10d. to stimulate the demand.
Amidopyrin .. .. 13s. 6d. per lb. Demand negligible
Ammon. Benzoate .. 3s. 9d. per lb. English make.
Ammon. Carbonate B.P.. £37 per ton.
Atropine Sulphate .. 12s. 6d. per oz. for English make.
Barbitone .. .. 16s. per lb. Weak market.
Benzonaphthol .. .. 6s. 3d. per lb. Firmer.
Bismuth Salts .. .. A steady market. Prices according to quantity:
Bismuth Carbonate .. 12s. 9d.—14s. 9d. per lb.
" Citrate .. .. 11s. 4d.—13s. 4d. "
" Salicylate .. 10s. 2d.—12s. 2d. "
" Subnitrate .. 10s. 9d.—12s. 9d. "
Borax B.P. .. .. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides— Per lb.
Potassium .. .. 9½d.—10d. } English make.
Sodium .. .. 9½d.—10d. } No alteration of
Ammonium .. .. 10½d.—11d. } any moment.
Foreign prices are somewhat unsteady. A lot of damp sodium bromide is being offered.

Calcium Lactate .. .. 2s. 6d. per lb. for best English make. This is cheaper than the Continental product of the same quality. Indifferent qualities are offered down to 1s. 9d. lb.

Chloral Hydrate .. .. 3s. 9d. per lb.

Chloroform .. .. 2s. per lb. for cwt. lots.

Cresote Carbonate .. 6s.—6s. 6d. per lb. Little demand.

Guaiacol Carbonate.. .. 13s. per lb. for small stocks available.

Hexamine .. .. 3s. 9d. per lb. for foreign makes. Weaker. Large supplies available.

Homatropine Hydrobromide .. .. .. 30s. per oz.

Hydroquinone .. .. 3s. 9d. per lb. Foreign make.

Iron. Ammon. Citrate, B.P. 1s. 11d.—2s. 3d. per lb., according to quantity.

Magnesium Carbonate—
- Light Commercial .. £36 per ton net.

Magnesium Oxide—
- Light Commercial .. £75 per ton, less 2½%.
- Heavy Commercial .. £26 per ton, less 2½%.
- Heavy Pure .. .. 2s.—2s. 6d. per lb., according to quantity. Steady market.

Menthol—
- A.B.R. recryst. B.P. .. 60s. per lb. Market firmer.
- Synthetic .. .. 26s.—35s. per lb., according to quantity. English make. Steady demand.

Mercurials—
- Red oxide .. .. 4s. 9d.—4s. 10d. per lb.
- Corrosive sublimate .. 3s.—3s. 1d. „
- White precip. .. .. 4s. 1d.—4s. 2d. „
- Calomel .. .. 3s. 5d.—3s. 6d. „

Methyl Salicylate .. 2s. 7d.—2s. 9d. per lb. for carboys. Slightly easier.

Methyl Sulphonal .. 24s. per lb. Scarce.

Paraformaldehyde .. 3s. 6d. per lb., without much inquiry.

Paraldehyde .. .. 1s. 4d.—1s. 8d. per lb. in free bottles and cases.

Phenacetin .. .. 6s. 6d.—7s. per lb. Dull.

Phenazone .. .. 7s. 6d. per lb. for cwt. lots. Spot prices much lower than forward offers.

Penolphthalein .. .. 7s. 3d.—7s. 6d. per lb. Firm.

Potass. Bitartrate—
- 99/100% (Cream of Tartar) .. .. 88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.

Potass. Citrate .. .. 1s. 8d.—2s. per lb.

Potass. Iodide .. .. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.

Potass. Metabisulphite .. 7½d. lb., 1-cwt. kegs included.

Potass. Permanganate—
- B.P. Crystal .. .. 8¾d.—9d. per lb. carriage paid. English make.
- Commercial .. .. 8d.—8¼d per lb. carriage paid. English make.

Quinine Sulphate .. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.

Resorcin .. .. 6s. 3d. per lb.

Salol .. .. 3s. 9d. per lb. Price fluctuates.

Silver proteinate .. 10s. per lb.

Sod. Benzoate, B.P. .. 3s. 3d. per lb. In more plentiful supply.

Sod. Citrate, B.P.C., 1923 1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.

Sod. Hyposulphite—
- Photographic .. .. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.

Sod. Metabisulphite cryst. 37s. 6d.—60s. per cwt. nett cash, according to quantity.

Sod. Nitroprusside .. 16s. per lb. Less for quantity.

Sod. Potass. Tartrate (Rochelle Salt) .. 76s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.

Sod. Salicylate .. .. A weak market with various prices quoted. Powder 2s. 7d.—2s. 10d. per lb. Crystal at 2s. 7d.—2s. 11d. per lb.

Sod. Sulphide—
- Pure recryst. .. .. 10d.—1s. 2d. per lb., according to quantity.

Sod. Sulphite, anhydrous £27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.

Sulphonal.. .. .. 18s. 6d. per lb.

Tartar Emetic .. .. 1s. 4d. per lb.

Thymol .. .. .. 13s. 3d.—14s. per lb. for good white crystal from ajowan seed. Somewhat cheaper than of late.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.
Aubepine	13s. 6d. „
Amyl Acetate	3s. „
Amyl Butyrate	7s. 3d. „
Amyl Salicylate	3s. 6d. „
Anethol (M.P. 21/22° C.)	3s. 9d. „
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. „
Benzyl Alcohol free from Chlorine	3s. 3d. „
Benzaldehyde free from Chlorine	3s. 6d. „
Benzyl Benzoate.. ..	3s. 9d. „
Cinnamic Aldehyde Natural	17s. 6d. „
Coumarin	20s. „
Citronellol	16s. „
Citral	10s. „
Ethyl Cinnamate ..	15s. „
Ethyl Phthalate.. ..	3s. 9d. „
Eugenol	10s. 9d. „
Geraniol (Palmarosa) ..	35s. „
Geraniol	10s.—17s. 6d.
Heliotropine	8s. 3d. per lb.
Iso Eugenol	15s. 9d. „
Linalol ex Bois de Rose ..	22s. 6d. „ Advanced.
Linalyl Acetate	22s. 6d. „ Advanced.
Methyl Anthranilate ..	9s. 6d. „
Methyl Benzoate ..	6s. „
Musk Ambrette	52s. 6d. „
Musk Xylol	19s. „
Nerolin	4s. „
Phenyl Ethyl Acetate ..	12s. 6d. „
Phenyl Ethyl Alcohol ..	16s. „
Rhodinol	57s. 6d. „
Safrol	1s. 10d. „
Terpineol	2s. 9d. „
Vanillin	„

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. ..	14s. 6d. per lb
Anise Oil ..	Again advanced to 2s. 6d. per lb. Firmer market forward.
Bergamot oil ..	16d. per lb. dearer.
Bourbon Geranium Oil ..	30s. " "
Camphor Oil ..	75s. per cwt.
Cananga Oil, Java	9s. 3d. per lb.
Cinnamon Oil, Leaf	6½d. per oz. Advanced. Market firm.
Cassia Oil, 80/85%	9s. 3d. per lb. Cheaper.
Citronella Oil—	
Java 85/90% ..	5s. 3d. " Much firmer.
Ceylon ..	3s. 9d. " Slightly dearer.
Clove Oil ..	8s. 6d. "
Eucalyptus Oil 70/75%..	2s. 3d. per lb.
Lavender Oil—	
French 38/40% Esters	24s. 6d. per lb.
Lemon Oil ..	3s. 4d. " dearer.
Lemongrass Oil	2¼d. per oz
Orange Oil, Sweet	12s. 6d. per lb.
Otto of Rose Oil—	
Bulgarian ..	30s. per oz.
Anatolian ..	24s. 6d. per oz.
Palma Rosa Oil ..	18s. 6d. per lb.
Peppermint Oil—	
English ..	70s. per lb.
Wayne County	18s. 6d. per lb.
Japanese ..	None offering on spot. 19s. per lb. offered.
Petitgrain Oil ..	9s. 6d. per lb.
Sandal Wood Oil—	
Mysore ..	25s. per lb.
Australian ..	21s. per lb.

TRADE NOTES

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during February has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 445, of which 372 were from merchants or importers. To these should be added 35 cases outstanding on February 1, making a total for the month of 480. These were dealt with as follows:—Granted, 369 (of which 344 were dealt with within seven days of receipt). Referred to British makers of similar products, 72 (of which 52 were dealt with within seven days of receipt). Referred to reparation supplies available, 22 (all dealt with within two days of receipt). Out-standing on February 29, 1924, 17. Of the total of 480 applications received, 418, or 87 per cent., were dealt with within seven days of receipt.

Trade Information

Dyestuffs.—What magic there is in this simple word! And the British Dyestuffs Corporation has done its best to show something of this magic in a tastefully produced series of booklets, illustrating its products. One series illustrates Chlorazol Dyes (Chlorazol being the group name for the Corporation's direct colours, replacing the old name "Dianol"), *e.g.*, Fast Bordeaux LK, Fast Orange R, Fast Scarlet 4BS, Drab RH, Brown PB, Diazo Blue 2B, Fast Eosine B, Black GF, Brown 2G, Fast Helio BK, each booklet containing concise instructions for use, and a table of the general properties of the particular dyestuff. A special book is issued, relating to "Chlorazol Colours on Cotton Yarn." Other booklets of a similar kind are also devoted to Ionamine B, Disulphine Green B, Solochrome Black F, Quinoline Yellow, Lissamine Green V conc., and Acronol Brilliant Blue, most of which are additions to the range of dyestuffs manufactured by the Corporation. In addition, the Corporation issues a series of larger booklets, amongst which mention may be made of those on "Basic Colours on Cotton," and on "Mordant and Non-Mordant Colours." Mention can be made of only a few of the products of the Corporation, but even this limited note would be incomplete without drawing attention to the booklet on Lake Colours, illustrated by a large number of fine colour plates and accompanied by a couple of charming colour prints, showing the effects produced by the use of these lakes. All the literature mentioned can be obtained from the British Dyestuffs Corporation, 70, Spring Gardens, Manchester.

Technical and Scientific Books.—We have received a catalogue of second-hand and new technical and scientific books, which can be obtained from W. and G. Foyle, Ltd., of 121-125, Charing Cross Road, London, W.C. 2. Messrs. Foyle render ready service in supplying out-of-the-way books, as well as current publications, and, further, are willing to supply any book in stock on approval. Their catalogue, Dept. No. 7, contains a long list of books under the headings of Brewing, Brick-making, Cements, Concrete, all branches of Chemistry, including Chemical Engineering, Colour manufacture, Dyeing, etc., Explosives, Fuels, Ceramics, Glue, India-rubber, Inks, Leather, Metallurgy, Oils and Fats, Paper, Photography, and many other subjects of interest to chemists.

PUBLICATIONS RECEIVED

The Second Annual Report of the British Cast Iron Research Association, for the Year 1922–23. *Pp.* 19. *Birmingham: The Birmingham Printers, Ltd.*, 1923.

Abridged Scientific Publications from the Research Laboratory of the Eastman Kodak Company. *Vol.* VI., 1922. *Pp.* 238+*vii*. *New York: Eastman Kodak Company*, 1923.

Manganese and Manganiferous Ores in 1922. *Department of the Interior, U.S. Geological Survey. By* H. A. C. Jenison *and* H. M. Meyer. *Mineral Resources of the United States*, 1922. *Part I. Pp.* 585—594. *No. I*: 28. *Washington: Government Printing Office*, 1924.

A Treatise on Light. *By* R. A. Houston. *Pp.* xi+486. *London: Longmans Green and Co.*, 1924. *Price* 12*s*. 6*d*.

Messrs. H. K. Lewis and Co., Ltd., have arranged to act as agents for the publications of the Chemical Catalog Company in the British Isles, and will be pleased to supply a list of these works to any enquirers. All the principal books are kept in stock.

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EDITORIAL

THE long letter from Dr. P. Fritzsche, which we print in this week's issue translated into English, is so interesting and important that it requires some comment. Dr. Fritzsche states that the view he puts forward is one animating the vast majority of German scientists. We do not dispute this claim; we in England have very inadequate means of finding out the opinions of the vast majority of German scientists, and we have no reason to doubt that Dr. Fritzsche is right in claiming to speak for this majority. He asks us a question about the Boer War; our answer is that a great many people in this country thought the Boer War was a mistake and that the British policy at that time was mistaken; they did not hesitate to publish that opinion, and we do not recall that any important manifesto supporting the British policy was ever published by a body representing the science of this country. We have no wish to discuss pure matters of history, and we do not agree with Dr. Fritzsche's views as to the origin either of the Franco-Prussian War or of the late war, but this is not the place to argue the matter or to explain our reasons. We are concerned with the future of international chemistry, not past history or past politics. That a spokesman of German men of science should state that in 1871 France was allowed to escape with very mild peace conditions and that the damage to France in 1914-1918 was well merited, seems to us not likely to conduce to a very speedy reconciliation. We wonder if Dr. Fritzsche saw Chauny immediately after the war; we did, in the spring of 1919, and the impression left on our mind is still vivid. If German men of science think that this piece of destruction was well merited, we have no more to say. Dr. Fritzsche, who compares Germany in 1914 to a harmless passer-by attacked by robbers, is not likely to value very highly the opinions of one of the robbers, whether France or Britain.

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It seems fairly obvious from Dr. Fritzsche's letter that German men of science on the whole approve of the destruction in the North of France and in Belgium, and that their feeling towards their neighbours is one of dislike perhaps tinged with a little contempt. We confess that we have heard from friends who have visited Germany since the war that many people in that country believed that Germany, a harmless, good-natured country, was in 1914 attacked by a gang of robbers, and that this country and Belgium were accomplices to this scheme. But we did not imagine that German men of science, well educated and gifted with the art of weighing evidence and arriving at a logical conclusion, could in this year 1924 adhere to such an opinion. The German men of science, believing as they do in the view put forward by Dr. Fritzsche, are not likely to desire any cordial relations with the men of science in the great majority of other countries. Our Belgian friends will not for some considerable period of time acquiesce in the view that the treatment of Belgium by Germany was well merited, and we think that it will be equally difficult to convince some of the scientific men, even in the countries which were neutral during the war, that this action was particularly creditable to Germany. However, if the German men of science are satisfied on this point, the other men of science in the world can remain dissatisfied. We fear that Professor Noyes has a long task before him in attempting to promote kindlier feelings among chemists in all countries. Dr. Fritzsche's letter is of considerable value in letting the whole world know the attitude of German men of science, and his obviously sincere statement is a definite view which can be recognised by all who read his letter.

* * *

The jubilee of the Physical Society, which has just been celebrated so brilliantly, tempts one to look back on science generally and wonder at the progress made these last fifty years. Physics at one time included all natural knowledge; thus Aristotle included all nature in his "Physics," and a trace of this conception still exists in the chairs of natural philosophy at some of our universities. Centuries passed before the allied sciences of chemistry, geology, botany and zoology began to be considered as separate studies, and then physics

itself began to be divided up, as the new phenomena of astronomy, meteorology, magnetism became known. For a time physics was limited almost to the laws of motion, but it has since more than made up for any past restrictions by invading many other fields of activity, including our own field of chemistry. Many years ago we actually heard Sir Ernest Rutherford say that he did not know where the dividing line between physics and chemistry was, and nowadays we know still less. People who were apparently immersed in placid domains of "pure" chemistry and who only appeared at times before learned societies with syntheses and analyses of organic compounds of the greatest complication, matched only by their names, now appear as familiars of Bohr, Zeeman, Michelsen, Langmuir, and many others who delve into the structure of matter. In this very issue we print two articles, worthy of the closest attention, that show how indefinite the border line is, if there is one. What, one wonders, does Prof. Armstrong think of it all; and where is the "purity" of chemistry and, indeed, of any science nowadays?

* * *

How calm and peaceful was the world a hundred years ago! It is true that another great war had just ended, but think how small text-books were in those days. Cavendish, Rumford and Watt were just dead; Humphry Davy was developing his safety lamp and making arc lights; Dr. Thomas Young was objecting to Newton's theory that light consisted of little bodies travelling "with an eel-like motion," and saying "how amusing and popular" were the external phenomena of electricity; Oersted and Ampère were playing to such good purpose with magnets: and Wollaston had discovered but not comprehended the Fraunhofer dark lines. And March 12, 1824, marks the birth of Kirchhoff, who was destined to gather up the scattered phenomena of spectrum analysis and become the founder of the "far-reaching science of celestial chemistry." Celestial it is in its beauty, but familiarity has robbed it of some of its glamour. Kirchhoff's work with Bunsen was done somewhere about 1860, and 14 years later Prof. Guthrie founded the society for the advancement of physical science, whose jubilee has now been so worthily celebrated. And our own Society will attain its jubilee in eight years! But for the present we have the Annual Meeting and several other matters to think about.

* * *

Our correspondence column this week provides us with other editorial comments. The status of chemists who are not qualified to become Fellows of the Institute is not an easy problem to solve. We have published in the Journal of the Society of Chemical Industry some letters which, in places, criticise the Institute, a body with whom the Society works cordially. We see no reason why our correspondents should not criticise the Institute, the Society, or even, if they think fit, the Royal Society or the intellectual department of the League of Nations. Letters from critical individuals are printed with no hall-mark of editorial approval; they are the spontaneous effusions of those who have something to say, and choose our columns as their medium. We make this explanation lest any readers fancy that an official publication such as our Journal should exclude any statements which reflect on the aristocracy of the chemical world. Since the days of Milton we imagine no one considers that any useful purpose is served by unduly restricting the liberty of individuals to disclose their views. In every association which possesses a set of rules some arbitrary line must be drawn which inflicts hardship on those who are excluded by it. A fixed subscription, a qualification, residence in a particular place, nationality, and all similar tests exclude people who are on the border line and resemble very closely those admitted within the fold. The remedy, probably the only remedy, is the due recognition of this fact. Mr. Winston Churchill is very nearly a member of Parliament, and his political utterances will be very nearly as valuable as those put forward by the actual members. The man who just escapes the liability for super-tax is nearly as wealthy as he who pays it. Many a virtuous chemist has failed to secure a C.B.E., many a bold bad man has been kept out of a baronetcy by someone with a better claim to the title and estates. We recommend our correspondents to reflect on the philosophical views of that four-footed animal who concluded that the great length of the vascular bundles through which the sap had to flow, and the poor opportunities for photo-synthesis, necessarily tended towards the impoverishment of the grape.

* * *

The Report on Vitamins of which a second edition has just been published, appears to contain matter of interest to us all. The stability of some of the vitamins seems to be quite extraordinary. The schoolboy absorbs in cod-liver oil vitamins which the cod extracts from the plankton of the sea. The small animals which compose the plankton derive their vitamins from the microscopic organisms known as diatoms. Where the diatoms obtain their vitamins is not explained, but it seems hardly probable that they make it by some synthetic process. We imagine that small quantities of it are absorbed by the diatom from something that it feeds upon, and that the vitamin increases when the conditions are suitable. If we remember the life-history of the diatom correctly it has a siliceous skeleton which does not grow in size, it is not like the skeleton of a lobster or an oyster. And the next generation of the diatom consists of slightly smaller organisms equally limited in their powers of growth. One might suppose from this that the breed of the diatom is steadily degenerating, but this seems not to be the case. As we are on the subject of natural history we are interested to see some recent work on the occurrence of snails on soils of varying acidity. It is not the ordinary snail preying on vitamin-producing herbs in the garden which is the subject of this memoir, but the pond-snail, a parasite of which is the liver-fluke, which kills so many sheep. The price of mutton is a function of the acidity of the soil, and of the occurrence of pond-snails and some other variables.

ATOMIC STRUCTURE

By Dr. J. D. MAIN SMITH

In Bohr's scheme of the structures of the atoms of the elements, the division of the extra-nuclear electrons into groups, and the subdivision of the groups into sub-groups, is determined by two quantum numbers, an *azimuthal* quantum number governing the eccentricity of the elliptical orbit of an electron rotating about the nucleus, and a *radial* quantum number, such that the sum of the radial and azimuthal quantum numbers determines the major axis of the orbit, and, consequently, the energy of the electron in the orbit. If k be the azimuthal quantum number, and n be the sum of the azimuthal and radial quantum numbers, the energy of the orbit is inversely proportional to n^2, the major axis of the orbit is directly proportional to n^2, and the latus rectum of the orbit is directly proportional to k^2. The number of different types of orbits having the same total quantum number n is equal to n. The maximum number of electrons in an atom that can possess the total quantum number n is equal to $2n^2$, and the maximum number of electrons in any one type of orbit, *i.e.*, in a quantum sub-group, is $2n$. Bohr then proposed the following scheme of structure for the elements :—

Total—										
Quantum number ..	1	2		3			4			
Number of electrons	2	8		18			32			
Subgroup—										
Quantum numbers..	1_1	2_1	2_2	3_1	3_2	3_3	4_1	4_2	4_3	4_4
Number of electrons	2	4	4	6	6	6	8	8	8	8

This scheme, however, does not conform to the spectral evidence on which alone the scheme of quantum groups claims to be deduced. It is certain that the 2 quanta group or L level consists of at least 3 levels, the 3 quanta group or M level of 5 levels, and the 4 quanta group or N level of 7 levels. The emission of radiation, for example, by the sodium atom when its valency electron moves from a 3_2 to a 3_1 orbit ought on the foregoing scheme to be characterised by a single yellow line, whereas in fact the radiation consists of the well-known yellow doublet. To reconcile this and many other spectral anomalies, Bohr has recently resorted to dividing the elliptical orbits into two types, a and b, such that electron transitions only occur from a to b, or b to a, but never from a to a, nor from b to b. This device, however, invalidates the scheme of quantum *sub-groups*, by which the number of electrons in a level is equal to $2n$. The Bohr sub-groups can therefore no longer be maintained as integral portions of atomic structure.

The chemical evidence, on which Bohr partly based his theory, consisted almost entirely of the general properties of the elements as disclosed by the periodic classification. This evidence can be regarded as supporting any scheme of atomic structure by which the electrons are divided into groups of 2, 8, 18, and 32. The detailed structure of the atom requires a much closer acquaintance with the specific properties of each element, and these properties can be shown not merely not to support Bohr's detailed scheme, but like the spectral evidence, to controvert it. This evidence, for example, involves that the second periodic group (from Li to Ne) must be subdivided into two groups of two electrons each and one group of four electrons, that the third periodic group must be subdivided in precisely the same way as the second, and that the fourth periodic group must extend from K (19) to Kr (36), and that the fourth group of electrons is not added to between Sc (21) and Ga (31). The chemical evidence further indicates the creation of a new group at titanium (22), and of yet another new group at manganese (25), the new groups when completed having 4 and 6 electrons respectively. The structure of the scandium ion is, consequently, 2,224,224, the structure of the chromous ion, 2,224,22404, and the structure of the cuprous ion, 2,224,22446. Similar evidence of similar structure is furnished by the two groups of transition elements, from Zr (40) to Ag (47), and from Ct or Hf (72) to Au (79), each of these transition groups containing eight elements succeeding a tervalent element. The evidence furnished by the rare-earth transition group is much less certain, but indicates that the first formed groups as in Xe (54) and the La ion persist, and that the additional electrons go to form two new groups of 6 and 8 electrons, respectively, the samarous ion having the structure, 2,224,22446,2244606,224, and the lutecium ion having the structure, 2,224,22446,2244668,224, this transition group thus consisting of fourteen elements also following a tervalent element.

The rules discernable from these structures are that the number of sub-groups in a quantum group is $2n-1$, the number of electrons in a quantum group is $2n^2$, and the number of electrons in a sub-group is $2k$, every sub-group possessing *radial* quantum number being divided into two equal groups differing slightly in total energy. It consequently follows that the number of levels in the various quantum groups is 1, 3, 5, and 7, for the quantum numbers 1, 2, 3, and 4, as required by the spectral evidence. It may further be inferred that the 5 and 6 quanta groups would contain a maximum of 9 and 11 subgroups, being made up of 22446688 10, and 22446688 10 10 12 electrons respectively.

The foregoing scheme differs from Bohr's chiefly in the number of electrons in the sub-groups having radial quantum number, the sub-groups having the whole of their energy in the azimuthal quantum being identical with those in Bohr's scheme. The latter, however, is not compatible with the detailed properties of specific elements, whereas the former is deduced on no other grounds than the chemical idiosyncracies of individual elements. To take one of the simplest cases in chemistry, the existence of carbon monoxide is inexplicable in Bohr's scheme, but follows from the foregoing scheme.

In devising the scheme account has been taken, not merely of the properties of the elements as disclosed by their valency, *i.e.*, capacity for oxidation or reduction, but also by their residual affinity as disclosed by their co-ordination compounds. One of the chief inferences to be drawn from the scheme is that the bond between two non-ionisable atoms consists of one electron, except in a few instances where the chemical properties indicate a double-bond, two electrons then being assigned to the junction between two atoms. This inference alone is possible for the elements

possessing the co-ordination number of six in the third and fourth periodic groups, for the groups can accommodate only one sub-group of six electrons. Similarly this inference is alone possible for the elements possessing the co-ordination number of eight, for the completed group having the highest quantum number possesses only one sub-group of eight electrons. For the elements of the second periodic group no such inference is imperative, and it is conceivable that a pair of electrons may function in the chemical bonds between such atoms as carbon, nitrogen and oxygen. The bulk of the evidence of inorganic chemistry, at least, is, however, opposed to the idea that more than one electron invariably functions in a single bond. The existence of triatomic hydrogen, the positively charged diatomic hydrogen molecule, the hydroborons, nitric oxide, nitrogen di- and tetroxides, and chlorine dioxide, is readily explicable on the ground that the chemical bond is identical with one shared electron. The existence, on the other hand, of elements with diatomic molecules, such as F_2, involves the acceptance of the idea that a chemical bond must sometimes consist of two electrons, and it may be inferred that the single bonds between carbon atoms in organic chemistry frequently consist of dielectronic junctions. These considerations enable the following definitions to be made—positive valency is numerically equal to the electrons contributed by an atom, by ionisation or by sharing, to the structure of another atom, and negative valency is numerically equal to the electrons acquired by one atom, by ionisation or by sharing, from another atom; negative residual affinity is the capacity of an atom to acquire electrons by sharing with an atom having valency already operative, and positive residual affinity is the capacity of an atom, having valency already operative, to contribute electrons by sharing with another atom; the co-ordination number of an atom is equal to the number of other atoms with which electrons are shared. From these definitions it follows that the co-ordination number of an atom has no necessary maximum, and is determined only by the number of atoms possessing residual affinity that can be accommodated at the surface of a central atom. It may be inferred, however, that the most stable structures will be obtained only when such co-ordinated atoms contribute to the central atom a number of electrons equal to the maximum number that can be accommodated in the sub-group next to that already containing a maximum number of electrons. The cases of two typical co-ordinating elements illustrate the points. The chromous ion has the structure 2,224,22404, one of the 3_2 groups possessing none of its four possible electrons. The addition of $6NH_3$ groups, however, completes the structure by contributing six shared electrons, forming the groups 2,224,22446. On oxidation to the chromic ion with the structure 2,224,22403, the addition of $6NH_3$ groups gives the structure 2,224,22436. In this case one of the 3_2 groups is incomplete and the complex is consequently less stable than in the case of the chromous complex. The three electrons in the 3_2 sub-group can, however, be arranged in the structure with a symmetry scarcely inferior to that of four electrons, owing to the fact that the orbits of the electrons of the second 3_2 group do not diverge very greatly from circular orbits, the three electrons having their orbits in the three octahedral planes of symmetry perpendicular to the three tetragonal axes, the six 3_3 electrons having their orbits in the six planes of symmetry perpendicular to the six digonal axes, and the eight electrons in 3_1 and 3_2 elliptical orbits having their axes coincident with the eight directions of the four trigonal axes. The groups in the chromous complex have four 3_1 electrons in orbits with axes coincident with the four tetrahedral trigonal axes of the inner 2 quanta group, the eight electrons of the 3_2 groups having the axes of their elliptical orbits coincident with the eight directions of the four octahedral trigonal axes, the six 3_3 electrons as in the former case having their orbits in the six planes of symmetry perpendicular to the six digonal axes.

The cobaltous ion has the structure 2,224,22425. As the 3 quanta groups are largely filled, co-ordination can take place only in the 4 quanta groups, the maximum number of electrons being that found in the next transition group, *i.e.*, six as in the Ag ion. Smaller co-ordination numbers should exhibit greater stability, with a maximum stability at 2, the number of electrons possible in the first 4_1 group. This is the known order of stability of cobaltous complexes. On oxidation to the cobaltic ion, with the structure 2,224,22424, a symmetrical structure can be obtained with six additional electrons from $6NH_3$ groups only by rearrangement of the 3_3 and 3_3 electrons, the structure becoming 2,224,22446,2, the 3 quanta group having its complete quota of electrons, and the next sub-group, 4_1, having its complete quota of 2 electrons. The symmetry of the structure is identical with that of the chromous complex, with the addition of two electrons in highly elliptical orbits having their orbital axes coincident with those of two of the less eccentric 3_2 orbits, and emerging from the atomic surface in the space between two sets of three of the six NH_3 groups, by which they are sterically protected from approach of and reaction with other atoms as valency electrons. To this high degree of symmetry is to be ascribed the great stability of the cobaltic complexes as compared with the unco-ordinated cobaltic ion and the complexes of other elements of this transition group except chromium, for which, as already indicated, a similar symmetry is suggested and similar stability exists.

The following tables indicato the atomic structures involved at the various critical points in the periodic classification :—

Total quantum number .. .. n =	1	2	3	4	5	6
Azimuthal quantum number .. k =	1	112	11223	1122334	11223	1122
He (2)	2					
Gl (4)	2	2				
C (6)	2	22				
Ne (10)	2	224				
Ar (18) and Sc^{3} (21)	2	224	224			
Cu^{1} (29)	2	224	22446			
Kr (36) and Y^{3} (39)	2	224	22446	224		
Ag^{1} (47)	2	224	22446	22446		
Xe (54) and La^{3} (57)	2	224	22446	22446	224	
Lu^{3} (71)	2	224	22446	2244668	224	
Au^{1} (79)	2	224	22446	2244668	22446	
Em (86)	2	224	22446	2244668	22446	224
U^{2} (92)	2	224	22446	2244668	22446	2244

Transition Groups

Total quantum number .. n=	1	2	3								
Azimuthal quantum number .. k=	1	112	112	23	23	23	23	23	23	23	
Valency of ion ..	—	—	—	1	2	3	4	5	6	7	
Ti (22)	2	224	224	—	02	01	00				
V (23)	2	224	224	—	03	02	01	00			
Cr (24)	2	224	224	—	04	03	—	01	00		
Mn (25)	2	224	224	—	14	13	12	—	10	00	
Fe (26)	2	224	224	—	24	23	—	—	20		
Co (27)	2	224	224	—	25	24	23				
Ni (28)	2	224	224	—	26	—	24				
Cu (29)	2	224	224	46	45	44					

Total quantum number, n=	1	2	3	4								
Azimuthal quantum number, k= ..	1	112	11223	112	23	23	23	23	23	23	23	23
Valency of ion ..	—	—	—	—	1	2	3	4	5	6	7	8
Zr (40) ..	2	224	22446	224	—	02	01	00				
Cb (41) ..	2	224	22446	224	—	03	02	01	00			
Mo (42) ..	2	224	22446	224	—	04	03	02	01	00		
— (43) ..	—	—	—	—	—	—	—	—	—	—	—	—
Ru (44) ..	2	224	22446	224	—	24	23	22	—	20	10	00
Rh (45) ..	2	224	22446	224	—	25	24	23	—	21		
Pd (46) ..	2	224	22446	224	—	26	—	24				
Ag (47) ..	2	224	22446	224	46	45						

Total quantum number, .. n=	1	2	3	4				5
Azimuthal quanu number, .. k=	1	112	11223	11223	34	34	34	112
Valency of ion ..	—	—	—	—	2	3	4	—
Ce (58)	2	224	22446	22446	—	01	00	224
Pr (59)	2	224	22446	22446	—	02	01	224
Nd (60)	2	224	22446	22446	—	03	—	224
-- (61)	—	—	—	—	—	—	—	—
Sa (62)	2	224	22446	22446	06	05	—	224
Eu (63)	2	224	22446	22446	16	15	—	224
Gd (64)	2	224	22446	22446	—	16	—	224
Tb (65)	2	224	22446	22446	—	17	16	224
Ds (66)	2	224	22446	22446	—	18	—	224
Ho (67)	2	224	22446	22446	—	28	—	224
Er (68)	2	224	22446	22446	—	38	—	224
Tm (69)	2	224	22446	22446	—	48	—	224
Yb (70)	2	224	22446	22446	—	58	—	224
Lu (71)	2	224	22446	22446	—	68	—	224

Total quantum number, .. n=	1	2	3	4	5								
Azimuthal quantum number, k=	1	112	11223	1122334	112	23	23	23	23	23	23	23	23
Valency of ion	—	—	—	—	—	1	2	3	4	5	6	7	8
Ct or Hf (72) ..	2	224	22446	2244668	224	—	—	—	00				
Ta (73) ..	2	224	22446	2244668	224	—	03	02	01	00			
W (74) ..	2	224	22446	2244668	224	—	04	03	02	01	00		
(75) ..	—	—	—	—	—	—	—	—	—	—	—	—	—
Os (76) ..	2	224	22446	2244668	224	—	24	23	22	—	20	—	00
Ir (77) ..	2	224	22446	2244668	224	—	25	24	23	—	21		
Pt (78) ..	2	224	22446	2244668	224	—	26	—	24	—	22		
Au (79) ..	2	224	22446	2244668	224	46	—	44					

Chemistry Department,
Birmingham University
March 8, 1924.

Dr. W. C. White has died of illness contracted some years ago whilst erecting an oil-extraction plant in Bombay. During the war, Dr. White, who was an authority on shale oil, did valuable work at the Gretna Munitions Factory.

COUNT L. M. HILAIRE BERNIGAUD DE CHARDONNET

The death of Count L. M. Hilaire Bernigaud de Chardonnet closes a career of singular devotion to technical ideal. Born at Besançon in 1839, and trained at the Ecole Polytechnique, he left that Institution (1861) well-equipped for pioneer research work.

Early investigation of the absorption of ultra-violet light by growing plants, and an extension to human physiology in connexion with diseases of the eye brought him into contact with the Biological School and there is no doubt that the well-known work of Pasteur on the silkworm fixed his attention and directed his imagination in the line of what proved to be his life work.

The great Réaumur, as early as 1734, in a work on the natural history of insects categorically forecasts the possibility of "Artificial Silk." There appears to have been no result from this until 1855, when a certain Audemars of Lausanne patented the manufacture of a product which he calls "Artificial Silk." This appears to be based on a curious mixture of cellulose nitrate and caoutchouc, but no result of this invention can be traced.

Chardonnet, it appears, worked in the period 1878-1884, in which year he deposited with the Academy of Sciences a *pli cacheté*, which is a specification of the definite invention, even of the details of projection of his collodion through an orifice of 1·10 mm. dimension into a bath of water which solidified the thread. He describes the silky aspect and indicates the tenacity of thread in terms of breaking strain, 30 kilos. per square mm. of section.

Following this in the Exhibition of 1889, in the machinery section, Chardonnet organised a practical demonstration of the manufacture, for which he received the Grand Prix. With the increasing recognition of the possibilities of the invention his friends of Besançon induced him to identify the new industry with his birthplace, and the necessary capital for the pioneer factory was found by local financiers. From this date onwards the development of the actual industry was rapid, and the company reached in 1900 a position of very great financial success.

As is well known, the production of thread from cellulose nitrate is associated with exceptional difficulty, and the success of the Chardonnet group in overcoming these difficulties rather encouraged inventors to explore the possibilities of the alternative solutions of cellulose derivatives. The subsequent history of the matter which was rather in favour of the cuprammonium product, and later, still more in

favour of the product made from viscose, are matters of common knowledge.

The recognition of the pioneer work of Chardonnet has been world-wide. In this country the definite recognition of this achievement is in the award by the Society of Dyers and Colourists (1914) of the Perkin Medal. Chardonnet was the recipient of many other honours; he was elected Member of the Institute in 1918.

As stated in our opening words, this is a career of a typical "genial" inventor, not a mere empiric, but of a student seeking by the strict methods of science, to realise a technical ideal.

Chardonnet died at the age of 84, and within a few weeks of his death filed a new patent for a mechanical improvement of his spinning apparatus, for which the drawings were prepared by his own hand. It is clear, therefore, that in this case the extraordinary difficulty of his career, only known to those who are aware of the inner history of "Artificial Silk," in no sense impaired his faculties.

The writer had only occasional personal contact with Chardonnet, and therefore cannot speak further than of the impressions so obtained, which were those of a genuine enthusiast, great clarity of vision, and entirely honest. In Hilaire de Chardonnet we cordially recognise a type of pioneer peculiarly French, and as in other notable instances France sows the seed and raises the tender plant against enormous difficulty, preparing the larger harvest perhaps for those who come and follow after.

C. F. Cross

EXPLOSIVES AND THERMITS

By A. MARSHALL

An explosive has been defined as a solid or liquid substance or mixture of substances which is liable, on the application of heat or a blow to a small portion of the mass, to be converted in a very short interval of time into other more stable substances largely or entirely gaseous.[1] There are some apparent exceptions to this definition. It has for instance been pointed out by A. Slingervoet-Ramondt[2] that a mixture of aluminium powder and potassium chlorate behaves as an explosive and that silver acetylide detonates when ignited although the reactions give no gaseous products:

$$2Al + KClO_3 = Al_2O_3 + KCl$$
$$C_2Ag_2 = 2C + 2Ag.$$

A mixture of magnesium powder and potassium perchlorate has indeed been used on a considerable scale in the British service under the name of Ophorite as a bursting charge for incendiary shell, smoke bombs, etc.[3] It has however been shown by J. Eggert and H. Schimank that the destructive effects produced by silver acetylide are due to the presence of impurities such as silver nitrate and silver oxide.[4] When prepared by passing acetylene into a solution of silver nitrate in nitric acid the acetylide may contain as much as 43 per cent. of the nitrate and the product is as violent as silver azide and more so than mercury fulminate, and the evolution of gas is almost as great. If made by passing acetylene into an ammoniacal solution of silver nitrate the acetylide is much purer but even then contains some 14 per cent. of oxide, and the effects are much smaller. These effects are therefore due to the evolution of gas by the impurities intensified by the extreme rapidity of the reaction.

The comparatively mild explosions of mixtures of chlorates and perchlorates with such metals as aluminium or magnesium appear to be due to the evolution of gaseous oxygen. A proper investigation of these apparent exceptions therefore only confirms the accuracy of the above definition of an "explosive." It should, however, be borne in mind that it is possible to have an explosion even when no explosive is present. An explosion is said to occur whenever gas or vapour expands or generates pressure with sufficient violence to produce a loud noise. So one may have an explosion of a cylinder of compressed gas, a steam boiler or a pneumatic tyre, or again of a mixture of air and a combustible vapour such as that of petrol.

Schimank has defined a thermit as a system which is capable of undergoing an endothermal chemical reaction with great or comparatively great velocity without giving gaseous end-products.[5] Pure silver acetylide would therefore be a thermit, but the ordinary product contains impurities which convert it into an explosive. It is evident that the reaction spreads through a column of this substance with a speed equal to that of the ordinary detonating explosives, that is several thousand metres per second. The thermits of commerce, such as a mixture of aluminium powder and iron oxide, react with a much lower velocity, probably only a few metres per second. If they were rapid there would generally be a sufficient proportion of gas-forming impurity present to convert them into explosives. With a slow mixture the generation of gas is too gradual to cause an explosion and the consequent scattering of the material. A better definition of a thermit would therefore be "a substance or mixture capable of undergoing an endothermal reaction with sufficient velocity to prevent the reaction dying out, without giving off sufficient gaseous products to scatter the material." If the velocity of reaction be of the same order as that of a high explosive and the material be not specially pure, it will in most cases behave as an explosive and not as a thermit.

[1] A. Marshall, "Explosives," 2nd ed., 1917, 1.
[2] *Chem. Weekblad.*, 1917, 544.
[3] A. Marshall, "Dictionary of Explosives," 1920.
[4] *Ber.*, 1918, **51**, 454. *Z. Elektrochem.*, 1918, 213; *Z. ges. Schiess-u. Sprengstoffw.*, 1918, **13**, 117, 153, 287. Also W. Brieger and H. Schimank, *ibid.*
[5] *Z. ges. Schiess-u. Sprengstoffw.*, 1918, **13**, 158.

Prof. H. Carmichael, for 37 years a consulting chemical engineer in Boston, Mass., and before that professor of chemistry in Iowa College, died recently aged 77. He was the originator of processes for handling copper ore, and for making boards from wood pulp.

THE MECHANISM OF MOLECULAR ACTIVATION

By R. G. W. NORRISH, B.A.

It is now generally admitted that, in order to explain the high temperature-coefficient of chemical reactions we must have recourse to some hypothesis of molecular activation, such as that originally suggested by Arrhenius.[1] According to this view only a small percentage of the molecules of a reacting substance are in a reactive state, and become so by the absorption of a certain quantity of energy.

It can easily be shown that such an hypothesis leads to an expression for the temperature coefficient η of a reaction.

$$\eta = \frac{k_1}{k_2} = e^{\frac{-(q_a + q_b + --)}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)}$$

where k_1 and k_2 are the velocity constants, at absolute temperatures T_1 and T_2 differing by 10°, and q_a, q_b, etc., are the energies of activation per gram molecule of each molecular species, termed by McG. Lewis the critical increments of the substances.

It should be noted that if a molecule becomes activated in stages, then the q measured from the temperature coefficient will be that referring to the slowest of the processes of activation proceeding.

Many attempts[2] have been made in recent years to provide a universal theory of molecular activation on the basis of the absorption of temperature radiation in equilibrium with the system, in terms of quanta. The authors of the radiation theory write

$$q = NhV$$

where V is the frequency of the active radiation, N the Avogadro number and h Planck's constant. From a knowledge of the temperature coefficient of a purely thermal reaction it is thus possible to calculate the frequency of the activating radiation. The substance in question should thus show an absorption band in the region of the spectrum corresponding to V, and the reaction should also be photochemically accelerated by subjecting the reactants to light of the requisite wave length. Neither of these predictions have in general proved true, though there is no reason why the radiation theory in a restricted sense should not continue to be regarded in the light of a working hypothesis.

We will now consider briefly an alternative method by which the problem of chemical reactivity may be attacked, which may be termed the hypothesis of kinetic activation.

A calculation of the increase in number of molecular collisions per second with temperature, has shown it to be totally inadequate to explain the high temperature coefficient of a reaction. If,[3] however, we regard only those molecules of the substance which have a kinetic energy of translation exceeding a certain limiting value, as being potentially active, we obtain an expression for the temperature coefficient of the right form, since their number increases exponentially with temperature. Thus we may imagine the molecule of phosphine to decompose when the energy of its rotational degree of freedom passes a certain limiting value. As a parallel conception for a bi-molecular reaction, we may imagine reaction between two molecules to occur only after a collision in which a minimum momentum exchange has been effected. This would mean that a minimum force of distortion must be exerted between the colliding molecules before reaction could occur, and it follows from the mathematical treatment that the work done during the exercise of this minimum force of distortion is equal to q, the critical increment of the reaction.

There is, however, one point which requires mention,[4] namely, that it follows as a mathematical necessity, in order to preserve the Maxwellian distribution of velocities, that energy absorbed in the activation of molecules, either from the kinetic energy set free on collision, or from the kinetic energy of vibration, should take an appreciable and calculable time to pass from the one form to the other. This time is equal to or greater than the so-called period of relaxation, and its existence warns us that we are dealing here with something outside the Newtonian mechanics. It is probable that at this point, that is in the transfer of energy from the outside to the inside of the molecule, the quantum relationships of the atom enter in.

Upon this kinetic theory of activation we may regard the catalytic effect of such substances as water vapour, ammonia, polar surfaces, and solvents in general as a preliminary weakening of the molecular system of the reacting substance, effected by close molecular association, and thus rendering lower the value of the critical increment of activation necessary to render the molecule completely unstable.

An example[5] of this is provided by a mixture of ethylene and bromine, which when dried and placed in a vessel of non-polar paraffin walls reacts only extremely slowly at 0° C., whereas at higher temperatures, when an appreciable number of favourable impacts occurs, it reacts in spite of these conditions at much greater velocities. When, however, the gases are damp, or polar walls of stearic acid are substituted, the velocity of combination at 0° is very great, the critical increment of activation, having been lowered by the catalysts so that molecular collisions of much lower momentum exchange are now favourable.

It would seem that the kinetic and the radiation theory of molecular activation are together sufficient to cover the broad field of chemical reactivity, and they are by no means mutually exclusive; indeed, there would seem no reason why both processes should not at times be simultaneously operative in the same chemical reaction.

That molecular activation, whether kinetic or radiational, takes place in terms of quanta seems extremely probable in view of our modern knowledge of atomic and molecular structure, and if we follow G. N. Lewis[6] in regarding activation as the displacement of the bonding electrons of the molecule to higher quantum orbits, it follows as a mathematical necessity. Thus it follows that there there must be some undiscovered process by which the external energy of vibration or collision is transferred in terms of quanta to the interior of the molecule, a process which occupies an appreciable period of

time already referred to above as equal to or greater than the "period of relaxation." With activation by radiation the process is presumably instantaneous.

In view of this reasoning it is of interest that experimental evidence is now available to show that activation is a quantum phenomenon. In our study of the various reactions which sulphur undergoes with hydrogen and with oxygen, Dr. Rideal and I[7] have shown that in all cases the critical increments of activation of the reactions are the simple multiple of a constant quantity which may be regarded as the critical energy required to displace one bonding electron of the sulphur molecule to the next higher quantum orbit.

The values of the critical increments found for the various reactions investigated are shown in the accompanying table, which is taken from our paper "On the Conditions of Reaction of Hydrogen with Sulphur, Part IV" (*loc. cit.*).

Reaction	Temp. coeff.	Critical Increment at 300° or heat of reaction per gm. mol. = c cals.	Number of free sulphur bonds produced x2 = n	Constant = c/n cals.
$\frac{1}{2}(2H_2+S_2)$ gaseous ..	2·19	51,460	4	12,865
H_2+S surface ..	1·48	25,750	2	12,875
$\frac{1}{2}(S_2\rightarrow 2S)$ gas dissoc. ..	—	50,000	4	12,500
Liq. $S\rightarrow S_2$ gas	—	28,000	2	14,000
Latent heat at 316° per gm. mol. S_2	—	23,200	2	11,600
Allotropic change of liquid S.	1·48	25,750	2	12,875
O_2+S surface A. ..	1·48	25,750	2	12,875
O_2+S surface B. ..	1·78	37,450	3	12,480

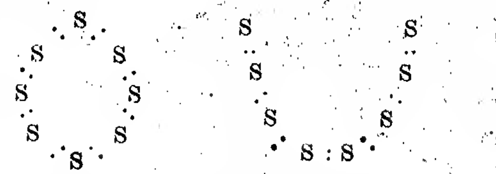
In addition we have just found that the reaction between hydrogen and sulphur vapour can be effected photochemically by ultra-violet light, composed of the wave lengths given by the mercury vapour lamp.

The critical increment 51,460 found for the gaseous reaction $\frac{1}{2}(2H_2+S_2=2H_2S)$ corresponds to an activating wave length of 2762 A.U., a wave length which may therefore reasonably be expected to occupy the head of the absorption band of sulphur in the ultra violet. This point will shortly be tested experimentally. It may be mentioned that there is a fairly strong line in the mercury vapour spectrum at 2745 A.U., which will account for the photochemical activity of mercury vapour ultra-violet light, found for the above reaction. At the same time strong lines exist also at 2536 and 3127 A.U., bracketing this supposedly active line, and since the absorption band of a vapour usually has considerable breadth, these may also be absorbed by the sulphur, without necessarily contributing to the photochemical reaction, which is probably extremely selective in character.*

* Since writing the above the attention of the author has been drawn to the work of J. I. Graham on the absorption spectrum of sulphur vapour in the ultra-violet (*Proc. Roy. Soc.*, **84A**, 311). The absorption spectrum for S_2 vapour was obtained, and consists of a band stretching from wave length 3415 A.U. to wave length 2620 A.U. showing fine structure and having its head at 2665 A.U. in close agreement with the predictions of the above work.

There is evidence (discussed at the end of our paper on the reaction of sulphur with oxygen) to suggest that the sulphur in the A and B surface relations, at least, is activated by molecular collision alone, so that if it turns out that the wave 2745 A.U. is the photochemically active agent, as seems likely, we shall have obtained evidence that the sulphur atom, whether activated by collision or by radiation, always requires a critical increment of activation which is some multiple of a constant value, a multiple depending upon the number of bonding electrons which require elevating to their higher quantum orbits.

For example the activation of the molecule S::S involves the displacement of four bonding electrons, a process which may be identical with dissociation, while the activation of the molecule (I) involves the displacement of but two electrons, to give the broken ring (II).



I II

The former of these processes involves a multiple of 4, while the latter involves a multiple of 2.

A further piece of evidence seemingly in favour of the conception of kinetic activation occurring in quanta has recently been advanced by Olson and Storch,[8] who subjected a mixture of nitrogen and hydrogen to an electron stream. Reaction commenced only when the activating electrons reached a certain minimum velocity, and thereafter as the velocity of the electron stream was increased the reaction rate increased by a series of jumps producing a step-like curve. The experimental facts seem to indicate that the nitrogen becomes activated by electron impact when this reaches a minimum value and that as the violence of the electron impact is increased, the intensity of the activation of the nitrogen molecule increases by a series of jumps corresponding to the absorption of an integral number of quanta for a given collision.

Further experiments of this relatively simple nature should throw much light on the absorbing problem of chemical reactivity which appears to be becoming slowly bound up with the wider problems of quantum dynamics.

[1] *Zeit. Physikal. Chem.*, 1889, **4**, 226; 1889, **28**, 317.
[2] Papers by W. C. McC. Lewis, *J. Chem. Soc.*, 1914-1922. Perrin, *Abs. Chem. Soc.* (ii), 1919, 177. General discussion by Faraday Society on the Radiation Theory, 1922, **17**, 546. Earlier papers by Trantz, *Z. Wiss. Photochem.*, 1906, **4**, 160, and Krüger, *Z. Electrochem.*, 1911, **17**, 453.
[3] Sutton, *Phil. Mag.*, 1914 (VI), **28**, 798. Todd and Owen, *ibid.*, 1919, **37**, 225. Lindemann, *Trans. Farad. Soc.*, 1922, **17**, 546.
[4] Lindemann, *ibid.*
[5] Norrish, *J. Chem. Soc.*, 1923, **123**, 3006.
[6] G. N. Lewis, Valence, *Chemical Monograph Series*, p. 159.
[7] Norrish and Rideal, *J. Chem. Soc.*, 1923, **123**, 695, 1689, 3201.
[8] *J. Amer. Chem. Soc.* (XLV), 1923, 1605.

FORTHCOMING EVENTS

Mar. 28. SOCIETY OF CHEMICAL INDUSTRY, *Glasgow Section*, Engineers' and Shipbuilders' Institute, 39, Elmbank Crescent, at 7.15 p.m. "The Influence on Chemistry of the Recent Knowledge Gained of Atomic Structure," by J. A. Cranston, D.Sc.

Mar. 31. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2 (Cobb Lecture), at 8 p.m. "Certain Fundamental Problems in Photography" (Lecture II.), by Dr. T. Slater Price.

Mar. 31. SOCIETY OF CHEMICAL INDUSTRY, *London Section*, with *Institute of Chemistry, London and South-Eastern Counties Section*.—Joint Meeting in the Hall of the Institution of Mechanical Engineers, Storey's Gate, S.W. 1, at 8 p.m., when the following cinematograph films relating to chemical industries will be shown, by the kind permission of Mr. W. J. U. Woolcock, O.B.E.:—(1) "Coal and its Products"; (2) "Heavy Chemicals."

Apr. 1. HULL CHEMICAL AND ENGINEERING SOCIETY, Hull Photographic Society's Rooms, Grey Street, Park Street, Hull, at 7.45 p.m. "The Constitution of Coal," by A. R. Warnes.

Apr. 1. MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, 36, George Street, Manchester, at 5.30 p.m. "Physical Research in the Cotton Industry," by Dr. A. E. Oxley, M.A.

Apr. 2. SOCIETY OF PUBLIC ANALYSTS, Chemical Society's Rooms, Burlington House, Piccadilly, W. 1, at 8 p.m. (1) "The Routine Examination of Dairy Products, with Special Reference to the Mojonnier Tester," by L. H. Lampitt, E. B. Hughes, and M. Bogod. (2) A Report on the World's Dairy Congress held at Washington, D.C., U.S.A., by J. Golding, D.S.O. (3) "Experiments on the Absorption of Copper following the Consumption of Vegetables containing Copper Sulphate," By J. C. Drummond, Miss M. G. Palmer, and Miss D. E. Wright. (4) "Determination of Sugar in Urine by means of Fehling's Solution with Methylene Blue as Internal Indicator," by J. H. Lane and L. Eynon. (5) "Attempt to extend Mitchell's Colorimetric Method to the Catechol Tannins," by Miss P. H. Price. Informal dinner has been arranged at St. James's Restaurant, 178, Piccadilly, W. 1, at 6.30 p.m.

Apr. 2. INSTITUTION OF CIVIL ENGINEERS, Great George Street, S.W. 1, at 6 p.m. "The Manufacture of Solid-Drawn Steel Tubes," by Engineer-Captain J. A. Richards, R.N.

Apr. 3. THE CHEMICAL SOCIETY, Burlington House, Piccadilly, W. 1, 8 p.m. "The Tautomerism of the Dyads." Part II. "Acetylene and its Halogen Derivatives," by E. H. Ingold (Usherwood). "The Potassium Salts of Phenolphthalein," by H. Bassett and D. J. T. Bagnall. "A Phase-rule Study of the Cupro-, Argento-, Auro-, and Thallo-Cyanides of Potassium," by H. Bassett and A. S. Corbet. "The Hydrolysis of Potassium Ferricyanides and Potassium Cobalticyanide by Sulphuric Acid," by H. Bassett and A. S. Corbet.

SOCIETY OF CHEMICAL INDUSTRY

ANNUAL GENERAL MEETING, 1924

July 9—12

PATRON: H.M. THE KING

Preliminary information regarding this meeting was given on p. 309 of *Chemistry and Industry* for March 21.

A programme will be issued shortly.

Members are asked meantime to note that the railway companies in Great Britain (except the Metropolitan and London Electric Railway Companies) have agreed to issue tickets at the ordinary single fare and one-third for the double journey to passengers travelling to attend the meeting. The tickets will be available from July 8 to 14.

OFFICIAL NOTICE

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

The eighth volume of these Reports is now ready and copies are in course of being despatched to purchasers.

Full particulars regarding the above and preceding volumes will be found on p. xiii of the Advertisement Section of this issue.

LIST OF MEMBERS ELECTED,

March 14, 1924

(continued)

Nagai, Professor Yuzaburo, Dept. of Applied Chemistry, Faculty of Engineering, Tokyo Imperial University, Tokyo, Japan. Professor of Applied Chemistry.

Pozzi-Escot, Professor Matius E., c/o Sociedad Quimico Industrial "Lima," Lima, Peru.

Ratz, Roswell D., c/o Dominion Tire Factory, Kitchener, Ont., Canada. Technical Superintendent.

Savage, Joseph, 111, Greenway Road, Runcorn. Chemist and Works Manager.

Smellie, Peter, 13, Dean Park Crescent, Edinburgh. Chemist.

Smith, Thomas A., c/o J. E. Pearse and Co., 88 to 94, Overstone Road, Northampton. Technical Chemist.

Somerville, Percy G., The National Benzole Association, Wellington House, Buckingham Gate, London, S.W. Secretary.

Taylor, Thomas, 2a, Hartington Road, Buxton, Derbyshire. Director of Chemical and Colour Works.

Weiss, Morris L., 441, Riverside Ave., Newark, N.J., U.S.A. Research Chemist.

Wait, F. G., Mines Branch, Dept. of Mines, Sussex Street, Ottawa, Canada. Chemist.

Wilkie, Arthur L., 2, Osborne Street, Sherwood, Nottingham. Analytical Chemist.

DEATHS

Bentz, Ernest (elected 1890), of Westwoodside, Wilbraham Road, Manchester, S.W. Technical Chemist. On February 20, 1924.

Chambers, Edgar V. (elected 1920), of The Manse, Lightcliffe, Yorks, Chemical Engineer. In July, 1923.

Mansfield, John F. (elected 1915), of Riverview, Devonport Avenue, Hessle, Yorks, Chemical Manufacturer. On February 15, 1923.

BIRMINGHAM AND MIDLAND SECTION

The annual general meeting was held at the Birmingham University on March 18, Dr. E. B. Maxted presiding.

Mr. George King (hon. secretary) announced that the following officers had been elected for the ensuing year:—Chairman, Prof. G. T. Morgan, D.Sc., F.R.S.; vice-chairmen, Mr. F. R. O'Shaughnessy and Dr. D. F. Twiss; hon. secretary and treasurer, Mr. G. King; Committee, G. H. Blenkarn, S. A. Brazier, W. A. S. Calder, W. T. Collis, W. C. Davis, A. E. Johnson, A. W. Knapp, Dr. A. Parker, Dr. E. B. Maxted, C. Watson, Dr. W. Wardlaw, C. E. Wood, Dr. T. J. Murray, J. C. Mann and L. M. Jones. The meeting approved the election of about a dozen associate members.

The following papers were then read:—(1) "The Fermentation of Cacao" by A. W. Knapp, B.Sc., and (2) "The Relation of the Theobromine Content of Cacao to its Fermentation" by A. W. Knapp and R. V. Wadsworth.

Mr. Knapp pointed out that there was no complete account of what precisely happened in the fermentation of cacao. Many planters could produce the kind of bean that cocoa manufacturers required, but the former had neither equipment nor the scientific training necessary to carry out successful experiments. Manufacturers definitely preferred fermented cocoa to unfermented cocoa. An attempt to find out when the theobromine first went into the shell of the bean showed that it began within 24 hours, but there was a sudden increase between 48 and 60 hours. Washing the beans did not appear to affect appreciably the theobromine content of shell or nib, a conclusion which, in respect of cacao shell, was contrary to the expectation expressed by one of the authors in a previous paper. They were satisfied from an examination of the cacao beans of commerce that theobromine passed into the shell during fermentation. Theobromine, free and combined, existed only in the cotyledons of the fresh cacao bean. The skin of the fresh bean was practically free from theobromine. As fermentation proceeded the temperature was high enough to kill the bean, and at once the liquid which permeated the bean contained theobromine. Thus theobromine passed into the shell, so that it was usual in a well-fermented bean of the "forastero" type to find from 0·8 to 2·98 per cent. of theobromine in the dry shell, practically all of which had come from the cotyledons. Hence the longer the fermentation, the less theobromine would be found in "nibs."

Dr. Maxted asked for information on the influence of a constant temperature upon the rate of fermontatiowfcadso if the distinctive aroma of cocoa could r, withoied artificially. Mr. F. R. O'Shaughnesochemical rehat the effect was on fermentation if thve in charact excluded or much restricted. Mr. R writing the above the that theobromine, if not present to the work of J. I. ht exist as a tannate. Mr. Howse ulphur va in the ble that a constituent like linalool. The formation arge a proportion of the essential oil of cocoa.

Mr. Knapp in reply said that he did not know of any work showing the influence of constant temperature, neither was he aware of an artificial produc comparable with the real article. The importance c aeration in the fermentation process could not b over-rated. He knew of nothing that contradicte the theory that theobromine might exist as a tannat

YORKSHIRE SECTION

On March 17 there was a good attendance t to hear the president of the Society, Dr. E. F. Armstrong, F.R.S., deliver an address on "Some Problems in the Chemistry of Fats and Oils"; Dr. L. L. Lloyd in the chair.

The feature of the address which marked it throughout was the skilful manner in which the facts and the most recent theories were knit together to make a connected whole. The great difficulties in manipulation were touched upon, and the speaker explained why the chemistry of fats and oils was in such a backward condition, notwithstanding their very great importance in industry. The address does not admit of condensation, but its scope will be gathered from the subjects treated, viz., the nature of the fatty acids, unsaturated and saturated, and their glycerides, the structure of the fats, the Hardy-Langmuir theory of the oil film, crystalline structure with Bragg's results, and the hydrogenation of fats. Certain biological questions were also treated.

The president suggested that some University should be equipped with the necessary accommodation and funds to carry out the laborious research needed to elucidate the many problems still awaiting solution.

BRISTOL SECTION

On March 6 the annual general meeting was held, and the following officers were elected for the coming session:—Chairman, M. W. Jones, Esq.; Vice-Chairman, Prof. F. Francis; Hon. Secretary, Arthur Marsden; Hon. Treasurer, M. W. Jones; Auditors, Dr. Bywaters and F. J. Popham; Committee, Drs. Butler and Rixon, Messrs. Gray, R. Robertson, R. P. Littler, E. Lewis, C. J. Waterfall, D. T. H. Beaton, C. M. Watkins, E. J. Holmyard. A hearty vote of thanks to the University, for the excellent facilities granted during the session, was carried with acclamation.

At the ordinary meeting which followed, a paper on "Fuel Economy Questions" was read by Mr. H. Womersley, who discussed the properties of the chief fuels and their use for raising steam, special attention being paid to the rates of combustion of coal from different areas. Thus, with similar conditions, northern coals were open and quick burning, whereas Forest of Dean coal was medium and Somerset coal slow-burning. Detailed accounts were given of the modern application of high-pressure, superheated, and exhaust steam, and it was suggested that in the near future factories using low-pressure steam would use exhaust steam from power stations. In conclusion the insulation of high-pressure mains, recording instruments for boiler plants, pulverised fuel and other points were considered, the paper leading to an excellent discussion.

CHEMICAL SOCIETY

An ordinary meeting was held on Thursday, March 20, when the President, Prof. W. P. Wynne, read a congratulatory address which the Council had presented to the Physical Society on the occasion of the celebration of its fiftieth anniversary. Further announcements were to the effect that the Faraday Lecture would be delivered by Prof. R. A. Millikan on June 12 instead of June 26, and that the Society of Chemical Industry had kindly arranged for copies of the Report on the Progress of Applied Chemistry to be available for Fellows of the Chemical Society at the reduced price of 10s.

The first paper was read on behalf of the author by one of the Secretaries :—

The action of thionyl chloride on alizarin. By Albert Green.

A contradiction of a statement previously made (December 6, 1923), that the action of thionyl chloride on alizarin gives an isomeric form of the latter substance. The product is mainly 2-acetyl-alizarin together with a small amount of unchanged alizarin, and arises from the interaction of an unstable intermediate compound and the acetic acid used in recrystallisation.

Dr. P. C. Austin then read the following paper :—

Rotatory dispersion of derivatives of tartaric acid. Part I. Methylene derivatives. By P. C. Austin and V. A. Carpenter.

By the action of formaldehyde on tartaric acid two compounds can be obtained, one of which is strongly dextro-, the other lævo-rotatory. These were prepared and examined in order to obtain further evidence on the nature of the dynamic isomerides which are present in aqueous solutions of *d*-tartaric acid of all concentrations (Lowry and Austin, *Phil. Trans. Roy. Soc.*, A. 1922, **222**, 249). Methylenetartaric acid, prepared by a modification of the method of Lobry de Bruyn and van Ekenstein (*Rec. trav. chim.* 1902, **21**, 313) was found to possess a specific rotation $[\alpha]_D^{20°} = -81°\cdot3$ for solutions of different concentrations. Its rotatory dispersion is simple, *i.e.*, it is expressed by one term of Drude's equation. Dimethylene tartrate on the other hand is strongly dextrorotatory but its rotatory dispersion is also simple. Alternative formulæ are suggested for the latter compound. It is claimed that the complex character of the dispersion of tartaric acid is due to an oscillation of the molecule between two configurations, since this oscillation is prevented by bridging across the hydroxylic groups, when derivatives of simple dispersion result.

Prof. T. M. Lowry said that the evidence which was now brought forward enabled one to obtain a clear picture of the possible isomerism, the explanation being chemical in character.

Dr. R. H. Pickard deprecated the practice of referring to the existence of dynamic isomerides of tartaric acid and its derivatives as proven when there was no evidence except that of rotary dispersion for such a statement. In collaboration with Dr. Kenyon, he had examined many cases in which measurements of rotary dispersion might be considered to point to the existence of dynamic isomerism, but he had been quite unable to find any support for this view. Further, Mr. Hunter had recently shown that rotary dispersion could not, in the present state of knowledge, be considered to possess any chemical significance whatever, and that in all probability simple rotatory dispersion did not exist. Finally, he failed to see how *X*-ray measurements of crystal structure could be considered in relation to rotatory dispersion measurements made with a substance in solution.

Prof. E. C. C. Baly said that the expression $k_1/(\lambda^2-\lambda_0^2) + k_2/(\lambda^2-\lambda_2^2)$ when written $p_1/(v_1^2-v^2) + p_2/(v_2^2-v^2)$ was similar in form to an expression employed in tidal calculations; it is thus not empirical, but has a definite physical meaning. He objected, therefore, to the use of a variation such as $[\alpha] = k_1/(\lambda^2-\lambda_2^2)-k/\lambda^2$.

Mr. H. Hunter asked how the dispersion equations for the methylene derivatives of tartaric acid had been calculated; it appeared that only two of the observations had been used for this purpose. He thought that the evidence for the existence of boro-tartaric acid in aqueous solutions of boric and tartaric acids ought to be supplemented, and outlined a method dependent on change of p_H of mixtures of the acids whereby this might be accomplished.

At this point, Prof. Lowry was invited to read the following paper :—

The rotatory dispersive power of organic compounds. Part XV. The molecular weight of ethyl tartrate and the origin of anomalous rotatory dispersion in tartaric acid and its derivatives. By T. M. Lowry and J. O. Cutter.

(*a*) The cryoscopic constant of carefully-purified formamide, melting at 2·2° is 5·16° per gram-mol. of urea in 1000 grams of solvent.

(*b*) Purified ("glacial") ethyl tartrate is unimolecular in this solvent up to a concentration of 16 per cent., the mean value of the cryoscopic constant being 5·18°. The dispersion curves for ethyl tartrate in this solvent are, however, strongly complex in character.

(*c*) The molecular weight of ethyl tartrate in benzene increases to nearly double its normal value at a concentration of about 20 per cent. In this range of concentration the rotatory power of ethyl tartrate increases up to about 10 per cent. and then decreases again.

(*d*) In ethylene bromide, the polymerisation of ethyl tartrate is more rapid than in benzene, but is accompanied by a progressive diminution of the lævorotatory power of the ester.

(*e*) Ethyl tartrate gives even higher dextrorotations in naphthalene at 70° than in formamide at 20°; but it is more strongly polymerised (50 per cent. at 9 per cent. concentration), in this solvent at 80° than in benzene at the same temperature (Patterson).

(*f*) These results are incompatible with Astbury's view that the dextrorotatory component of tartaric acid is a single molecule, whilst the lævorotatory component is a polymeride in which the structure of the crystal is in part maintained.

Prof. Lowry added that he was unable to see any valid objection to the use, from the point of view

of rotatory power, of an equation with one positive and one negative term.

The discussion was resumed by Dr. W. T. Astbury, who said that Prof. Lowry's remarks were directed against a misconception of his theory, and included the unwarranted assumption that the speaker's views regarding tartaric acid were applicable also to its esters. His own suggestion was that, granted that the dispersion is represented by the two-term Drude equation arrived at by Prof. Lowry, the *d*-term is to be associated with the carbon nucleus (irregular tetrahedron) of the molecule, and the *l*-term with the remainder which is subject to the action of various chemical and physical disturbances. As an example of physical disturbance he cited the force which is brought into play during supersaturation and crystallisation. The crystal-structure, the stable system towards which concentration and supersaturation are tending, suggests that finally the *l*-rotatory parts of adjacent molecules link up and evolve a *l*-rotatory system which completely overpowers the dextro-nucleus. These arguments could not, however, be transferred bodily to the case of another substance such as the ester. The speaker's suggestions were simply an attempt to find a basis for the two terms, assuming these to be correct, in the case of the acid; no sound general theory of anomalous rotatory dispersion exists. He was unable to ascribe any meaning to "simple" and "complex" dispersion; the former indicated only that the dispersion appears "simple" within the range examined and within the limits of experimental error. Finally, he regarded Dr. Austin's arguments, intended to correlate borotartaric and methylenetartaric acids, as fallacious, since they were based on the assumption that the methylene- and boro-groups are equivalent in their action on light; the point could be illustrated by reference to the isomorphous *d*- and *l*- rotatory potassium and ammonium sodium tartrates.

In reply, Dr. Austin remarked that Dr. Astbury had himself suggested an alternative solution of the problem of anomalous rotatory dispersion as a corollary to his work on the X-ray examination of crystals. Dynamic isomerism still offered a better explanation, since in the compounds described the 4-carbon chain persisted, although with lævo-rotation.

Mr. W. E. Garner described experiments on :—

The heat of adsorption of oxygen by charcoal. By E. A. Blench and W. E. Garner.

The heat of adsorption of oxygen on a purified wood charcoal has been determined over a range of temperatures from 18° to 450°, and for varying degrees of saturation of the charcoal surface. The charcoal, suspended in a platinum container, was heated at 900° for two hours in a high vacuum, cooled to the experimental temperature, a small quantity of oxygen was introduced into the space above the charcoal, and the rise in temperature was measured with a thermocouple. The gaseous products, carbon monoxide and dioxide, were removed and analysed; the gas pressure above the charcoal was reduced to 10^{-3} mm., a further small volume of oxygen was then introduced, and the temperature was measured as before. A third admission of oxygen was sometimes carried out in a similar manner.

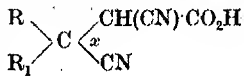
The following are typical results obtained with 4·5 gm. of charcoal:—at 18°, 1·299 c.c. gave 52 Cal.; at 199°, 1·331 c.c. gave 115 Cal.; at 283°, 1·295 c.c. gave 154 Cal.; and at 450°, 0·593 c.c. gave 224 Cal. per gm. mol. oxygen adsorbed. The heat of adsorption decreases as successive quantities of oxygen are adsorbed on the charcoal.

It is deduced that the heat of formation of stable groups of carbon and oxygen atoms on the surface increases with rise in the temperature of adsorption. This is in agreement with the experiments of Rhead and Wheeler on the thermal dissociation of the adsorption complex.

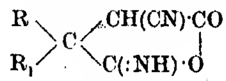
Prof. J. F. Thorpe discussed: —

Ring-chain tautomerism. Part X. Inhibited tautomerism. By F. Dickens, L. Horton and J. F. Thorpe.

When the sodium salts of the acids (I), in which the tetrahedral angle x is altered by making R, R_1 represent *cyclo*hexane,

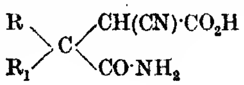


I

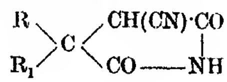


II

dimethyl, and *cyclo*heptane, respectively, are treated with mineral acids, neither of the compounds (I) or (II) can be isolated, the only substances present being the acid amides (III) and the imides (IV) :—



III

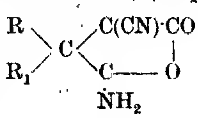


IV

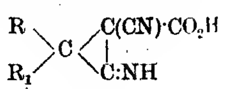
The amounts of (III) and (IV) respectively are: *Cyclo*hexane, 100%, nil. Dimethyl, 70%, 30%. *Cyclo*heptane, nil, 100%.

The entrance of the mobile hydrogen atoms to form the free carboxylic acids (I) leads at once, in all cases, to the formation of the oximino-compounds (II), but tautomerism between these substances is inhibited since, on or shortly after their formation, the oximino-compounds undergo changes in two directions :—

(i) If the deflection of the tetrahedral angle is sufficiently great, as in the *cyclo*hexane series, the amido-form (V) is quickly attained.



V



VI

(ii) If the deflection is not great enough, the imide (IV) is obtained, as in the *cyclo*heptane series.

The amino-compounds (V) are, however, unstable, and tend to pass into the isomerides (VI), in which

form they are readily hydrolysed to the acid amides (III). The mixed products in the dimethyl series are therefore due to the changes proceeding in both directions.

The experiments supply further proof that the *cyclo*heptane ring is not uniplanar.

The President congratulated Prof. Thorpe on the completeness of the investigations carried out in his laboratories.

BIRMINGHAM UNIVERSITY CHEMICAL SOCIETY

A meeting was held on March 4, when the President, Prof. G. T. Morgan, F.R.S., welcomed Dr. F. W. Aston, F.R.S., and recalled the lecturer's former association with the Society. Dr. Aston delivered a lecture entitled "Atomic Weights and Isotopes," and commenced by showing how the existence of isotopes modified Dalton's postulate that "atoms of the same element are similar to one another and equal in weight." The two methods by which the postulate can be tested experimentally are either by comparing the weights of individual atoms or by demonstrating that chemically identical samples of an element can have different atomic weights. The lecturer dealt with the method of analysis by means of positive rays, describing the apparatus and method of Sir J. J. Thomson and leading up to his own work on the measurement of the mass spectrographs of the elements. Various elements were discussed and the mass-numbers of their isotopes indicated. The work on the attempted separation of the isotopes of neon by distillation and the partial separation effected by diffusion experiments were discussed. Deviations from the whole number rule among the elements were then considered. Hydrogen is the oldest known exception and it has recently been shown that tin is another exception. Tin tetramethyl was used for this work, and it was shown that while the masses of the lines of tin were integral with regard to each other, yet when compared with the two strong xenon lines they gave values less than whole numbers by 2—3 parts in 1000. It is suggested that these divergencies are due to the method of packing of the nucleus. The lecturer concluded with a discussion of the spectra of isotopes and gave an account of the work of Bronsted and Hevesy on the partial separation of the isotopes of mercury by distillation in high vacua.

At the meeting held on March 17, Mr. R. L. Wormell, B.Sc., read a paper entitled "Ionisation in Non-aqueous Solvents." The lecturer showed that all liquids were capable of conducting an electric current when suitable substances were in solution. Types of conductance curves were discussed especially for solvents of low dielectric constants, *e.g.*, sulphur dioxide, methylamine and bromine. The relation between solvent power and dielectric constant was briefly indicated. The connexion between unsaturation and ionisation, and finally the conception of the solvation of ions, were described in some detail.

SOCIETE DE CHIMIE INDUSTRIELLE

The Economic Group met on February 27, under the chairmanship of Monsieur C. Drouets, director of the Industrial Property Section of the Ministry of Commerce, to hear a paper on "The General Technique of Action" by Monsieur Otlet, director of the International Institute of Bibliography of Bruxelles. Monsieur Otlet said that three orders of ideas or movements had developed under different names and had been elaborated into independent bodies of doctrine: the doctrine of administration, the doctrine of works organisation, and the doctrine of "documentation." Many facts are common to all three, such as human co-operation in the works, public services, and scientific institutions, the great part played by paper bearing writing or print in all transactions, and the use of reason and experiment to replace routine and empiricism. There was reason to ask in what measure these three doctrines, in particular "Taylorism" and the conceptions elaborated by the International Institute of Bibliography and Documentation, are of mutual assistance. Such an investigation leads to the question, is it possible to outline and elaborate a general technique of action in which should be synthesised the data and principles of the three doctrines, thus forming three parts of one whole.

Monsieur Jean Gérard followed with a paper on "The Organisation of a National Office of Chemical Documentation," in which he attempted to show that in chemistry the question of documentation was of enormous importance. Amongst the sources of documentation were printed material, unpublished reports, information on industrial and commercial establishments, and the lecturer suggested the establishment of a complete office of chemical documentation comprising seven departments. Pure chemistry; apparatus, etc., for laboratory and plant; fuels; metallurgical and mineral industries; organic industries; agriculture and agricultural industries, and economic organisation, comprising sources, markets and legislation. Such a bureau should possess a bibliographic card index, a collection of documents, a collection of chemical standards of raw materials and manufactures, a collection of samples, a list of research institutions, a list of manufacturers of products and plant, and a collection of commercial information and catalogues. The documentation would be made up of cards referring to both general, special and occasional literature. Such an office, useful in every way, could only reach complete utility in a "Chemistry House" in which were concentrated all the material and moral forces of associations of chemists and chemistry, thus corresponding to a programme under consideration by the Société de Chimie Industrielle.

March 12, was the centenary of the birth, in Königsberg, of Gustav Robert Kirchhoff, the pioneer investigator, with Bunsen, of spectrum analysis. Kirchhoff died in 1887.

CORRESPONDENCE

A GERMAN SCIENTIST'S OPINION

SIR,—In your Editorial of February 29, you profess yourself ignorant as to whether the majority of German scientists still approve the actions of the German Government before and during the World War.

Although I do not count among the leading German scientists I am enabled by a long and laborious life in the service of chemistry, which has brought me into contact with very many colleagues both at home and abroad, to inform you what is the current opinion amongst people of my circle concerning your way of thinking.

Before I go into details I should like to put the following question to you. What would you reply if a German, before entering into an exchange of scientific ideas with you, demanded of you publicly to condemn the attitude of the British Government during the Boer War or before the World War, an attitude which thwarted William II. in his striving after peace? I believe the reply would be that the matter need not be further discussed. We Germans, however, are well known to be always objective, and, as I cannot free myself from this national failing, I will therefore discuss your contention more closely.

You say that between the French and Germans there are deep misunderstandings and opine that the guilt of these differences falls on the Germans as they have invaded France twice within the last sixty years. Apart from anything else, the choice of the last sixty years has been made much to the detriment of Germany. If you will kindly contemplate a somewhat longer interval of time, entirely different grounds for these differences would come to the surface, grounds which are entirely to the discredit of the French. As regards the German invasions of France, the first took place as the reply to an insolent insult to our venerable monarch, who was to be challenged in order that his expected defeat would strengthen the tottering French throne. The enemy is recognised to have been treated most humanely in that campaign and, unfortunately, was allowed to escape with very mild peace conditions. The second invasion was rendered necessary because Germany had already palpable proofs of the fact that a number of jealous neighbours had banded together to carry out a stroke against her, by which she would be economically and politically weakened sufficiently to be unable to have a further voice as a serious competitor in the counsels of the world. That Germany first of all finished off the weakest of the accomplices in order to free the road to the most vindictive and dangerous adversary is, to my knowledge, a generally applied process when a harmless passer-by is attacked by robbers. Possibly the damaging of the foe went farther than wisdom counselled, but the damage was well-merited and the authors must be allowed extenuating circumstances as the purpose of the enemy plot was the economic ruin of Germany. These facts are, of course, represented by your Government and Press in a different light and it is a case of opinion *versus* opinion. Which of the two is the right one will be ascertained by impartial historic research. In the realms of science, however, it is not at all necessary to await this verdict, for a Peace Treaty has already been concluded between the belligerents. It is not a German custom to require of one of the combatants, after a treaty has been signed, that he should explicitly condemn his attitude before and during the struggle; nor is this generally the case in England. This demand can only be made of Germans. Why? Is the Peace Treaty not taken seriously in England either? It certainly is not taken seriously by the most dishonourable of our enemies, as he acts on the presumption that it is binding on Germany only. It is true that he signed it voluntarily but with the unmistakable intention of breaking it as soon as he felt strong enough. When this was the case, he broke the Treaty, invaded Germany, drove thousands of her inhabitants from their homes, imprisoned them and to this day carries out through his myrmidons the most revolting outrages against the property and liberty of the population of the occupied territories. No foreigner, able to judge objectively, who calls these facts to mind, will have the courage to demand of a German that he should disapprove of the actions of the German Government in the year 1914 in order to enjoy the privilege of being tolerated in an international assembly of scientists. Justice demands that, in the realms of science, politics should henceforth be mute! If the German scientists can conquer their feelings to the extent of forgetting the past and also the crying injustice which is still being meted out daily to their compatriots, it is a proof of self-abnegation which must suffice the scientists of all foreign nations as a basis of negotiations. We will then say to you, welcome!

I cannot hope that you will adopt this way of thinking. It is, however, the idea animating the vast majority of German scientists who hope therefore that no obscure German man of science may be found ready to accede to your wishes. Such admission as you require would surely be used to the detriment of the German nation, which would have to pay in the last resort for such a dishonourable and shameless attitude.—I am, Sir, etc.,

DR. P. FRITZSCHE

Leipzig

March 10, 1924

QUALIFICATION OF CHEMISTS

SIR,—I wish to give my support to the remarks of "An Unqualified Chemist" which appear in your current issue.

I was the pupil of a public analyst (a Fellow of the Institute), and a fee of 200 guineas was paid when my articles were signed. The laboratory in which I served my time was a regular "pupil shop." There were about half a dozen pupils altogether—the number varied—and although I cannot say that no time was devoted to teaching theory, the amount of time so spent did not exceed one hour per pupil per month! There was very little encouragement given to attend evening classes or to obtain theoretical knowledge otherwise. The only qualification required of a prospective pupil was the possession of

200 guineas ; there was no entrance examination whatsoever, and no consideration of one's previous educational record. At the end of the three years one had to find a job elsewhere—if possible.

Personally, I was lucky. About six months after the termination of my pupilship I obtained a job in a works, and now hold a responsible position.

By attending evening classes I have improved my theoretical knowledge and have gained the Associateship of the Manchester College of Technology in General Chemical Technology. Nevertheless, I am denied admission to the Institute.—I am, Sir, yours faithfully,

"Another Unqualified Chemist"

Sir,—I can assure "An Unqualified Chemist" that he is not alone in his amazement at the fearful and wonderful ways of the Institute of Chemistry. It is not only those who have no degrees who are victimised. I, personally, am a Master of Science, am just preparing to sit for the Doctor of Science (in Chemistry) and have been chief chemist to a firm of world-wide repute for seven and a half years. Presumably because I gained my degrees by spare-time study, without attending day classes in a university, the door is closed against me unless I pass their exam. This I will not do. On the other hand, I know men without degrees, but with friends in high places, who have been admitted without trouble. Their qualifications are no higher than mine. Can it be that kissing goes by favour ?

There is so much dissatisfaction with the Institute that one feels it should put its house in order before trying to dictate to the world who are and who are not chemists. "Who made thee a ruler and a judge over us ?"—Yours, etc.,

A Chemist

ROTATORY DISPERSION

Sir,—I followed with interest the discussion on rotatory dispersion at the last meeting of the Chemical Society, but was deterred from taking part in it by the closure of the discussion consequent on the lateness of the hour. If therefore you find the following remarks of sufficient interest I should be glad if you would publish them.

Dr. Pickard was very insistent that no rigid proof of the hypothesis that tartaric acid and its esters contain dynamic isomerides with rotatory powers of opposite sign and different dispersion had been brought forward. That must be admitted. Nevertheless the hypothesis accounts satisfactorily for :—

(a) the fact that the rotatory dispersion of these substances is undoubtedly complex and generally anomalous ;
(b) the manner in which the dispersion curves vary with change of temperature, concentration and solvent ;
(c) the fact that derivatives of high negative and high positive rotary power and (as far as can be determined) simple dispersion can be obtained.

It is granted that these facts form no rigid proof, and I would willingly abandon the hypothesis in favour of another embracing a still larger class of facts. Failing this, however, I see no reason for abandoning it until evidence can be found that it is incorrect.

With reference to Dr. Astbury's remarks I should like to protest against his contention that the rotatory dispersion of derivatives of tartaric acid has nothing to do with that of tartaric acid itself. No chemist would quarrel with Mr. Austin for seeking to increase our knowledge of tartaric acid by examining its derivatives, and no one who has studied rotatory dispersion can doubt that the ultimate cause of the complex dispersion of the esters and certain other derivatives of tartaric acid is the same as that of the acid itself.—I am, Sir, etc.,

E. E. Walker.

REVIEWS

Sir,—In the current issue of *Chemistry and Industry* there appears a review of a new book on clays and ceramic materials, which raises the question of reviews in general. I am not acquainted with this particular book, nor with its author, but think it unjust to the latter and unfair to your readers that a 700 page book should be dismissed with a few contemptuous lines. Those of us who have not ready access to an up-to-date scientific library are largely guided by your reviews in our purchase of new books, and we require information about the scope, arrangement and general treatment of the subject-matter, in addition to the reviewer's considered verdict on the book as a whole. When the reviewer disagrees with the author, surely the reasons for such disagreement should be given. If the book in question is as bad as your reviewer thinks it is, why mention it at all ? If he wants to save us from spending 55s. on it, he should tell us something about the book and give us some opportunity of judging for ourselves. Pontifical statements that a book is bad are valueless.

Another recent case which occurs to me, is the review in *Chemistry and Industry* (1923, 1013) of the new edition of Bloxam's "Chemistry." Here the reviewer is so intent on proving that the book has not been thoroughly revised, that he states dogmatically : ". . . It is noteworthy that no mention is made of permutit as a water softener." Had he taken the trouble to consult the index, he would have found this reference, both under "Permutites" and "Water softening."

Such cases, fortunately, are not frequent, but they do suggest that some reviewers should take their responsibilities more seriously.—I am, Sir, etc.,

N. K. Smith

168, Trent Boulevard, Nottingham

CONTINUOUS CAUSTICISING AND CRESYLIC ACID

Sir,—The attention of Mr. Walmsley and myself has been drawn to the possible ambiguity of a statement which appears in the abstract of our paper "Notes on Continuous Causticising and Cresylic Acid," which appeared in *Chemistry & Industry* of March 7. The statement was that "There was

no advantage in obtaining the maximum causticity —a causticity of between 85 per cent. and 90 per cent. being ideal for the treatment of tar acids." That, of course, only applies to a continuous process where all factors aiding rapid settling of the precipitate produced have to be exploited and in which regenerated sodium carbonate is recausticised.—I am, Sir, etc.,

R. F. STEWART

Glasgow
March 19, 1924

HYDROGEN PEROXIDE AS A BLEACHING AGENT

SIR,—I have read Mr. Weber's letter in the last number of the *Journal*. I did not see the report of the discussion before publication. I know, of course, that hydrogen peroxide is used for bleaching gelatin. I intended to emphasise certain difficulties connected with its use. The extract given by Mr. Weber from Bennett's book indicates these also. They are: (1) Hydrogen peroxide is a poor bleaching agent in acid solutions. (2) If used in alkaline solutions there is some danger of hydrolysis of the gelatin. (3) Gelatin acts as an anti-catalyst, and at the temperature at which gelatin liquors are bleached, much of the peroxide remains undecomposed. (4) This residual peroxide, unless removed by means of a reducing agent, may cause a "bubbly" appearance in the dried cakes. I have such a sample before me as I write.—I am, Sir, etc.,

S. R. TROTMAN

1, Regent Street, Nottingham

PERSONAL AND OTHER ITEMS

Sir William M. Bayliss, F.R.S., Professor of Physiology in University College, London, has been elected by the Belgian Academy of Medicine a corresponding member.

Prof. H. von Halban has resigned his post as Conservator of the Chemical Institute of the University of Würzburg.

The Nichols Medal for 1924 was presented to Dr. C. A. Kraus, of Brown University, at the March meeting of the New York section of the American Chemical Society.

The Iron and Steel Institute has awarded the Bessemer gold medal for 1924 to Prof. A. Sauveur, professor of metallurgy and metallography at Harvard University.

Helium in South Dakota.

It is announced that drilling in S. Dakota has revealed the presence of a high-pressure natural gas well which has the largest content of helium yet recorded.

Explosion at Oppau.

The Times reports the explosion of a gas generator at the Badische Anilin und Soda works at Oppau. Considerable damage is reported to have been caused and it is thought that parts of the works will have to close down for three months.

FRANCE

Coal Output, 1923

The French production of coal in 1923 increased by 6,600,000 metric tons, to 38,576,815 t., a gain of roughly 20 per cent., due largely to the mines in the Nord and Pas de Calais districts, where reconstruction made great progress. In these districts alone the gain in production was nearly 5½ million t., or 35·4 per cent. Still better results are recorded for coke. Excluding coke ovens belonging to metallurgical works, the production of coke at the mines has increased from 1,030,755 t. in 1922 to 1,985,735 t. in 1923, a gain of nearly 95 per cent., this gain being largely due to the mines of the Nord district. A similar increase is shown in the output of briquettes, viz., 147·3 per cent. to 3,056,376 t.

Imports in 1923 comprised 26,269,865 t. of coal and lignite (17,954,597 t. from Great Britain), compared with 22,384,126 t. in 1922 (12,098,927 t. from Great Britain); coke, 3,628,398 t. in 1923, (384,101 t. from Great Britain), against 5,140,183 t. in 1922; briquettes, 776,267 t. Exports were, coal and lignite, 2,364,172 t.; coke, 496,398 t. and briquettes, 238,116 t. Supplies of coke are approaching those of 1913, and the new plant now under construction (*cf. Chem. & Ind.* 1923, p. 794), will bring about still further improvement.

CANADA

Water Power

Since 1900 when the total installed horse power was some 150,000, water power development in Canada has been very rapid, and to-day the Dominion possesses nearly 3,000,000 operating h.p. and some 21,000 miles of transmission and distributing system. The total value of water power production for present installation is estimated at over $83,000,000 per year. Out of the 3,000,000 operating h.p., no less than 900,000 h.p. is in the Province of Quebec, where there is an available total of 15,000,000 h.p.

AUSTRALIA

Radium mining

The Radium and Rare Earths Treatment Co., Melbourne, is working some radium-bearing properties at Mt. Painter, in South Australia, where a shaft has been sunk and some exploratory work carried out. The chief radio-active minerals on the property are torbernite (hydrated phosphate of uranium and copper) and autinite (hydrated phosphate of uranium and calcium). Another property is situated at Olary, near Broken Hill. Mr. S. Daddow, of London, has been appointed chemist to the company.—(*Chem. Eng. and Min. Rev., Dec.* 5, 1923.)

UNITED STATES

Factory Explosion

The daily Press reports that an explosion, "presumably of TNT," occurred on March 1 in the works of the Ammonite Co. at Nixon, near New Brunswick, causing many deaths and casualties. The Ammonite Co. was manufacturing a fertiliser from the materials contained in TNT shells after the TNT had been extracted at the arsenal, and it is supposed that some TNT left by error in the shells caused the explosion.

BRITISH INDIA

Final Memorandum of the Groundnut Crop of 1923-24

From information based on reports received from the three provinces of Madras, Burma and Bombay, which comprise 99 per cent. of the entire groundnut area of British India, the total yield is estimated at 1,078,000 tons of nuts in shell, as against 1,236,000 tons last year, or a decrease of 13 per cent. The total area under the crop is 2,731,000 acres, compared with 2,633,000 acres in 1922-23. The conditions of the weather on the whole have been unfavourable. The quantities exported by sea to foreign countries during the nine months (April to December) 1922-23 and 1923-24 have been 159,200 tons and 158,500 tons respectively.—(*Ind. Tr. J., Feb.* 21, 1924.)

GENERAL

Patents in Japan

A translation of all the Ordinances and Notifications published in Japan since the earthquake and relating to rights in industrial property has now been received, and may be consulted in the Public Library of the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C. 2.

Notes from Italy

The Sugar Crop.—The production of beet sugar during the campaign 1923-24 in Italy by 39 factories was 3,114,500 quintals (from 28 million q. of beets grown on 93,000 hectares), compared with 2,616,073 q. (23·9 mill. q. of beets grown on 85,000 hectares) in 1922-23. Imports of sugar during 1923 totalled 314,626 quintals.—(*G. Chim. Ind. ed. App., Jan.,* 1924.)

The National Italian Congress of Industrial Chemistry will be held in Milan from April 12 to 17, when special attention will be paid to fertilisers, fuels and chemistry in the national defence. As the Sample Fair will be held at the same time, an exhibit will be provided to show the scope and quality of chemical production in Italy.

The Photographic Exhibition

This year the Photographic Exhibition has been held in conjunction with the Ideal Home Exhibition, so that visitors were more numerous than ever, although some prominent makers were not represented. Once again Messrs. Johnson, Matthey and Co., Ltd., delight the eye with their beautiful exhibit of crystals and silver nitrate, potassium chloroplatinite and gold chloride, and Messrs. Johnson and Sons show, in addition to various photographic chemicals, the various stages in the manufacture of the "Scales" brand of hydroquinone and metol. Messrs. David Allan demonstrate a variety of appliances designed to aid the photographer, many being suitable for use in laboratories where occasional photographs have to be taken at short notice. Of great interest, as showing the quality of British products, was the exhibit by Messrs. Wellington and Ward of prints from negatives on "Anti-Screen" plates which were developed in Central Africa at over 100° F., a severe test of quality. The same firm has introduced a new panchromatic plate, the "Spect[illegible] attract all interested in ortho-chromatic photography. Messrs. Ilford, Ltd., exhibited a fine series of colour filters and illustrated the various steps in the making of a dry plate. Many well known makers of photographic products, papers films and plates were represented, and the high quality of the specimen prints exhibited provided convincing testimony to the excellence required to keep in the front rank of this particularly English industry.

REVIEW

Quantitative Chemical Analysis. *By* Prof. Frank Clowes, D.Sc., and Prof. J. Bernard Coleman, A.R.C.Sc. *Twelfth Edition. Pp.* vii + 576. *London: J. and A. Churchill,* 1924. *Price* 18*s*.

The twelfth edition of this well-known book by the late Prof. Frank Clowes and Prof. J. B. Coleman has just been issued. First published in 1891 as a book of instruction in quantitative analysis, its range has, in the course of time, been extended so much, as to render it also a useful book of reference on general analysis for those engaged in analytical and consulting practice.

The arrangement of the matter conforms to the primary purpose of the book. After an introductory part covering 72 pages, which deals with the preliminary and general operations employed in analysis, comes a description of the more important gravimetric determinations of single substances. This is followed by a similar section dealing with volumetric analysis. After this comes Part IV, which covers an immense range of applications. The analyses of alloys, of ores, of silicates, of iron and steel, of water, of food, of soap and oils, fat and waxes, are dealt with. Part V is devoted to the ultimate analysis of organic compounds and the determination of molecular weights. Part VI deals with methods of gas-analysis by means of the Hempel apparatus and the Lunge nitrometer. The determination of vapour density by the Victor Meyer and the Dumas method is also described in this section. The remaining parts contain typical results of analyses, tables of useful constants, and details regarding the materials used in the analytical laboratory such as distilled water, compressed gases, analytical reagents, etc.

The book has deservedly achieved a high degree of popularity on account of its detailed and trustworthy directions. Only well-tried and established methods are given. As a result, a student who has worked conscientiously through only a fraction of the contents of this book will have attained confidence in his own work, and the large number of practical applications given to the teacher to choose from, render it easy to maintain and stimulate the student's interest. The qualities which render the book valuable to the student will also commend it to the practitioner. For work of a more special nature references are given to suitable treatises. The reviewer has no doubt that the book will maintain its popularity among the chemical profession.

Henry J. S. Sand

PARLIAMENTARY NEWS

HOUSE OF COMMONS

Safeguarding of Industries Act

Mr. Graham stated in reply to Sir F. Wise that the revenue received under Part I and Part II of the Safeguarding of Industries Act during the period from April 1, 1923, to February 29, 1924, amounted to £357,000 and £230,000 respectively.—(Mar. 12.)

Fire Precautions

Answering Mr. Gray, Mr. Henderson said that the recommendations dealing with fire precautions in factories and workshops he hoped to incorporate in the Bill which is now under consideration, and the Report of the Royal Commission on Fire Brigades and Fire Protection would no doubt afford a useful basis for legislation on other topics, as opportunity offered. With regard to the recommendations made by the Commission on the subject of fire brigade organisation, he could not say when legislation would be possible.—(Mar. 13.)

Safeguarding of Industries Act

In reply to Sir F. Wise, Mr. Graham said that the net amount of revenue received under Part II of the Safeguarding of Industries Act on mantles for incandescent lighting and component parts thereof, during the months from April, 1923 to February, 1924 inclusive, was £35,867.—(Mar. 13.)

Safeguarding of Industries Act

Mr. Webb, in reply to Mr. Lamb, said he was aware that serious unemployment was being created in the pottery trade (china) because German and Czechoslovakian ware was being imported at prices below the British cost of production, but he did not feel that any advantage would be gained in forming a committee to report on the position.—(Mar. 18).

Glass and Hollow-ware

Answering Major Burnie, Mr. Webb said he had received from members of the glassware trade and the hollow-ware trade, applications for the Depreciated Currency Order of October 1922, issued under Part II, of the Safeguarding of Industries Act, to be reconsidered by a committee set up by the Board of Trade in accordance with Section 9 of the Act, on the ground that German exports to this country were no longer assisted by a depreciated currency. He had invited the applicants to furnish certain information, on receipt of which the applications would be carefully considered.—(Mar. 18.)

Poison Gas

Replying to Mr. Broad, Mr. Walsh said that the expenditure in the current financial year on poison-gas experiments was about £80,000, and a similar sum had been provided for 1924-25. The animals experimented upon were cats, guineapigs, goats, mice, monkeys, rabbits and rats. The total number used from April 1, 1923, to the present date was 689, out of which 618 animals have been killed or destroyed. The Government was a signatory to the Washington Resolution of [illegible], which condemned the use in war of asphyxiating and poisonous gas, but this Resolution had not yet been ratified by all the signatory powers.—(Mar. [illegible]).

Dyestuffs

Answering Mr. Turner, Mr. Webb said that the negotiations between the British Dyestuffs Corporation and the Interessen-Gemeinschaft were still proceeding and no draft agreement had yet been submitted to the Board of Trade.—(Mar. 18).

COMPANY NEWS

UNITED ALKALI CO., LTD.

At the annual meeting the chairman said that, generally speaking, the year had been one of steady progress. A feature of outstanding interest was the centenary of the alkali industry in this country, at which some 1300 guests, including scientists, public men and consumers were entertained and shown some of the operations of the company. The effect was being followed up by a striking display at the British Empire Exhibition, where, under the auspices of the Association of British Chemical Manufacturers, was being prepared a survey of British chemistry, from the simplest practical processes to the most advanced theoretical developments, which was expected to be unique in the history of exhibitions. Referring to the company's interests in Spain, the chairman said that much attention had been given to the close co-ordination of the mines and their consuming works. The results obtained entirely justified the policy adopted, and very large quantities of pyrites were available at a cost much below the price at which this raw material for the production of sulphuric acid could be bought from any other source.

An efficient research organisation had always been well maintained, and with the company's large interests in the development of the organic chemical business in this country it had been necessary to increase these research facilities still further.

In conclusion the report and accounts were adopted (*cf. Chem. & Ind.*, p. 235, 1924).

BRITISH PORTLAND CEMENT MANUFACTURERS, LTD.

The final dividend on the ordinary shares is to be 5 per cent., making 10 per cent. for 1923. The carry forward is £187,751. The same dividend was paid in 1922, when the carry forward was £188,144.

BRITISH GLASS INDUSTRIES, LTD.

At the annual meeting, the chairman, Sir W. Sinclair, reviewed the position of the company and its associated companies, and reported progress in the scheme of reorganisation. To reorganise the company it was proposed to reduce the capital from £5,000,000 to £2,255,218, and to increase the reduced capital to £5,000,000 by the issue of 2,409,709 new £1 shares and 1,340,291 new 5s. shares. The working for the 21 months ended December 31, 1923, resulted in a net loss of £32,412, but he (the chairman) believed the corner had been turned; all the associated companies were making profits and the reorganisation would have a favourable influence. The report and accounts were adopted.

REPORTS

First Experimental Report to the Atmospheric Corrosion Research Committee of the British Non-Ferrous Metals Research Association. *By* W. H. J. Vernon, B.Sc. *Pp.* 62 (*Presented to the Faraday Society, Dec.* 17, 1923.)

Mr. Vernon's report is a record of a patient and conscientious study of the alteration which occurs to various metals when exposed to different atmospheric conditions over periods ranging up to twelve months. The work was carried out at the Royal School of Mines, South Kensington; Mr. Vernon expresses his appreciation of the advice and encouragement accorded him by Prof. H. C. H. Carpenter, F.R.S., and the staff. The full measure of the valuable and detailed information included in the report will only be gained by reference to the original. All that can be attempted in the present brief survey is to call attention to the most important results which have emerged from Mr. Vernon's work.

The research concerns "tarnishing" or "surrosion," rather than "corrosion" in the ordinary sense, since the layer which was produced on the metallic specimens exposed in the tests generally clung closely to the unattacked metal. In fact, in the quantitative work, the magnitude of the alteration was expressed not by the *loss* of weight, but by the *gain* in weight. The discoloration of the surface as a result of exposure was also studied, and the loss of "reflectitivity"—measured by Guild's method on a Lummer-Brodhun photometer—was employed as an alternative means of following the tarnishing process.

The larger portion of the report is devoted to the description of "*Field Tests*," in which metal plates measuring 10 cm. square (either with polished or matte (emeried) surfaces) were exposed to four different types of atmosphere. These were :—

(1) Exposure in a *basement-room* at South Kensington, which was heated continuously so as to keep the temperature above the dew-point; thus the air was always *unsaturated* with water vapour.

(2) Exposure in a *tank-room*, in which the moisture content from time to time *reached the saturation value*.

(3) Exposure in an ordinary domestic *kitchen* at Wimbledon, in which gas was used for cooking and lighting.

(4) Exposure *out of doors* on the roof of the Royal School of Mines at South Kensington.

The metals and alloys studied included copper, zinc, brass, nickel, nickel silver, monel metal, cupronickel, fine silver, standard silver, "special standard" silver (containing 1·75 per cent. cadmium) and iron. The behaviour of iron differed fundamentally from that of copper in that the iron rusted in isolated spots and remained bright elsewhere, whilst the copper soon became tarnished over the whole surface. The tarnishing of the copper specimens kept in the basement-room, however, usually commenced at the edge of the plates and extended inwards, a sequence of beautiful colours being observed. In the kitchen merely a gradual darkening of the copper occurred. The copper specimens exposed out of doors also darkened considerably, and over certain areas a blue deposit (containing sulphate) and a green deposit (containing presumably basic carbonate) appeared. The nickel specimens when exposed in the "kitchen" were found to be susceptible to the change known as "fogging"; in the early stages of fogging, the film produced was capable of being removed by washing with alcohol and rubbing with cotton-wool. Fogging was also noticed on some of the brass plates under all the "indoor" conditions of exposure; but here it was impossible to remove the film with alcohol. As regards the silver alloys, it is interesting to note that, whilst bright plates of "special standard" silver lost their reflecting power much more slowly in the kitchen atmosphere than did bright plates of ordinary "standard" and "fine" silver, there was little to choose between the three varieties when rough (emeried) surfaces were compared.

Particularly interesting are the results of the gravimetric method of following the progress of the attack. Curves showing the relation between weight increment (W) and time (t) have been plotted in many cases. Three types of curves may be distinguished :—

(1) Those in which the rate of increase *falls off* with the time, as the surface-film becomes thicker and obstructs the access of the tarnishing agent to the unchanged metal below. In the case of copper exposed in the warm basement-room, the curve is a parabola. It is significant that the same relation ($W^2=kt$) which was found by Pilling and Bedworth for the high-temperature oxidation of copper holds good for the tarnishing of copper in damp air at low temperatures.

(2) Those in which the rate of increase *does not alter* with the time. In the case of zinc exposed in the basement-room, the curve is a straight line, indicating that the corrosion product had no protective action on the unchanged metal below.

(3) Those in which the rate of attack *increases* with the time. The iron specimens kept in the tank-room rusted at a rate which increased as the rust accumulated.

The last seven pages of the report are devoted to the description of "*Laboratory Experiments*," mainly upon the tarnishing of copper by London air, which had been treated in different ways. Mr. Vernon thinks that, although hydrogen sulphide is certainly a powerful tarnishing agent when present, an appreciable amount of discoloration can occur even in air which contains very little hydrogen sulphide; he suggests that some other sulphur compound may have the power of causing the change, and describes an experiment in which tarnishing is produced artificially by means of a mixture of sulphur dioxide and benzene vapour. Whatever the tarnishing constituent in London air, experiments show that it is removed by filtration of the air through granulated silver, and even by washing with water.

The observation of U. R. Evans that the velocity of tarnishing of copper by hydrogen sulphide is very greatly reduced if the gas is dried is confirmed. But Mr. Vernon describes an experiment to show that not only water, but also benzene, has the power of accelerating the action of hydrogen sulphide on

the metal; he concludes that the tarnishing of copper is not an electrochemical process.

It is understood that these laboratory researches are being continued, and the publication of fresh results will be awaited with interest by all who have studied the present report. U. R. E.

REPORT ON THE ECONOMIC AND FINANCIAL CONDITIONS IN VENEZUELA, SEPTEMBER, 1923. *By* T. J. MORRIS, *Chargé d'Affaires, Caracas. Department of Overseas Trade.* *Pp.* 31. *H.M. Stationery Office*, 1923. *Price* 1s.

Trade in Venezuela for the last twelve months has been comparatively good. The only difficulties imposed by the war were high freights and curtailment of markets. With these removed the country has made steady progress and seems likely to continue to do so (*cf. Chem. and Ind.*, 1923, 17). The greater part of the population is engaged in cattle raising, and the production of such agricultural commodities as coffee, cocoa, sugar, cotton, tobacco, and maize; balata, rubber, Tonka beans, timber, and other tropical forest products are also obtained. Coal is found in parts. The petroleum industry is now attracting great attention, and the most promising fields are in British hands; 334,923 tons was exported in 1922, against 218,146 t. in 1921, and with better transport facilities no doubt the industry would gain fresh impetus.

In 1921 imports were valued at £4,090,294, and exports at £5,719,909; in the first six months of 1922 they were £1,885,682 and £3,431,385, respectively. The United Kingdom and Trinidad supply about one-quarter of the imports, the United States about one half. British firms seeking business in Venezuela are in a good position for there is marked preference for their goods, owing to the cordial relations of the country with Britain. The principal distributing towns are Caracas, the capital of the country, for the comparatively wealthy centre and northern zone, Ciudad Bolivar for the hinterland and the south, a district of poor and primitive conditions, and Maracaibo for the petroleum areas and Andean regions; importers are recommended to work through all three centres together.

The principal imports are textiles, machinery, crockery, drugs, chemicals, perfumery, automobiles and foodstuffs. In drugs and chemicals British firms are not adequately represented, the United States, Germany and France holding the market. Among items of import in 1922 (first six months) were coal, 8008 t.; cement, 4215 t.; drugs, 257 t.; perfumes, soaps, and toilet preparations, 59 t.; tanned skins, 42 t.

Several manufactures hav[illegible]en started recently in the country, for producing [illegible] comparatively small scale cotton textiles, sole [illegible]her, soap, candles, cement, paper, and glass. [illegible] country has vast potential wealth in its mine[illegible]esources, which are, however, almost untouched [illegible]ng largely to shortage of labour, the population [illegible]e country being very sparse.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

Business is maintained at a satisfactory level with a fair export business and very steady values.

Acetic Acid, 40% tech. ..	£24 per ton. Fair inquiry.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations; 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5¼d. per lb.
Potass. Chlorate	3d.—3¼d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76% ..	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton carr. paid. In
Sod. Bisulphite Powder 60/62%	Prices reduced to £18—£19 per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis ..	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included

RUBBER CHEMICALS

Antimony sulphide ..	Expected to advance in sympathy with the crude metal.
Golden	5¼d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide ..	4s. per lb.
Carbon Bisulphide ..	£24—£26 10s. per ton according to quantity

Carbon Black .. .. Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.

Carbon Tetrachloride .. £56 per ton, drums free.

Chromium Oxide .. .. 1s. 3d. per lb.

Indiarubber Substitutes, White and Dark } 5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.

Lamp Black .. .. 40s. per cwt., barrels free.

Lead Hyposulphite .. .. 7½d. per lb.

Lithopone .. .. £22 10s. per ton.

Mineral Rubber "Rubpron" .. .. £15 10s. per ton f.o.r. London.

Sulphur .. .. £10—£12 per ton, according to quality.

Thiocarbanilide .. .. 2s. 9d. per lb.

Vermilion, pale or deep .. 3s. 4d.—3s. 6d. per lb.

Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade, but these are the only products in this section which show any activity.

Acetate of Lime—

Brown .. .. .. £14 10s. per ton d/d. Demand active.

Grey .. .. .. £21 per ton.

Liquor .. .. .. 9d. per gall. 32° Tw.

Charcoal .. .. .. £7 5s.—£9 10s. per ton, according to grade and locality. Market steady.

Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. " " 24° Tw.

Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.

Wood Creosote .. .. 2s. 7d. per gall. Unrefined.

Wood Naphtha—

Miscible .. .. 5s. per gall. 60% O.P. Dull market.

Solvent .. .. 5s. per gall. 40% O.P. Dull market.

Wood Tar .. .. £5—£6 per ton according to grade. Demand not very brisk. Ample supplies.

Brown Sugar of Lead .. £47 per ton. Demand active.

TAR PRODUCTS

Acid Carbolic—

Crystals .. .. 7½d.—8d. per lb. Better demand, and firmer market. London prices reported up to 9d.

Crude 60's .. .. 2s.—2s. 3d. per gall. Market stronger; better demand; limited supplies.

Acid Cresylic, 97/99 .. 1s. 11d.—2s. 1d. per gall. Demand still good. Market firm.

Pale 95% .. .. 1s. 10d.—2s. per gall. Steady demand.

Dark .. .. .. 1s. 8d.—1s. 11d. per gall. Steady business.

Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.

Anthracene Oil—

Strained .. .. 10d.—11d. per gall. Very quiet.

Unstrained .. .. 8½d.—9d. per gall.

Benzole—

Crude 65's .. .. 10½d.—1s. per gall. ex works in tank wagons.

Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.

Benzole, Pure .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.

Toluole—90% .. .. 1s. 4½d.—1s. 7d. per gall.

Pure .. .. 1s. 8d.—1s. 11d. per gall.

Xylol coml. .. .. 2s. 3d. per gall.

Pure .. .. 3s. 3d. per gall.

Creosote—

Cresylic 20/24% .. 11d.—11¼d. per gall. Few inqui

Middle Oil .. .. } 8d.—9d. per gall. according

Heavy .. .. .. } grade and district. Mar

Standard Specification } easier.

Naphtha—

Crude .. .. 8d.—9d. per gall. } Better dema

Solvent 90/160 .. 1s. 2d.—1s. 4d. } Prices show

Solvent 90/190 .. 1s. 1d.—1s. 3d. } ward tenden

Naphthalene Crude—

Drained Creosote Salts £6—£8. Demand still good.

Whizzed or hot pressed £9 10s.—£12 per ton. Not mu inquiry.

Naphthalene—

Crystals and Flaked .. £18—£19 per ton.

Pitch, medium soft .. 65s.—70s. per ton. Better dema for prompt and forward deliver Prices hardening.

Pyridine—90/140 .. 17s.—17s. 6d. per gall. Mo demand at still higher price

Heavy .. 11s.—12s. Fewer inquiries.

INTERMEDIATES AND DYES

Business in dyestuffs has increased and reflects a improvement in the textile trade. Orders have been fo larger quantities than of late. Prices remain firm.

In the following list of Intermediates delivered price include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.

Acid H. .. .. .. 4s. 4½d. per lb. 100% basis d/d.

Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.

Acid Neville and Winther 5s. 10d. per lb. 100% basis d/d.

Acid Salicylic, tech. .. 1s. 4d. per lb. Steady demand.

Acid Sulphanilic .. .. 10½d. per lb. 100% basis d/d.

Aluminium Chloride, anhyd. .. .. 1s. per lb. d/d.

Aniline Oil .. .. 7½d.—8½d. per lb. naked at works.

Aniline Salts .. .. 7½d.—9d. per lb. naked at works.

Antimony Pentachloride 1s. per lb. d/d.

Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.

Benzyl Chloride 95% .. 1s. 3d. per lb.

p-Chlorphenol .. .. 4s. 3d. per lb. d/d.

p-Chloraniline .. .. 3s. per lb. 100% basis.

o-Cresol 19/31° C. .. 4¾d.—5¼d. per lb. Demand moderate.

m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Demand moderate.

p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Demand moderate

Dichloraniline .. .. 3s. per lb.

Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.

p-Dichlorbenzol .. .. £75 per ton.

Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.

Dimethyaniline .. .. 2s. 5d. per lb. d/d. Drums extra.

Dinitrobenzene .. .. 9d. per lb. naked at works.

Dinitrochlorbenzol .. £84 10s. per ton d/d. Advanced in sympathy with benzol.

Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.

66/68° C. 1s. 2d. per lb. naked at works.

Diphenylamine .. .. 3s. 3d. per lb. d/d.

Monochlorbenzol .. .. £63 per ton.

a Naphthol .. .. 2s. 5d. per lb. d/d.

β Naphthol .. .. 1s. 1d. per lb. d/d.

a-Naphthylamine .. 1s. 4½d. per lb. d/d.

β-Naphthylamine .. 4s. per lb. d/d.

m-Nitraniline .. .. 5s. 3d. per lb. d/d.

p-Nitraniline .. .. 2s. 4d. per lb. d/d.

Nitrobenzene .. .. 8½d.—9½d. per lb. naked at works.

o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11½d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	4s. 2d. per lb. d/d.
p-Phenylene Diamine	10s. 6d. per lb. 100% basis d/d.
R. Salt	3s. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 6d. per lb. 100% basis d/d.
o-Toluidine	7d.—8d. per lb.
p-Toluidine	3s. 10d.—4s. 3d. per lb. d/d.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The market is dull and values generally lower.

Acid, Acetic 80% B.P.	£52 per ton.
Acid, Acetyl Salicylic	3s. 5d.—3s. 6d. per lb. Weaker tendency continues on a quiet market.
Acid, Benzoic	Commercial acid 2s. 6d. per lb. B.P. quality is being sold in small lots at 4s. 6d. lb.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	18s.—20s. per lb. Business normal.
Acid, Citric	1s. 6d. per lb., less 5% for ten lots. Market extremely firm. Upward tendency.
Acid, Gallic	3s. per lb. for pure crystal. Market firmer.
Acid, Pyrogallic, Cryst.	6s. per lb., for 28 lb. lots.
Acid, Salicylic	Market uncertain. Prices quoted from 2s. 3d. per lb. down to 1s. 10d. for ton lots. In good demand.
Acid, Tannic	3s. 0d. per lb. for B.P. quality
Acid, Tartaric	1s. 1½d. per lb. less 5%. Much firmer with more demand. Upward tendency.
Amidol	9s. per lb. d/d.
Acetanilide	2s. 8d.—3s. per lb. Weaker. Offers at low prices are being made to stimulate the demand.
Amidopyrin	13s. 6d. per lb. Demand negligible
Ammon. Benzoate	3s. 6d.—3s. 9d. per lb. English make.
Ammon. Carbonate B.P.	£37 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make.
Barbitone	15s. 6d. per lb. Weak market.
Benzonaphthol	6s. 3d. per lb. Firmer.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Per lb.
Potassium	9½d.—10d. English make Prices uncertain
Sodium	9½d.—10d. English make Prices uncertain
Ammonium	10½d.—11d. English make Prices uncertain
Calcium Lactate	2s. 3d. per lb. for best English make. This is cheaper than the Continental product of the same quality. Indifferent qualities are offered down to 1s. 9d. lb.
Chloral Hydrate	3s. 9d. per lb.
Chloroform	2s. per lb. for cwt. lots.
Creosote Carbonate	6s. per lb. Little demand.
Guaiacol Carbonate	12s. 6d. per lb. for cwt. lots.
Hexamine	3s. 9d. per lb. for foreign makes. Weaker. Without much inquiry.
Homatropine Hydrobromide	30s. per oz.
Hydroquinone	4s. 3d. per lb. Foreign make.
Iron. Ammon. Citrate, B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	2s.—2s. 6d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B.P.	60s. per lb. Market firmer.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Very much firmer in view of the rise in the price of quicksilver.
Red oxide	4s. 9d.—4s. 10d. per lb.
Corrosive sublimate	3s.—3s. 1d. „
White precip.	4s. 1d.—4s. 2d. „
Calomel	3s. 5d.—3s. 6d. „
Methyl Salicylate	2s. 7d.—2s. 9d. per lb. for carboys. Slightly easier.
Methyl Sulphonal	24s. per lb.
Paraformaldehyde	3s. 6d. per lb., without much inquiry.
Paraldehyde	1s. 4d.—1s. 8d. per lb. in free bottles and cases.
Phenacetin	6s. 6d. per lb. Dull.
Phenazone	7s. 6d. per lb. for cwt. lots. Spot prices much lower than forward offers. Firmer tendency.
Penolphthalein	7s. 3d.—7s. 6d. per lb. Firm.
Potass. Bitartrate— 99/100% (Cream of Tartar)	88s. per cwt., less 2½% for ton lots. Firm market. Prices have upward tendency.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. lb., 1-cwt. kegs included.
Potass. Permanganate—	
B.P. Crystal	8¾d.—9d. per lb. carriage paid. English make.
Commercial	8d.—8¼d per lb carriage paid. English make.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz tins. Steady market.
Resorcin	6s. 3d. per lb.
Salol	3s. 9d. per lb.
Silver proteinate	10s. per lb.
Sod. Benzoate, B.P.	3s. 3d. per lb. In more plentiful supply.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite—	
Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	76s. 6d.—81s. 6d. per cwt., according to quantity. Market quiet.

Sod. Salicylate ..	..	A weak market with various prices quoted. Powder 2s. 7d.—2s. 10d. per lb. Crystal at 2s. 7d.—2s. 11d. per lb.
Sod. Sulphide—		
Pure recryst. ..	..	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous		£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal ..	..	18s. 6d. per lb.
Tartar Emetic ..	..	1s. 4d. per lb.
Thymol ..	..	13s. 6d.—15s. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.		
Aubepine ..	.. 13s. 6d.	,,	
Amyl Acetate ..	.. 3s.	,,	
Amyl Butyrate ..	.. 7s. 3d.	,,	
Amyl Salicylate ..	.. 3s. 6d.	,,	
Anethol (M.P. 21/22° C.)	4s.	,,	Advanced.
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d.	,,	
Benzyl Alcohol free from Chlorine ..	.. 3s. 3d.	,,	
Benzaldehyde free from Chlorine ..	.. 3s. 6d.	,,	
Benzyl Benzoate ..	.. 3s. 6d.	,,	Cheaper.
Cinnamic Aldehyde Natural ..	.. 16s. 6d.	,,	Cheaper.
Coumarin ..	.. 20s.	,,	
Citronellol ..	.. 16s.	,,	
Citral ..	.. 10s.	,,	
Ethyl Cinnamate ..	.. 15s.	,,	
Ethyl Phthalate ..	.. 3s. 9d.	,,	
Eugenol ..	.. 11s.	,,	Advanced.
Geraniol (Palmarosa)	.. 35s.	,,	
Geraniol ..	.. 10s.—17s. 6d. per lb		
Heliotropine ..	.. 8s. 3d. per lb.		
Iso Eugenol ..	.. 15s. 9d.	,,	
Linalol ex Bois de Rose ..	21s. 6d.	,,	
Linalyl Acetate ..	.. 21s. 6d.	,,	
Methyl Anthranilate	.. 9s. 6d.	,,	
Methyl Benzoate ..	.. 6s.	,,	
Musk Ambrette ..	.. 52s. 6d.	,,	
Musk Xylol ..	.. 19s.	,,	
Nerolin ..	.. 4s.	,,	
Phenyl Ethyl Acetate	.. 12s. 6d.	,,	
Phenyl Ethyl Alcohol	.. 16s.	,,	
Rhodinol ..	.. 57s. 6d.	,,	
Safrol ..	.. 1s. 10d.	,,	
Terpineol ..	.. 2s. 9d.	,,	
Vanillin ..	.. 25s. 3d.—26s. 6d. per lb.		

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. ..	.. 15s. per lb.
Anise Oil ..	.. 2s. 6d. per lb. Firmer market forward.
Bergamot oil ..	.. 17s. per lb. Still advancing.
Bourbon Geranium Oil ..	32s. ,, ,, ,,
Camphor Oil ..	.. 75s. per cwt.
Cananga Oil, Java	.. 10s. per lb.
Cinnamon Oil, Leaf	.. 6½d. per oz.
Cassia Oil, 80/85%	.. 9s. 3d. per lb.
Citronella Oil—	
Java 85/90% ..	.. 5s. 3d. ,,
Ceylon ..	.. 3s. 9d. ,,
Clove Oil ..	.. 8s. 4½d. ,,
Eucalyptus Oil 70/75%	.. 2s. 3d. per lb.
Lavender Oil—	
French 38/40% Esters	24s. 6d. per lb.
Lemon Oil ..	.. 3s. 4d. ,, dearer.
Lemongrass Oil	.. 2¾d. per oz.
Orange Oil, Sweet	.. 12s. 6d. per lb.
Otto of Rose Oil—	
Bulgarian ..	.. 30s. per oz.
Anatolian ..	.. 24s. 6d. per oz.
Palma Rosa Oil ..	.. 18s. 6d. per lb. Very short supply.
Peppermint Oil—	
English ..	.. 70s. per lb.
Wayne County	.. 19s. 3d. per lb. Again advanced.
Japanese ..	.. 18s. 3d. per lb., but very little being offered.
Petitgrain Oil ..	.. 9s. 6d. per lb.
Sandal Wood Oil—	
Mysore ..	.. 25s. per lb.
Australian ..	.. 21s. per lb.

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition within two months of the date given; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, 15 days after the date given.

I.—GENERAL; PLANT; MACHINERY

Applications

Akt.-Ges. für Chemische Produkte vorm. H. Scheidemandel, Askenasy, and Sakom. Manufacture of colloidal substances in grains etc. 5173. Feb. 28.

Bibby. 5668. *See* 11.

British Thomson-Houston Co., Ltd. Processes for making emulsions. 4819. Feb. 25. (U.S., 27.2.23.)

Carretero. Drying apparatus. 5354. Mar. 1. (Sp., 7.6.23.)

Compagnie Générale du Basalte C.G.B. Tilting melting-furnace. 4944. Feb. 26. (Fr., 29.6.23.)

Grauss. Centrifugal drying-machines etc. 5552. Mar. 4. (Fr., 8.3.23.)

Hansen. Method of producing porous substances. 5997. Mar. 8. (Denmark, 9.2.24.)

Hertenbein. Apparatus for extraction of solid matters in suspension in liquids. 5971. Mar. 8. (Fr., 12.3.23.)

Hood. Mixing-machine. 5692. Mar. 5.

International Combustion Engineering Corporation. Pulverisers. 4833. Feb. 25. (U.S. 15.3.23.)

Lengersdorff. Furnaces etc. 4924. Feb. 26. (Ger., 26.2.23.)

Millar. Crystallisation and drying of soluble substances. 5219. Feb. 29.

Nyrop. Treatment of liquids alone or in conjunction with gases or vapours. 4826. Feb. 25.

Pehrson and Pehrson. Rotary furnaces. 4798. Feb. 25.

Rigby. Rotary kilns. 5289. Mar. 1.

Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Separation of gaseous mixtures. 4799. Feb. 25. (Fr., 10.3.23.)

Soc. l'Air Liquide, Soc. Anon. pour l'Etude et l'Exploitation des Procédés G. Claude. Purification of gases etc. 6017. Mar. 8. (Fr., 20.11.23.)

Cooke and Michel. Agitating and mixing device. 6067. Mar. 10.

Deutsche Ton- und Steinzeug-Werke A.-G. Grinding-mills. 6394. Mar. 12. (Ger., 3.12.23.)

Garstang. Furnaces. 6337. Mar. 12.

Haas. Drying-tunnel etc. 6184. Mar. 11.

Hanemann and Speichert. Vacuum furnaces. 6426. Mar. 12. (Ger., 15.3.23.)

Hutchins and Swinburne. Extraction of dust etc. from gases and liquids. 6259. Mar. 11.

Lloyd. Filtering liquids. 6527. Mar. 13.

Merle. Method of manufacturing solid products from liquid or plastic materials. 6524. Mar. 13.

Patterson, and Worthington-Simpson, Ltd. Evaporators. 6514. Mar. 13.

Sellars. Preparations for building furnaces etc. 6176. Mar. 11.

Soc. Anon. le Carbone. Process for rendering porous powder impermeable to liquids. 6623. Mar. 14. (Fr., 27.12.23.)

Wade (Silica Gel Corporation). Separating a gas from a mixture of gases. 6296. Mar. 11.

Complete Specifications Accepted

29,946 (1922) and 4554 (1923). Mackenzie, Silvester, and Outwin. Fractionating, distilling, or scrubbing column. (211,542.) Mar. 5.

32,160 (1922). Jung. Filtering apparatus. (197,910.) Mar. 5.

32,231 (1922). Schnetzer. Preventing formation of scale in steam-boilers, evaporators, economisers, etc. (211,588.) Mar. 5.

32,700 (1922). Pickford. Recovery of volatile liquids, solvents, etc. (211,599.) Mar. 5.

32,734 (1922). Cashman. Furnaces. (211,962.) Mar. 12.

32,753 (1922). Burn, Lancaster, and Langford. Mixing or washing viscous, plastic, or pulverulent substances. (211,965.) Mar. 12.

1570–1 (1923). Patrick. Manufacture of catalytic agents. (212,034–5.) Mar. 12.

3938 (1923). Silica Gel Corporation, and Patrick. Manufacture of gels. (212,065.) Mar. 12.

5111 (1923). Minimax Ges. Production of foam for fire-extinguishing. (204,007.) Mar. 12.

6316 (1923). Knight and Smith. Means for separating liquids of different specific gravities. (211,717.) Mar. 5.

6445 (1923). Appareils et Evaporateurs Kestner. Evaporating apparatus for concentrating acid liquids. (195,365.) Mar. 5.

13,502 (1923). Oderberger Chemische Werke Akt.-Ges. Production of colloidal solutions and reversible dried residues. (197,966.) Mar. 12.

19,609 (1923). Roeder. *See* V.

24,423 (1922) Ionides, and Ransome Machinery Co. (1920), Ltd. Mixing machines (212,163.) Mar. 19.

30,726 (1922). Naamlooze Vennootschap Algemeene Norit Maatschappij. Process for treating liquids. (188,667.) Mar. 19.

33,341 (1922). Gill. Furnaces, gas-producers, etc. (212,303.) Mar. 19.

735 and 734 (1923). Roucka. Indicating, measuring, or recording physical or chemical quantities or qualities at a distance. (191,729 and 191,730.) Mar. 19.

901 (1923). Elmore, and Chemical and Metallurgical Corporation, Ltd. Tanks and other objects with acid-resisting linings and coverings. (212,355.) Mar. 19.

4115 (1923). Roucka. Apparatus for indicating, measuring, or recording physical or chemical quantities or qualities. (193,398.) Mar. 19.

6982 (1923). Roucka. Apparatus for recording physical or chemical values. (194,717.) Mar. 19.

20,531 (1923). McIntyre, and Milne and Son, Ltd. Grinding, refining and mixing machines. (212,490.) Mar. 19.

II.—FUEL; GAS; DESTRUCTIVE DISTILLATION; MINERAL OILS; LIGHTING

Applications

Bibby. Filtration of gas etc. 5668. Mar. 8.

Donald. Drying peat etc. 5108. Feb. 28.

Fathers and L[illegible]h. Manufacture of fuel briquettes. 5819. Mar. 6.

General E[illegible] Ltd. Manufacture of incandescent bodies [illegible] etc. 5060. Feb. 27. (Ger., 29.8.23.)

Goffin. Manufacture of coal gas. 5970. Mar. 8.

Goskar. Manufacture of carbonised briquettes. 594 Mar. 8.

Goyan. Bituminous solution. 5756. Mar. 6.

Green. Water-gas plants. 4982. Feb. 27.

Heath. Manufacture of hydrocarbons of low boiling poin from hydrocarbons of high boiling point. 5049. Feb. 27.

Hinman. Artificial fuel. 4821. Feb. 25.

Jackson. 4900. *See* IX.

Koppers. Ovens for distilling fuel. 5449. Mar. 3 (Ger., 2.3.23.)

Mackenzie, Outwin, and Sylvester. Carbonising plant etc 5272. Feb. 29.

Minerals Separation, Ltd., and Wood. Treatment o finely divided coal. 5263. Feb. 29.

Morris. Gas-generating apparatus. 5306. Mar. 1.

Novák and Trebicky. Extraction of coal, peat, etc. 5790 Mar. 6.

Simon. Combustion of waste and residues. 5770. Mar. 6

Simon. Firings for readily-ignitable fuels. 5771. Mar. 6 (Ger., 10.3.23.)

Simon. Combustion of granular etc. fuels. 5772. Mar. 6 (Ger., 5.4.23.)

Smith. Heat treatment for fuels etc. 5103. Feb. 28

Thompson. Apparatus for drying and utilisation of peat 4845. Feb. 26.

Aktiebolaget Separator. Reclaiming oil from chips 6140. Mar. 10. (U.S., 23.8.23.)

British Thomson-Houston Co., Ltd. 6510. *See* XII.

Dunstan, Pitkethly, and Smith. Utilisation of gas. 6371. Mar. 12.

Forwood and Taplay. Treatment and production of hydrocarbons. 6705. Mar. 15.

Glasgow. Manufacture of water-gas. 6521. Mar. 13.

Rice. Smokeless fuel. 6223. Mar. 11.

Complete Specifications Accepted

33,113 (1922). Jorgonsen, Ronne, and Middelboe. *See* IX.

33,335 (1922). Du Boistesselin, Dubois, Tabb, Varnier, and Hertenbein. Agglomeration of powdered or finely crushed fuel by means of pitch. (197,639.) Mar. 19.

33,341 (1922). Gill. *See* I.

33,563 (1922). Lymn. Utilising caking fuel in gas-producers. (212,311.) Mar. 19.

23,087 (1923). Boyen. Purification of brown coal wax. (209,389.) Mar. 19.

26,805 (1922). Smallwood. *See* X.

29,068 (1922). Kirke. Water-gas plants. (211,537.) Mar. 5.

29,111 (1922) and 17,607 (1923). Lockwood. Treatment of coal or other mineral. (211,538.) Mar. 5.

31,686 (1922). Algemeene Norit Maatsch. Production of decolorising carbon. (189,148.) Mar. 5.

32,387 (1922). Koppers Co. Purification of gases. (190,131.) Mar. 12.

32,961 (1922). Marshall. *See* XII.

1787 (1923). V.L. Oil Processes, Ltd., and Lucas. Treatment of mineral oils. (211,664.) Mar. 5.

1922 (1923). Greene and Laucks. Carbonising coal. (211,667.) Mar. 5.

3190 (1923). Starkey. Low or medium temperature distillation of oil shale, bituminous coal, etc. (212,053.) Mar. 19

10,879 (1923). Travers and Clark. Manufacturers of gas from coal etc. (211,748.) Mar. 5.

27,677 (1923). Koppers Co. Purification of gases. (212,201. Mar. 12.

31,451 (1923). Algem. Norit Maatsch. Process of producing decolorising carbon. (208,555.) Mar. 5.

III.—TAR AND TAR PRODUCTS

Applications

Edwards. Production of phenolic compounds from co tar etc. 6352. Mar. 12.

[illegible]

solid hydrocarbons from tars. 6268. Mar. 11. (Ger., 11.9.23.)

Rütgerswerke Akt.-Ges. Decreosoting tar and tar oils. 6608. Mar. 14. (Ger., 24.3.23.)

IV.—DYESTUFFS AND INTERMEDIATES

Applications

Durand et Huguenin Soc. Anon. Production of fast dyes. 5365. Mar. 1. (Ger., 9.3.23.)

Durand u. Huguenin Akt.-Ges. Manufacture of mordant dyestuffs. 5441. Mar. 3.

Pereira. Manufacture of vat dyes. 4937. Feb. 26. (Austria, 2.3.23.)

Pereira. Manufacture of vat dyes. 4938. Feb. 26. (Austria, 7.4.23.)

Scottish Dyes, Ltd., Smith, and Thomas. Production and purification of colouring-matters. 5273. Feb. 29.

Carpmael (Farbenfabr. vorm. F. Bayer und Co.). Manufacture of dyestuffs. 6241. Mar. 11.

Carpmael (Farbenfabr. vorm. F. Bayer und Co.). Manufacture of dyes. 6507. Mar. 13.

Cie. Nationale de Mat. Colorantes et de Prod. Chim. Manufacture of black vat dyestuffs. 6632. Mar. 14. (Fr., 16.3.23.)

Ransford (Cassella und Co.). Manufacture of dyestuffs. 6506. Mar. 13.

Scottish Dyes, Ltd., and Thomas. Production of dyestuff intermediates. 6091. Mar. 10.

Scottish Dyes, Ltd., and Woodcock. Manufacture of anthraquinone derivatives. 6092. Mar. 10.

Complete Specifications Accepted

29,258 (1922). Burt, Boulton, and Haywood, Ltd., and Miles. Manufacture of indophenolic bodies. (211,541.) Mar. 5.

1223 (1923). Green, Saunders, Frank, and British Dyestuffs Corporation, Ltd. Manufacture of azo dyestuffs. (212,029.) Mar. 12.

1314 (1923). Green, Saunders, Frank, and British Dyestuffs Corporation, Ltd. Manufacture of azo dyestuffs. (212,030.) Mar. 12.

9708 (1923). Imray (Soc. of Chemical Industry in Basle). Manufacture of monoazo dyestuffs. (211,742.) Mar. 5.

10,584 (1923). Johnson (Badische Anilin u. Soda Fabrik). Manufacture of vat colouring-matters. (212,145.) Mar. 12.

11,223 (1923). Bloxam (Chem. Fabr. Griesheim-Elektron). Manufacture of azo dyestuffs. (211,752.) Mar. 5.

20,401 (1923). Durand u. Huguenin Akt.-Ges. *See* VI.

20,488 (1923). Durand u. Huguenin Akt.-Ges. *See* VI.

20,748 (1923). Johnson (Badische Anilin u. Soda Fabrik). Manufacture of vat colouring matters. (211,802.) Mar. 5.

25,666 (1923). Pereira. *See* XX.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER

Applications

Bader, Eggert, and Wagner. Process for making artificial horn etc. from viscose. 5629. Mar. 5.

Cross, and Viscose Development Co. Manufacture of cellulose products. 5785. Mar. 6.

Granton. Method for de-inking printed paper. 5349. Mar. 1.

Havenith. Manufacture of artificial silk. 4777. Feb. 25.

Hinchley, and Stream-Line Filter Co. Recovery of detergents etc. used in cleaning fabrics. 5558. Mar. 4.

Newman. Paper. 4832. Feb. 25. (U.S., 2.11.23.)

Stocker. Treatment of artificial yarns wound on reels. 5512. Mar. 4.

Warren. Grinding wood pulp. 4896. Feb. 26.

A.-G. für Anilin-Fabr. Process of washing artificial silk. 6125. Mar. 10. (Ger., 3.12.23.)

Ingham. Treating paper. 6340. Mar. 12.

Marks (Naamlooze Vennootschaap Hollandsche Kunstzijde Industrie). Process for preparing artificial silk. 6100. Mar. 10.

... of separating animal and vegetable fibres. 6158. Mar. 10. (U.S., 24.4.23.)

Pott. Process of treating fibres etc. 6095. Mar. 10.

Walker. Waterproof material. 6532. Mar. 13.

Complete Specifications Accepted

4219 (1923). Hölken. Manufacture of artificial silk threads. (212,068.) Mar. 12.

4220 (1923). Hölken. Making artificial silk threads. (211,691.) Mar. 5.

7821 (1923). Dehn (United States Wool Co.). Wool product. (211,729.) Mar. 5.

9447 (1923). Olander and Moisio. Manufacture of paper. (211,740.) Mar. 5.

16,009 (1923). Carpenter Chemical Co. Methods of treating silk. (199,729.) Mar. 5.

19,609 (1923). Roeder. Manufacture of fabrics for filter etc. (201,919.) Mar. 5.

15,405 (1923). Leo. Paper manufacture. (212,471.) Mar. 19.

VI.—BLEACHING; DYEING; PRINTING; FINISHING

Applications

Baddiley, Browning, and British Dyestuffs Corporation. Dyeing acetyl cellulose. 5045. Feb. 27.

British Dyestuffs Corporation, and Sanderson. Dyeing acetyl silk. 6027. Mar. 8.

Courlander. Preparation for bleaching etc. fabrics. 4875. Feb. 26.

Farbenfabr. vorm. F. Bayer u. Co. Dyeing acidyl celluloses etc. 5690. Mar. 5. (Ger., 28.5.23.)

Farrar and Whitehead. Dyeing-machines. 5635 and 5636. Mar. 5.

Buchanan. Bleaching and dyeing kiers etc. 6576. Mar. 14.

Elson and Hermon. Dyeing yarns etc. 6258. Mar. 11.

Higgins, Kershaw, and Bleachers Assoc., Ltd. Production of effects on textiles. 6663. Mar. 15.

Ingham. Treating paper. 6340. Mar. 12.

Ogden. Decolorising or bleaching animal fibres. 6159. Mar. 10.

Complete Specifications Accepted

28,881 (1922). Plauson's (Parent Co.), Ltd. (Plauson). Dyeing. (211,912.) Mar. 12.

4863 (1923). Smethurst. Apparatus for bleaching etc. (212,084.) Mar. 12.

6738 (1923). British Dyestuffs Corporation, Ltd., Baddiley, and Shepherdson. Dyeing acetyl cellulose. (211,720.) Mar. 5.

10,664 (1923). Nuttall. Apparatus for dyeing and sizing yarns. (212,146.) Mar. 12.

18,442 (1923). Fuld and Hatch Knitting Co. Yarn-dyeing devices. (211,437.) Mar. 12.

20,401 (1923). Durand u. Huguenin Akt.-Ges. Manufacture of products for dyeing or printing textile fibres and other materials. (202,630.) Mar. 12.

20,488 (1923). Durand u. Huguenin Akt.-Ges. Manufacture of products for dyeing and printing textile fibres and other materials. (202,632.) Mar. 12.

18,235 (1923). Schoeller Gob. Apparatus for printing warps. (201,544.) Mar. 19.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS

Applications

Jahl, and Michael & Co. Production of soluble barium salts. 4967. Feb. 27.

Johnson (Badische Anilin- u. Soda-Fabrik). Manufacture of alkali cyanide. 5345. Mar. 1.

Nathansohn. 5351. *See* X.

Nathansohn. 5352. *See* XIII.

Metal Traders, Ltd. Production of sulphuric acid. 6404. Mar. 12. (Ger., 7.4.23.)

Rhenania Verein Chemischer Fabriken Akt.-Ges. and Ster. Manufacture of barium hydroxide or strontium hydroxide. 6151. Mar. 10.

Smith, and Chemical and Metallurgical Corp. Treatment of lead chloride. 6734, 6735. Mar. 15.

Smith. Method of producing white commercial pure ammonium chloride. 6618. Mar. 14.

COMPLETE SPECIFICATIONS ACCEPTED

29,791 (1922). Nitrogen Corporation. Ammonia synthesis autoclave. (188,651.) Mar. 12.

2665 (1923). Howard and Alvord. Process of making metal sulphides. (212,045.) Mar. 12.

7813 (1923). Verein für Chemische und Metallurgische Produktion. Production of chemically-pure hydrochloric acid. (196,258.) Mar. 5.

18,911 (1923). Jackson (L'Air Liquide Soc. Anon.). Separation of the constituents of air and the production of argon. (212,185.) Mar. 12.

19,218 (1923). Henkel et Cie., and Weber. Treatment of ammonium chloride lyes in iron vessels. (211,791.) Mar. 5.

23,950 (1923). Norsk Hydro-Elektrisk Kvaelstofaktieselskab. Process for the synthetic production of ammonia. (205,477.) Mar. 12.

6445 (1923). Appareils et Evaporateurs Kestner. *See* I.

14,954 (1923). Urfer. Synthetic production of ammonia. (199,032.) Mar. 19.

VIII.—GLASS; CERAMICS

APPLICATIONS

Michaelis. Manufacture of plate glass. 4897. Feb. 26. (Ger., 2.3.23.)

Oppermann. Melting glass. 4864. Feb. 26. (Belg., 23.5.23.)

Rowart. Drawing glass in sheet form. 5332. Mar. 1. (Belg., 5.3.23.)

Wade (Empire Machine Co.). Cooling and annealing sheet glass. 5548. Mar. 4.

Sellars. 6176. *See* I.

Soc. Anon. dite Progil. Cold enamelling on wood, metal, etc. 6122. Mar. 10. (Fr. 7.5.23.)

Young. Manufacture of porcelain etc. 6697. Mar. 15.

COMPLETE SPECIFICATIONS ACCEPTED

28,039 (1922). Grönqvist. Production of metallic coatings on refractory materials. (211,530.) Mar. 5.

30,764 (1922). Ruck and Lehane. Manufacture of refractory articles, such as retorts. (211,543.) Mar. 5.

12,621 (1923). Chem. Werke vorm. Auerges. Rendering enamel opaque. (197,933.) Mar. 5.

27,582 (1923). Danin. Production of refractory articles. (212,501.) Mar. 19.

IX.—BUILDING MATERIALS

APPLICATIONS

Cape Asbestos Co., Ltd., and Gow. Material for forming walls etc. 4905. Feb. 26.

Carpenter. Binder for binding an aggregate. 5600. Mar. 4.

Govan. 5756. *See* II.

Jackson (Warren). Manufacture of bituminous compositions. 4900. Feb. 26.

Lorenzetti, Marpillero, and Marzola. Manufacture of fibrous building material etc. 5867. Mar. 7.

Müller. Manufacture of bricks etc. for resisting X-rays etc. 5450. Mar. 3. (U.S., 8.9.23.)

Subox Akt.-Ges. Manufacture of building materials. 5581. Mar. 4. (Ger., 26.3.23.)

Ebner. Treatment of materials for manufacture of structural articles. 6588 [illegible] 14.

McHardy. Seasoning [illegible] 6196. Mar. 11.

COMPLETE SPECIFICATIONS ACCEPTED

33,113 (1922). Jo[illegible], Ronne, and Middelboe. Utilization of the combustion gases from rotary cement burning kilns. (212,298.) [illegible]r. 19.

33,340 (1922). Kitchen, Lefebure, and Powell Wood Process Syndicate, Ltd. Impregnation of timber. (212,301.) Mar. 19.

22,982 (1922). Andrews. Manufacture of Portland cement (211,517.) Mar. 5.

32,524 (1922) and 4269 (1923). Hodson. Manufacture of basic bricks etc. (211,944.) Mar. 12.

6192 (1923). Building Accessories and Flooring Co., Ltd., Goodwin, and Smith. Manufacture of coloured asphalt. (212,106.) Mar. 12.

21,143 (1923). Building Accessories and Flooring Co., Ltd., Goodwin, and Smith. Manufacture of asphalt. (212,188.) Mar. 12.

7250 (1923). Eriksson. Manufacture of a porous material from Portland cement. (212,419.) Mar. 19.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY

APPLICATIONS

Bagley. Blast etc. furnaces. 6625. Mar. 14.

Ellis (Bliss Co.). Process for working zinc. 6282. Mar. 11.

Ellis (Gamlon). Process for reducing ores. 6729. Mar. 15.

Ellis. Means for reducing ores. 6730. Mar. 15.

Morgan and Levin. Manufacture of wrought iron by piling. 6706. Mar. 15.

Rushen (Schreger). Utilisation of blast-furnace dust, burnt-out pyrites, etc. 6533. Mar. 13.

Smeeton, Smeeton-Wright Furnaces, Ltd. Protecting metals during cooling. 6548. Mar. 13.

Southern. Roasting and calcining ores etc. 6627. Mar. 14.

Cachemaille (Westinghouse Lamp Co.). Manufacture of thorium or bodies coated with thorium etc. 5037. Feb. 27.

Calver and Pocock. Treatment of metals etc. 5071. Feb. 27.

Compagnie Générale du Basalte C.G.B. 4944. *See* I.

Ferranti, Ltd., and Ferranti. Protection of metals. 5603. Mar. 4.

Ford. Manufacture of puddled iron. 5500. Mar. 4. (U.S., 9.4.23.) Mar. 4.

Hennes. Extracting metals from ores etc. 5697. Mar. 5.

Hutchins. Electrodeposition of metals. 5604. Mar. 4.

Millar. Desulphurisation and concentration of sulphide iron ores. 5908. Mar. 7.

Nathansohn. Separation of lead and zinc in roasted compound ores. 5174. Feb. 28.

Nathansohn. Process for obtaining products for metallurgical treatment from zinc chloride solutions. 5351. Mar. 1. (Ger., 9.7.23.)

Rogers. Silicon steel. 5194. Feb. 29.

Skappel. Splitting up ores etc. 4939. Feb. 26. (Nor., 26.2.23.)

Snead and Co. Heating and annealing metals. 4711. Feb. 25. (U.S., 15.3.23.)

Thierry. Welding aluminium. 6018. Mar. 8. (Fr., 20.6.23.)

COMPLETE SPECIFICATIONS ACCEPTED

32,682 (1922). Sunderland, and Sutcliffe. Bright annealing of wire etc. (212,291.) Mar. 19.

13,105 (1923). Fox. Treating the surface of bronze, brass, and like metals. (212,457.) Mar. 19.

26,805 (1922). Smallwood. Manufacture of ore or fuel briquettes etc. (211,529.) Mar. 5.

28,039 (1922). Grönqvist. *See* VIII.

28,919 (1922). Moxham. Treatment of silicious metal-bearing minerals. (211,536.) Mar. 5.

29,256–7 (1922) and 10,721 (1923). Leighton and Dendel. Manufacture of gold leaf. (211,539–40.) Mar. 5.

1321, 11,642–3 (1923). Petrie, and Petrie and McNaught, Ltd. Sherardising metals in wire or strip form. (212,0[illegible].) Mar. 12.

1356 (1923). Chief Consolidating Mining Co. Treatment of silicious ores. (201,879.) Mar. 5.

7252 (1923). Marks (American Manganese Steel Co.). Electric furnace melting of manganese steel scrap. (212,121.) Mar. 12.

8800 (1923). Jones. Smelting furnace. (212,136.) Mar. 12.

10,337 (1923). Harrison (Robertson Co.). Protecting metal articles. (211,746.) Mar. 5.

14,097 (1923). Potts (Electro-Metallurgical Co.). Zirconium steel and process of making same. (212,171.) Mar. 12.

15,061 (1923). Duparc. Alloy. (200,074.) Mar. 5.

17,831 (1923). Rossi. Powder for soldering aluminium. (211,780.) Mar. 5.

30,405 (1923). Rousseau. Machines for recovering precious metals. (212,208.) Mar. 12.

XI.—ELECTRO-CHEMISTRY

Applications

Brown. Storage batteries. 6332. Mar. 12.

Loke. Electric furnaces etc. 6134. Mar. 10.

Slater, Cunningham, and Fine Cotton Spinners' and Doublers' Assoc. Insulating material. 6724. Mar. 15.

Stimmel, Willis, and Consolidated Mining and Smelting Co. of Canada, Ltd. Acid-proof structures for electrolytic etc. operations. 6310. Mar. 12.

Brindley. Electric primary cells. 5246. Feb. 29.

Fuller's United Electric Works, Ltd., and Welch. Thermo-electric batteries. 4837. Feb. 26.

Hutchins. 5604. *See* X.

Müller and Strasser. Lead electrodes for accumulators. 5251. Feb. 29. (Swiss., 8.3.23.)

Price. Electric accumulators. 5343. Mar. 1.

Complete Specifications Accepted

31,895 (1922) and 20,868 (1923). Seal Co. (London), Ltd., Pattinson, Rose, and Jascourt. Inert galvanic cells. (211,571.) Mar. 5.

33,194 (1922). Quain. Ozone apparatus. (211,982.) Mar. 12.

6089 (1923). Mallett. Secondary batteries. (211,714.) Mar. 5.

7252 (1923). Marks. *See* X.

22,008 (1923). Metropolitan-Vickers Electrical Co., Ltd. (Westinghouse Electric and Manufacturing Co.). Electric furnaces. (212,190.) Mar. 12.

22,009 (1923). Metropolitan-Vickers Electrical Co., Ltd. (Westinghouse Electric and Manufacturing Co.). Electric furnaces. (212,191.) Mar. 12.

XII.—FATS; OILS; WAXES

Applications

Douglas-Pectin Corporation. Oil or fat emulsions. 4969. Feb. 27. (U.S., 4.9.23.)

Wilson. Detergent compositions etc. 5374. Mar. 3.

British Thomson-Houston Co., Ltd. Methods of protecting oils against oxidation. 6510. Mar. 13. (Fr., 13.3.23.)

Price. Treatment of oils. 6544. Mar. 13.

Complete Specifications Accepted

31,632 (1922). Dujardin. *See* XIX.

32,961 (1922). Marshall. Solutions of non-mineral oils with mineral oils. (211,978.) Mar. 12.

13,566 (1923). Lewis. Extraction of oils and fats from oil or fat bearing material. (212,461.) Mar. 19.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS

Applications

Jones. Manufacture of paint. 6704. Mar. 15.

Free, Shuck, and Maclean and Co. Manufacture of printing-inks. 6543. Mar. 13.

Nathansohn. Process for obtaining lead carbonate. 5352. Mar. 1. (Ger., 26.1.23.)

Complete Specifications Accepted

22,727 (1922). Gardner. Paints, enamels, japans, etc. (211,516.) Mar. 5.

6432 (1923). Smith (Indelible Coloration Corporation). Fusible staining-ink. (211,718.) Mar. 5.

XIV.—INDIA-RUBBER; GUTTA-PERCHA

Applications

Cohen. Manufacture of rubber from latex. 6619. Mar. 14. (Holl., 4.12.23.)

Broomfield and Russell. Manufacture of rubber compounds. 4892. Feb. 26.

Complete Specifications Accepted

22,645 (1922). Owen, and Rowe, White, and Co. Manufacture of articles from rubber. (211,515.) Mar. 5.

24,592 (1922). White (Goodrich and Co.). Manufacture of vulcanised articles. (211,524.) Mar. 5.

XV.—LEATHER; BONE; HORN; GLUE

Applications

Anderson. Manufacture of leather. 6066. Mar. 10.

Simmons, and British Xylonite Co., Ltd. 6714. *See* XIX.

Fitzgerald. Production of mouldable products from blood. 6082. Mar. 10.

Fitzgerald. Moulding solid objects obtained from blood etc. 6083. Mar. 10.

Bader, Eggert, and Wagner. 5629. *See* V.

British United Shoe Machinery Co. (United Shoe Machinery Corp.). Tanning hides etc. 5404. Mar. 3.

Miller. Treatment of leather. 5883. Mar. 7.

Walter. Manufacture and treatment of leather. 5789. Mar. 6.

Complete Specification Accepted

10,583 (1923). Johnson (Badische Anilin u. Soda Fabrik). Manufacture of tanning materials. (212,144.) Mar. 12.

XVI.—SOILS; FERTILISERS

Application

Adelantado. Manufacture of phosphate fertiliser. 5710. Mar. 5.

Complete Specification Accepted

27,377 (1922). Thompson. *See* XIX.

XVII.—SUGARS; STARCHES; GUMS

Applications

Schlüter. Production of rice-starch. 5510. Mar. 4.

Kalhauge and Jorgensen. 6636. *See* XVIII.

Maxwell. Extraction of sugar. 6531. Mar. 13.

XVIII.—FERMENTATION INDUSTRIES

Application

Kalhauge and Jorgensen. Method of producing yeast from molasses etc. 6636. Mar. 14.

Complete Specification Accepted

29,576 (1923). Langemeyer. Manufacture of yeast. (207,546.) Mar. 19.

XIX.—FOODS; WATER PURIFICATION; SANITATION

Applications

Berczeller. Treatment of soy beans. 5327. Mar. 1.

Bolton and Mills. Apparatus for treatment of sewage etc. 4716. Feb. 25.

Bradley, Whynmper, and Peek, Frean and Co. Manufacture of chocolate. 5805. Mar. 6.

Croft and Letten. Manufacture of fish meal etc. 4985. Feb. 27.

Douglas-Pectin Corporation. Manufacture and use of a jellifying product. 4968. Feb. 27. (U.S., 23.4.23.)

Faitelowitz. Production of preserves of fruit etc. 4767. Feb. 25.

Magrath. Softening, sterilising, etc. water. 5550. Mar. 4.

Reynolds, and Joyes' Sanitary Compounds Co., Ltd. Purification of air. 6280. Mar. 11.

Simmons, and British Xylonite Co., Ltd. Manufacture of casein products. 6714. Mar. 15.

COMPLETE SPECIFICATIONS ACCEPTED

21,645 (1922). Sauer. Process for purifying liquids. (184,473.) Mar. 5.

26,617 (1922). Ward Baking Co. Production of food products. (186,634.) Mar. 19.

27,377 (1922). Thompson (Visser). De-watering activated sludge and producing a fertiliser therefrom. (212,220.) Mar. 19.

31,632 (1922). Dujardin. Manufacture of cattle-feeding cakes and oil. (211,923.) Mar. 12.

31,698 (1922). Elektro-Osmose A.-G. (Graf Schwerin Ges.), Ruppel, and Dietrich. Purification of water. (211,562.) Mar. 5.

12,587 (1923). Hilditch, Wheaton, and Crosfield and Sons, Ltd. Means for purifying or softening water by means of base-exchanging compounds. (212,453.) Mar. 19

XX.—ORGANIC PRODUCTS: MEDICINAL SUBSTANCES; ESSENTIAL OILS

APPLICATIONS

Agoleum Ges. Preparing stable colloidal solutions of silver. 6228. Mar. 11. (Austria, 14.3.23.)

Naugatuck Chemical Co. Treating styrol etc. 6251. Mar. 11. (U.S., 30.6.23.)

Sartig. Process of denicotinising tobacco. 5678. Mar. 5.

Soc. of Chemical Industry in Basle. Manufacture of 4-oxynaphthalene-1-arylketones. 5784. Mar. 8. (Swiss, 6.3.23.)

Wade (Karpen and Bros.). Manufacture of hexamethylenetetramine. 4932. Feb. 26.

COMPLETE SPECIFICATIONS ACCEPTED

32,520 (1922). Hirchberg. Compositions containing formaldehyde. (211,943.) Mar. 12.

14,502 (1923). Imray. (Soc. of Chemical Industry in Basle). Manufacture of solutions for medical injection. (211,771.) Mar. 5.

14,672 (1923). Bloxam. (Chem. Fabr. Griesheim-Elektron). Manufacture of acylacetyl compounds. (211,722.) Mar. 5.

21,181 (1923). Layraud. Manufacture of new salts of C.C-di-substituted barbituric acids. (202,660.) Mar. 12.

25,666 (1923). Pereira. Manufacture of 3.10-perylenequinone. (206,134.) Mar. 12.

26,749 (1923). Soc. des Etablissement Barbet. Apparatus for the production of formaldehyde by catalysis. (206,158.) Mar. 19.

28,997 (1923). Bloxam. (Chem. Fabr. Griesheim-Elektron). Manufacture of acylacetyl compounds. (211,814.) Mar. 5.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES

APPLICATIONS

Farmer. Colour photography and photographic printing. 5651. Mar. 5.

Sondermann, Woithe, and Ziehm. Manufacture of colloid layers containing chromate colloids sensitive to light. 6595. Mar. 14.

COMPLETE SPECIFICATIONS ACCEPTED

32,988 (1922). Clark. Production of photographic negatives. (212,294.) Mar. 19.

5000 (1923). [illegible]e. Light filters or screens. (212,390.) Mar. 19.

19,728 (1923). [illegible] Ges. für Anilin-fabrikation. Photographic films. (212[illegible]) Mar. 19.

XXII.—EXPLOSIVES; MATCHES

APPLICATIONS

Gurney. Matches. 4838. Feb. 26.

Rees. Matches etc. 5498. Mar. 4.

Schulz. Method of impregnating lucifer matches. 54 Mar. 3. (Ger., 6.3.23.)

XXIII.—ANALYSIS

APPLICATION

Newton and Newton. Apparatus for detecting noxic gases in the atmosphere. 5906. Mar. 7.

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific number:—*Argentina*: Centrifugal pumps (9319/F.L./E.C./A./2); *Australia*: Bootmaking materials (412/7/1/1/215); *Belgium*: Artificial silk (286); *Brazil*: Artificial silk yarns (305); *British India*: Steel (The Directors, Madras and Southern Mahratta Railway Co., Ltd., 25, Buckingham Palace Road, London, S.W. 1); *Italy*: Linseed oil, varnishes (293), leathers (22275/F.W./M.C./2); *Norway*: Electrodes (298); *Poland*: Shellac, gum arabic (301); *United States*: Mustard-seed oil, rapeseed oil (22291/F.W./C.C./2).

Australia: Hardware (412/7/1/1/216); *Belgium*: Metals, chemicals (307); *British India*: Steel (East India Railway Co., 73-6, King William Street, London, E.C. 4, Ref. 3701/43/T.G./E.C.); *Ecuador*: Hardware (322); *Egypt*: Cast iron (12682/F.E/E.C/2); *France*: Sugar, (308); *Italy*: Leather (310); *Netherlands*: Artificial silk (313); Iron and steel tubes (314); *South Africa*: Fluid disinfectant (13,356/E.D./C.C./2); *United Kingdom*: Steel (Corporation of Trinity House, Trinity House, Tower Hill, London, E.C. 3); *United States*: Pharmaceutical goods, hardware (320).

Safeguarding of Industries Act

A complaint under Section 1 (5) of the above Act, that rongalite, sodium formaldehyde sulphoxylate and zinc formaldehyde sulphoxylate had been wrongly included by the Board of Trade in their lists of dutiable articles was recently submitted to arbitration under the above subsection, and the Referee has now awarded that they were properly so included and that the complaint has failed.

Patents in Jugoslavia

A copy of an Ordinance modifying the Regulations for applications for patents, etc., claiming priority under Article 4 of the Industrial Property Convention of 1911, may be consulted at the Patent Office Library, 25, Southampton Buildings, Chancery Lane, W.C. 2.

Trade Information

Mr. A. F. Bird, 22, Bedford Street, Strand, W.C. 2, has been appointed English agent for the sale of publications by the Chemical Catalog Co., Inc., of New York.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

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EDITORIAL

THE discussion on the organisation of the profession and science of chemistry held in the Hall of the Mechanical Engineers on the 23rd. of January, was extremely interesting. Mr. Woolcock opened the discussion in an admirable speech, handling the topic with shrewdness and tact. The remainder of the discussion was rather discursive, but some useful points were made in it. Reference has often been made to the solidity of the legal profession and many chemists consider that a rigid definition of the term "chemist" and a restriction of chemical employment to qualified chemists will solve a number of difficulties. A comparison of the two professions may be of interest in this connexion. There are probably many more lawyers in the country than chemists, but chemistry will probably in a very few years become of greater importance and the number of chemists using the word in a wide sense may greatly increase. At the moment the lawyers are comprised in two classes, barristers and solicitors, each clearly defined and closely protected. In addition to these the legal profession includes a few special varieties whose numbers are small, and a large number of assistants and clerks, highly skilled in their own intricate details, the majority of whom will never become either barristers or solicitors. There is no organisation or society which includes the whole profession. Every barrister belongs to one close corporation, every solicitor to another quite distinct one. The men who are destined to receive an income of only £250 or £300 or so a year probably do not belong to either. The solicitor acquires his position after an examination and an expensive and long apprenticeship. The barrister has to pass an examination which does not involve, we imagine, so much study as a chemical degree, but the passing of the examination does not suffice to teach the barrister his business. Only a small proportion of barristers actually practice their profession, and the difference between those who know their job and those who do not, is not tested by any examination. Degrees and other academic distinctions count for far less in the law than they do in science.

Instead of a score of chemical societies we find only the two great legal societies. The Society of Chemical Industry has a council with several committees, many local sections each with a committee and possibly a revision committee. Many of the members of the Society are also members of the Chemical Society, or the American Chemical Society, or the Institute, or the Dyers and Colourists, or some of the other organisations. These have their committees also and there must be several hundred members of the Society who are on some chemical committee and perhaps a hundred members who are on several committees. Many of our chemists spend an appreciable proportion of their time, perhaps a fifth, attending committee and other meetings. The average lawyer spends no time on such work; he cannot afford it. The necessary work is done by few individuals, but as there are only two societies the total volume of such work is very small. Then again the lawyers do not spend any time in reading papers to each other. They keep abreast of the progress of their work by reading their professional journals, which are few in number. No lawyer spends his evenings listening to papers on the consolidation of mortgages or the Rule in Shelley's Case. Some of our chemical friends spend several hours a week in attending various meetings in different parts of London and the Provinces, notwithstanding the fact that they can read all the most valuable papers a month later in a chemical publication. We are inclined to think that the value of these committee and other meetings is greatly over-estimated and that the time spent on them could be reduced to one-third without detriment to the science.

Again, there is much less specialisation in the law than in chemistry; the lawyers who specialise on divorce or on trade marks or on company law have no little society or journal of their own. They read the same journals as the other lawyers and never quite lose touch with the general progress of legal knowledge. The spare time of the lawyer is spent in legal committee and other meetings, but

outside his professional circle. You find lawyers on borough and town councils, acting as secretaries of golf-clubs, or debating in local political societies. How many chemists—we do not mean chemical manufacturers—are rural councillors, county councillors or privy councillors? How many are active members of the local Conservative, Liberal or Labour parties? How many are churchwardens or treasurers of local billiard clubs? Very few. How many are members of Parliament? The answer is none. How many write letters to the *Times*? The answer is two, and perhaps, their epistles are not always published. If chemists wish to make an impression on the public they should abandon the practice of reading papers to each other on some new method of detecting thiophene in beer or determining the hydrogen ion concentration of clay soils in Northamptonshire. This sort of information should be published. Every day you may read in the *Times* a few columns of legal reports written by barristers, but in language diluted to the level of intelligence of the readers of that paper, with some of the hard words left out. The chemical organisation of this country can be greatly improved, the publications made more efficient, much time and much money saved, provided only that the chemists wish this to be done. Do they wish anything to be done? do they wish it so much that a few hundred of them are willing to spend say a couple of hours a month or half-a-crown a month towards that object?

* * *

For some time past it has been known that the British Dyestuffs Corporation has been negotiating with the Interessengemeinschaft—the German chemical combine familiarly known as the "I. G."—with the object, it was supposed, of arriving at an agreement similar to that made between the "I. G." and the chief dyestuffs company in France. This much was surmised, and only a few days ago a member of the late Government refused to make a definite statement as to the position on the grounds of expediency. Much surprise—indeed, the chemical dovecotes are fluttering with excitement—has therefore been caused by the publication in the *Manchester Guardian* of the outlines of what is claimed "on good authority" to be the draft agreement between the German and British interests. In brief, the "agreement" provides that the British firm shall have a monopoly of the British dye market, and a percentage share of foreign and colonial markets, at the same time receiving technical help and information as to manufacturing processes. In return, the "I. G." will receive a half-share in the profits of the Corporation, which will guarantee that any dyes it imports shall not be sold at prices higher than those charged abroad, but not what price shall be charged for its own manufactures. The *Guardian* further states that the agreement has been reached with the "full knowledge of the Board of Trade," and that it can be fitted into the framework of the existing Dyestuffs Act without any need for fresh legislation. The agreement, however, could not be worked without Government sanction, owing to the £2,000,000 invested by the State in the Corporation, or without the approval of the Board of Trade, which, with the help of an Advisory Committee, controls the grant of licences to import dyes.

* * *

It is, indeed, surprising, and already there are signs of the formation of a vigorous opposition to the proposal. We may again quote the *Manchester Guardian*, which says, in brief, that under the shelter of the Dyestuffs (Regulation) Act we have tried, "with conspicuous ill-success, to foster an industry which shows no signs of being able to stand on its own legs when the protection is withdrawn," and that "either the British company will become a mere selling agency of the German combine," or it will become a British monopoly, "capable of holding colour-users to perpetual ransom." With the questions of monopoly or protection or any other political problem of the kind we have nothing to do. But we and all chemists are very much concerned with the significance of the step. The flourish of drum and trumpet, with which the Corporation was founded, and the magnificent promises for the future of the fine-chemical industry are still fresh in our mind, though, to the general public, such things may be as discarded faded wreaths of long-past, forgotten feasts. However, that is another story now, for we are supposed to be at peace. Working agreements between companies of different nationality have been made before and, as far as we are aware, with beneficial results; some of our readers may remember the agreement made some years ago in the tobacco industry. But definite information as to the present agreement must be furnished before an opinion can be formed. What, we wonder, do Sir William Pope, Prof. Morgan, Prof. Green, and Dr. Levinstein think of the proposal? In the meantime, we await, with still greater curiosity, the dictum of that veteran author of works on the statistical aspects of political economy, Mr. Sidney Webb, now President of the Board of Trade.

* * *

The American Journal of Pharmacy a few weeks ago, published a paper by Mr. J. N. Taylor, on the definition of a chemical. This quoted the definition of the Synthetic Organic Chemical Manufacturers' Association. "*Chemical*—A material containing a preponderating proportion of an individual substance of definite elementary composition." Mr. J. N. Taylor referred to the editorial comment in our issue of May 18 last and to other definitions and suggests for consideration that *in the strictest technical sense every material thing is a chemical.* This is a very wide definition and we suggest a narrower one for the consideration of our readers. If we assume that matter is composed of elements and compounds of elements, and that a combination of elements to form a compound or a change in the manner in which elements are combined in compounds is a chemical change, it might be possible to state that all elements and all compounds are "chemicals" and that the noun "chemical" also includes such mixtures and solutions as are used for the purpose of causing or affecting chemical change.

THE EXTRACTION OF OIL FROM SEEDS, NUTS AND KERNELS*

By J. BREWIS

There are few mills in this country in a position to concentrate on the extraction of oil from one or two particular seeds. Fluctuations in the prices of seeds, oils, cakes, the frequent small margin of profit after crushing and the fact that the demand for certain cakes is seasonal makes such a procedure impossible for the majority of mills.

It may be necessary to extract the oil from cotton, til or rape seeds, soya beans, groundnuts, Babassu kernels, copra, palm kernels, shea nuts, mowha seed, linseed or castor seed, and as practically each of these seeds and nuts possesses some distinct peculiarity, calling for special treatment, few mills are in a position to handle the complete range in the most efficient manner. The method of extracting the oil is frequently a matter of compromise—to suit the available plant. The production of crude edible oil from certain seeds with limited plant is a familiar difficulty, yet some surprising results are obtained, for instance, from open-type presses, which were a few years ago considered unsuitable for rich oil-seeds. It is, however, impossible to recommend a definite type of plant to handle each seed with equal over-all efficiency, and the problem of obtaining the highest efficiency on a wide range of seeds on a particular plant is likely to remain—for the cultivation of the inventive faculty.

The raw materials of the English mill—the seeds, nuts and kernels, come from all corners of the earth; some are cultivated, others grow wild. They pass through so many and varied vicissitudes that the average good quality on arrival at the mill is surprising. We have no control over their production; they are bought on sample sometimes sent from the place of origin, but generally taken on the arrival of the parcel in this country. If the sample is collected in this country, it is assumed to have been taken in accordance with a definite custom and to be representative of the bulk. It may or it may not be so, for there are several factors which have a bearing on the over-all quality of a large parcel of seed.

Maturity of the Seed

If the seed is the wild-grown variety it is likely to be as varied as the blackberries on our hedges, and the native does not confine his attention to the ripe specimens. In the case of cultivated seeds, many of these (especially the small variety) are grown on small tracts of land farmed by a native, who decides very often the time of harvest not by the maturity of the seed, but the nearing religious festival, or the persistent attentions of the money-lender to whom he has mortgaged his crop.

The quantity of foreign matter in seed is very variable, and as it was not carefully distributed throughout the parcel at the place of origin the buying sample is not a reliable check. Until one has seen it done, the tendency for sand and stones to concentrate in certain bags is somewhat mystifying; nevertheless, unless engaged in the milling industry, we cannot but admire the generosity of the native who is prepared to sell so much of his native land for a handful of seed.

Further, the seed may have deteriorated on the voyage, due to heating, method of stowing. It may have been contaminated by other cargo or have been damaged by water. Analysis of the buying sample is not a reliable check on mill production.

The point for a critical inspection of the seed is at the mill intake for bulk seed, and the warehouse for bag seed. Here, when seed is to be used for the production of edible oil, is the opportunity to classify it and where necessary isolate undesirable batches. With bulk seed, lifted by means of a mechanical or suction-type elevator on to a band and discharged into bins or silos, it is easy to take a representative sample of each bin or silo. With bag seed it is more difficult, and the best solution appears to be to stack in definite piles. The respective silos and piles can then be classified in accordance with tests made on the warehouse samples, and seed sent to the mill can be blended to produce the desired grade of oil.

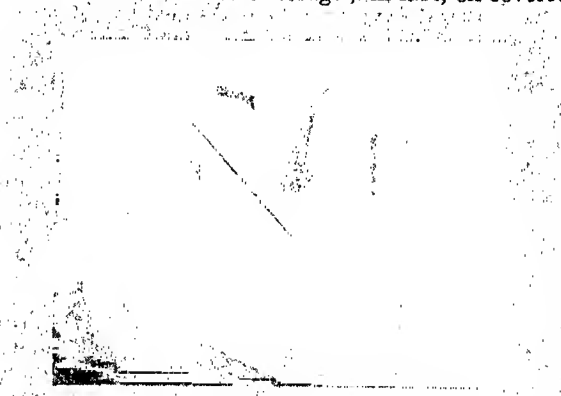
Cleaning the Seed

All seeds require cleaning in order to remove sand and foreign matter. Seed handled in bulk by pneumatic elevators is very free from sand on leaving the suction tube, but the more bulky foreign matter must be removed by screening. In the majority of mills the cleaning plant has to deal with all the undesirable material mixed with the seed, and it is generally placed in such a position that it can operate on the seed being transferred from warehouse to mill. Small seeds, rape, til, soya beans, linseed, can be very efficiently cleaned by means of the well-known revolving cylinder or reciprocating tray type of screen. Palm kernels and undecorticated groundnuts require more drastic treatment, owing to the amount of sand adhering to the skin and shell. Groundnuts taken from loamy soil are particularly troublesome in this respect, the indented shells being well adapted for holding the soil. Palm kernels and undecorticated groundnuts should be passed through a revolving inclined cylinder, sometimes termed a "tumbler," and the soil loosened by the action of the nuts rubbing together. The cylinder is sometimes perforated to allow the sand to pass out through the circumference; the more efficient arrangement is to use the "tumbler" only for the purpose of loosening the soil and to effect separation on a shaking tray screen.

The use of the tumbler type of cleaner for dealing with palm kernels is by no means general in this country, and a short explanation of the reason for its application may be useful, as palm-kernel oil is generally produced for edible purposes. The ordinary shaking tray screen deals only with the loose dirt and sand; it does not remove the sand and decayed vegetable matter attached to the skin of the kernel. In mills using only the shaking tray cleaner this can be verified by inspecting the condition of the feed

* Paper read at the joint meeting of the Liverpool Section of the Society of Chemical Industry and the Chemical Engineering Group on December 12, 1923.

roll and housing of the first break rolls, and sufficient evidence will be obtained to prove that the amount of foreign matter adhering to the kernel skin is considerable. This foreign matter is generally collected by kernels which at some time in their history have had their skin covered with oil drawn by heat of the sun or unsuitable storage; in fact, oil-covered kernels frequently reach the mill. The duty of the tumbler is to remove this attached foreign matter, and if the kernels are wet, also to remove the oil from the skin, otherwise the final oil produced is likely to taste "harsh" even after being neutralised.



Cottonseed Cleaning Plant

Fig. 1

The partial closing of coconut meat during drying forms a pocket for the accumulation of dirt, and the fine dust due to the action of weevils. This is shaken out by allowing the copra to fall over a series of steps on to a shaking tray screen.

The cleaning of woolly cottonseed is a problem which has received much more attention in America than in this country. This is, no doubt, due to the fact that in the early days of cotton-seed crushing in this country, the seed was mainly the Egyptian variety, which has no adhering cotton and is known as "black" seed. When the woolly varieties arrived the crusher was eventually faced with the problem of removing, in addition to loose sand and stones, the dirt in the lint. The evolution of the plant appears to have remained entirely in the hands of the crusher. English mills dealing with woolly seeds are equipped with cleaning plant which is more or less their own design and manufacture, or with American plant.

Woolly seed may be divided into two classes:—

1. Seed with fairly long outer lint covering a short tough fibre firmly attached to the seed husk.
2. Seed with no long lint but covered with the short tough fibre.

To obtain the best possible yield of oil from woolly cottonseed milled on the undecorticated system, the long lint and short fibre must be removed, the seed should be sent to the mill as [illegible] as possible, otherwise the lint will absorb oil and the cake have a rough and, from the farmers' point of view, unattractive appearance.

Certain varieties of woolly seed, even when efficiently delinted, yield a very low percentage of oil, and as the cost of delinting is a considerable item, it requires careful supervision, as it may not be advisable to carry the process beyond a certain stage.

The lint has a market value, depending on its freedom from dust and pieces of seed hull and dirt, its length of fibre, whiteness. Apart from the length of fibre, the quality of the lint produced depends on the efficiency of the cleaning and the method of removing it from the seed. For the moment we are concerned with the cleaning of the seed and lint covering it.

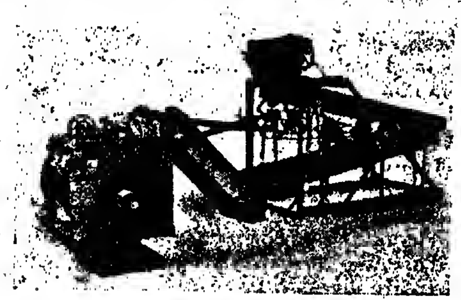
The removal of loose material from the seed is easily accomplished; the difficulty is to remove the dust and dirt from the lint. Plant used for the purpose of separating loose material and removing the dust from lint is shown in Figs. 1 and 2:—

Seed and Lint-cleaning Plant

For seed without long lint and covered with the short fibre only, the methods of cleaning described are quite efficient, but for dealing with seeds covered with long lint closely wrapped around the seed they are not efficient. It is impossible to remove the dust unless the long lint is opened out. If this could be accomplished the appearance of the lint finally obtained would be decidedly improved. The problem has in the past received much attention, but the tendency now is towards more intensive ginning and, consequently, less lint on the seed.

The removal of the lint or short fibre from the seed is accomplished in a variety of ways. For the removal of the long lint a modified form of saw gin is in general use. The Carver linter is representative of this type, Fig. 3.

In setting up the linter saws, full advantage should be taken of the seed being in contact with the side



Cottonseed Cleaning Plant

Fig. 2

of the saw teeth. The teeth should be sharpened in such a manner that as much "burr" as possible is left on the side of the teeth. This can be done by using the gummer after filing, and setting the gummer centre slightly behind the saw.

When seed has fairly long lint, it is sometimes the practice to double lint. The seed is first run through the linter at its maximum capacity and with dull saws, and then a second time with a normal feed and

sharp saws. This method produces a grade of first-cut lint free from husk and of a good colour but not free from fine dust. It will be noted that a large proportion of the dust released by the opening of the lint by the linter saws is blown back into the lint as it collects on the reel.

The removal of the short fibre is effected by passing

Linting Machine

Fig. 3

the seed between carborundum rolls. There are also machines of the defibrating type in which the short fibre is torn from the seed by the abrasive action of metal surfaces formed like a household grater.

In England, cottonseed, having been cleaned and delinted, is sent to the mill and the oil extracted on the undecorticated system, that is, the entire seed, hulls and kernels pass through the presses. In America, where the seed is decorticated, the hulls being separated from the kernels (or meats), the meats only pass into the mill to be pressed. Much has been said and written in order to induce English crushers of cottonseed to introduce the decorticating system into their mills. Among the advantages claimed for the system, the following appear to be the most important.

1. It gives a higher yield of oil.
2. The oil is of better quality than that produced from undecorticated seed.
3. The oil is refined more easily and with less loss.
4. The cake is a highly concentrated cattle food, more easily digested than the undecorticated cake.

The accuracy of items 1, 2 and 3 is generally admitted; the yield of oil on the decorticating system is on an average $1\frac{1}{4}$ to $1\frac{1}{2}$ per cent. greater than on the undecorticated system, the comparison being made on seeds of similar initial oil distribution.

Regarding the cake, the relative merits of decorticated and undecorticated cake as a food for English cattle is still a matter of controversy. There are those who maintain that the presence of the hull is necessary to meet the conditions and methods of feeding prevailing in this country. There may be some truth in this, and the argument is not without support. The greatest obstacle to the extension of cottonseed crushing in India is the system of feeding cattle with whole seed. The decorticated cotton-cake is not in demand, but such mills that produce it have no difficulty in disposing of the hulls to local farmers.

In this country, the controlling factor appears to have been the type of cake demanded by the farmer. If there had been a growing demand for the higher priced decorticated cake, the introduction of the means of producing it would have received more serious consideration.

Decorticating Plant

Decorticating plant for working on the double huller system is shown in Fig. 4. The first huller is set to cut about 85 to 90 per cent. of the seed. The large seeds are cut and the small seeds allowed to pass uncut. By this arrangement the larger seeds are cut without being pulverised and the small seeds pass to the second huller which can be adjusted to cut the remaining 10 to 15 per cent. The product from the first huller is discharged on to the double shaker and the hulls and coarse meats separated. The hulls and uncut seed pass to the first beater and the meats to the mill. In the first beater the fine meat dust is beaten out of the hulls and lint. The hulls and uncut seed then pass to the second huller where the remainder of the seed is cut; the product being dropped on to the second shaker for the removal of the remaining coarse meats. The hulls then pass to the second beater for the removal of the meat flour or dust. The hulls are now finished and are removed from the plant. The meat flour discharged through the mesh of the beaters contains small pieces of hull and lint, and on the intensive system of decorticating is not fit to mix with meats passing to the mill. It is, therefore, given a further treatment by the beater finishing screen, the flour passing through the screen to the meat conveyor, and the fine pieces of hull and lint to the last beater and thence into the hull conveyor. There are several other methods, each claiming

Decorticating Plant for Cottonseed

Fig. 4

some particular merit, for instance, the use of a knife huller for first hulling. It being claimed for this method that practically the whole of the seed is cut in the first machine, and that the cutting is more efficiently carried out than in the percussion type of huller, and that the absorption losses are lower. There is also the method by which a certain

amount of fine hulls is returned to the meats. Again there is the method of decorticating "black" seed in which the hulls are withdrawn by means of fan-suction.

During the process of decorticating linted cottonseed, there are two sources of loss known as the separation and absorption losses. The first is due to incomplete separation of hulls and meats; the latter is due to oil absorbed by the hulls and lint.

To obtain ideal conditions the seed should be cut in such a manner that the kernel or meat is not broken or pulverised, and the separation of hulls and meats should be effected as soon as possible. In actual practice, ideal conditions do not obtain, due to variations in the size of the seed and wear in the huller knives and plates; each seed is not cleanly cut, and a certain amount of pulverising takes place. This results in the production of meat flour, which adheres to the hulls and lint. Further, the seed should be cut as few times as possible, for repeated cutting, in addition to producing "flour," draws oil from the meats; this is absorbed by the hulls and lint, and cannot be recovered. An estimation of the efficiency of the process depends on, first, the percentage of hulls mixed with the meats; secondly, the percentage of oil absorbed by the separated hulls. A separation of 98 per cent. meats from hulls appears to be common with modern American mills; in fact, some claim higher efficiency. With seed properly prepared by delinting and hullers in good condition, there appears to be no difficulty in keeping the oil loss in hulls below 0·5 per cent.

It will have been noted that the system is very exacting; it demands very definite requirements in order to obtain the highest efficiency. The American mill, which deals with seed stable in character and consistent in oil content, has no difficulty in meeting these conditions.

This is not so with the English mill, which may have to deal with many varieties of cottonseed, varying in oil content and character, a large proportion being "black" seed. Again, the demand for cottonseed cake is seasonal, and during the off-season it is usual for the English mill to turn to other seeds, in which event the decorticating plant standing idle would add considerably to the unproductive capital charges. It is not surprising, therefore, that the English crusher has, up to now, remained unconvinced by the arguments advanced in favour of its adoption, and after cleaning and delinting the seed sends it to the milling plant undecorticated.

All seeds should pass over a magnetic separator before milling, cottonseed being passed before delinting. The most suitable place for the separator is at a point where the seed in transit is a minimum, obviously just sufficient to feed the mill. Large pieces of iron are removed by the cleaning plant, and the function of the magnetic separator is to collect the small pieces, which seem to have an affinity for prize cattle of fabulous value.

MILLING, ETC.

The subsequent operations for reducing, milling, cooking and pressing the seed are interdependent, and any attempt to isolate one of them so that it does not fulfil its functions in meeting the requirements of the others is soon apparent. The effect is, of course, more marked on certain seed. The effect is also cumulative—for instance, unsatisfactory milling may be the cause of imperfect cooking, resulting in excessive "foots" at the presses. In practical seed crushing there is no such thing as efficient reducing, milling or cooking considered independently; the only efficiency of any use is their combined efficiency. It has already been pointed out that the method of carrying out these operations is frequently a matter of compromise—to suit the available plant. It would appear, then, that in considering the plant used in reducing milling, cooking, and pressing we should not emphasise type unduly; for there is considerable difference of opinion as to the best type of plant for dealing with a particular seed or carrying out a certain operation.

The introduction of rich oilseeds and the demands for crude edible oils revolutionised oil milling. Methods in vogue for the extraction of oil from cottonseed, linseed, rape and other small seeds were found to be unsuitable when applied to palm kernels, groundnuts and copra. It was found that these latter required much more intensive methods, and heavier finishing rolls and presses were introduced. In the case of groundnuts and copra, the large amount of seed squeezed out of the press (foots) and the destruction of press cloths led to the introduction of the closed type of press with either fixed or movable cages. The difficulty in making a hard firm cake brought about the use of the closed press for palm kernels. The pressure applied to the cake has increased enormously—from 0·6 tons to 4 tons per sq. in., with a consequent increase in the cost of pressing plant.

During the introduction of these heavy cage presses, the gross pressures of the Anglo type press were also increased by greater ram area, and increased pressure in the hydraulic system. Further improvements in connexion with the Anglo system, such as increased cooker capacity, vastly improved cake-forming machines, together with a more intimate knowledge of the behaviour of rich oilseeds during the various processes, gave the system a new lease of life.

Opinion is now very divided as to the relative merits of the closed and open type of press. For obtaining a high oil-yield from a wide range of seeds hot pressed, the Anglo system is now considered by many crushers to be even more efficient than the closed pressing system.

There is now no difficulty in producing with the Anglo press, having a gross pressure of approximately 500 tons, palm-kernel cake containing only $5\frac{1}{2}$ per cent. of oil. The heavy cage press with a ram pressure of 970 tons does not improve on this; in fact, if the press is filled without mats, as is usual with palm kernel, the oil left in the cake is generally

nearer 6 per cent. The pressure on the cake in the open press is 1 to $1\frac{1}{4}$ tons per sq. in. and in the cage press 2·8 tons per sq. in.; the length of time under pressure is practically the same.

The press bagging in which the Anglo cake is wrapped provides a large area for the free flow of the oil. This, taken in conjunction with the fact of the full ram load being applied to the cake the whole of the time the press is open to pressure, offers a reasonable explanation for the better performance of the Anglo press. During the later stage of pressing with the cage press, the oil has to travel a very difficult path, and the pressure on the cake varies, due to the friction between the cake and cage.

The main objection to the Anglo press for pressing palm kernel is the unsatisfactory cake produced with a pressure that will keep the cost of press bagging within a certain margin. The cake is easily broken, even after storage, and is not suitable for transit in bulk. In fact, palm-kernel cake made in the cage press with a pressure of 3 tons per sq. in. on the cake is not now considered satisfactory. The latest cage-pressing plant for palm kernel is arranged for a pressure of 4 tons per sq. in. on the cake and a gross ram pressure of 1300 tons.

The utility of such a plant for other seeds, for instance, groundnuts and copra, is questionable, for these do not require such intense pressure for the production of firm cakes. In fact, in the case of groundnuts it is in the home trade a frequent complaint that cage press cake is too hard.

Here again (dealing with groundnuts), the cage press requires a greater pressure per sq. in. on the cake than the open press for equal oil yield, and the troublesome "foots" associated with decorticated groundnuts is not entirely eliminated by the use of the closed press. It is very difficult, when using heavy cage presses with large ram area to regulate the speed of the ram, to keep the quantity of oil drawn within the capacity of the cage drainage. The trouble occurs during the early stage of pressing, and if the ram is allowed to rise too rapidly more or less meal is washed out of the top and bottom of the cage. This restriction in speed of working together with the use of mats reduces the output of groundnuts considerably below that of palm kernel. The increase in size (due to wear) of the perforations which form the drainage area must also be taken into account, for as these increase in area so does the quantity of "foots." In the case of plate cages the perforations are usually 0·03 in. dia., and an increase to 0·04 in. makes an appreciable difference in the quantity of "foots," and the labour required to keep the cage chambers clean.

For dealing with rich oilseeds, and for cold pressing, the cage press has decided advantages, but for dealing with a wide range of seeds and producing a high oil yield, the Anglo or open type press, with its simplicity and low upkeep costs, is by no means supplanted. It is yet the utility plant of the mill.

The highest possible yield of oil is not the only consideration in seed crushing; the production of cake that will satisfy the requirements of the farmer must also be taken into account. The average farmer is now quite alive to the value of oil in the cake he uses, and that cake containing a high percentage of albuminoids and a low percentage of oil is not desirable. Further, he places particular value on the kind of oil: for instance, of linseed and cottonseed, linseed cake is certainly the most popular, mainly owing to its high oil content.

Cakes are now sold guaranteed to contain a certain percentage of oil, and actually the oil content is higher than the guarantee.

The oil content of the most important straight feeding cakes is given below:—

	Per cent.
Linseed cake	7–8
Coconut cake	$6\frac{1}{2}$–8
Groundnut cake	7–8
Palm-kernel cake	$6\frac{1}{2}$–8
Cottonseed cake	5–6

Owing to the amount of oil required to be left in the cake made from certain seeds, it is neither necessary nor the practice to make extraction as intensive as possible, and in using the open press the length of time the cake is under pressure is reduced, with a corresponding increase in output. Open type presses, arranged four presses per "side" or battery, are usually filled and discharged at the rate of six pressings per hour from the four presses, when the highest oil yield is desired. For the production of cake to contain a higher percentage of oil, seven or eight pressings per hour are taken from the four presses. This statement, however, requires some qualification; for in pressing rich oilseeds it is not possible to work the open press at the higher speeds, owing to excessive "foots." The open press does not then compare so favourably with the cage press.

Small seeds, such as rape, cotton, soya, and til, are, after cleaning, ready for the finishing rolls. The larger nuts, such as palm kernels, groundnuts, copra, require a preliminary reduction. Two pair reduction rolls are suitable for ground nuts, and for copra after it has been rough broken to the size of a palm kernel.

For dealing with palm kernel a three pair machine is generally used. A much better method is to use two of the two pair rolls in series, giving four gradual reductions instead of three. The reduced kernel is a more even grade and cleaner cut than is possible with the three pass machine. Further, with the three pass machine, the rolls have to be set so close that the grade of kernel passing is larger than the space between the rolls, consequently the kernel is excessively squeezed and oil is drawn. It is then impossible to obtain satisfactory results during final milling and cooking.

Five high finishing rolls are arranged to give four passes to the seed, each pass increasing in intensity due to the increasing superimposed weight of the rolls. This type of finishing roll is used for all varieties of seed. The usual size is five rolls 16 in. dia. by 48 in. long, but a better arrangement for the modern mill is 18 in. by 16 in. by 48 in., the three alternative rolls starting from the top being 18 in. dia. For milling palm kernels in rolls of this size and weight, eight passes are necessary and double milling is applied, two sets of rolls being

run in series. The recognised size of mill for palm kernel has rolls 24 in. dia. by 42 in. long, arranged five high.

The object of milling is to reduce the seed to the thinnest possible flake without drawing oil. If oil is drawn, the product from the rolls is a sodden mass, very difficult to deal with in the cookers. Further, with edible oils there is the risk of contamination due to oil-wet seed accumulating on the housing and becoming rancid or forming a medium for the creep of lubricating oil from the roll bearings.

The older mills are not well equipped for dealing with the rich edible oilseeds. They are generally so arranged that the milled seed is transferred from the rolls to the cookers by means of spiral conveyors. This answered very well for such seeds as cotton, linseed or soya, for the conveyor blades pulverised the seed and broke up the flakes. With palm kernel, groundnut, or copra, the pulverising action of the blade, and the squeeze which it gives to the milled seed in pushing it past the conveyor bearing is decidedly detrimental to efficient results in the cooker. Such conveyors are another source of contamination, for the seed collects the grease used to lubricate the intermediate bearing and the rolled seed which accumulates between the spiral and the conveyor casing is generally rancid. It is obvious that in the production of high-grade edible oils every source of contamination should be avoided. The modern mill is so arranged that the mechanical conveying of the seed after milling is entirely eliminated, and once the seed is opened out it is put through the intermediate processes and transferred to the cooker as soon as possible.

The remarks made concerning the intensity of final milling require some qualification when applied to decorticated groundnuts. Here there is no difficulty in breaking up the oil cells. The difficulty is to produce a milled product that will not ball in the cooker, and which will unite and stand up to the pressure in the press. It is a common practice to mill the decorticated nuts, whole, without any preliminary reduction. This is quite satisfactory provided a large proportion of the flake does not fall to "flour" and fine particles. It would appear that the best objective is to produce the thinnest firm flake with the minimum of flour possible, and as the flour comes from the edge of the flake it is obvious that the number of passes in the finishing rolls should be kept down by slightly reducing the nuts in a breaker. There is this advantage in breaking the kernels that a considerable amount of red skin is released which can easily be removed by passing the kernels under a fan suction.

It is, however, impossible to mill decorticated groundnuts without producing a certain amount of "flour" and fine nut meal, and as this forms the binding medium in the cooker, and prevents regular and even cooking, and also prevents the main particles of the cake coming to rest under pressure, both the flour and fine meal should be removed. This is easily done by passing the product of the finishing rolls over a short scalper.

Extraction of Oils by Means of Solvents.

For many years the pressing or expression system stood alone in this country as the only efficient means of obtaining oil from seeds. The cake gradually became established as a cattle food, and the farmer is now quite familiar with the residue of certain seeds in the form of cake. His system of cattle feeding is built up on its use. Further, many of the standards of value for oil and cake were based on the capacity of the pressing system, and have been revised as the system improved.

When the solvent system of extraction was introduced, one of the most difficult problems which had to be solved was the disposal of the residue, which in the form of meal contained much less oil than the standard cake made from similar seed. The increasing demand for compound feeding stuffs solved the problem—the solvent-plant meal became a recognised ingredient in the manufacture of sweetened meals, compound cakes, cubes, etc. At first it was used very sparingly owing to the prejudice against its use on account of low oil content and frequent trace of solvent. Improved methods and the use of more suitable solvents facilitated the production of solvent-free meal, and the value and use of a low oil-content ingredient for the compound mix is now fully appreciated.

The increasing demand for meals, etc., also brought about the extraction of oil from a larger variety of seeds by the solvent method, and although it is not suggested that the solvent-plant meal will entirely take the place of cake meal in the compound mixtures, it is being used in increasing quantity. Further, there is a decided tendency to produce meals of such oil content that will permit them to be used more freely than heretofore. As the guaranteed oil content of compound feeding stuffs is fixed much higher than that in the usual solvent-plant meal, the quantity which can be mixed with other ingredients of normal oil content is obviously limited.

The solvent system has developed rapidly since the war. There are now several plants each dealing with close on 1500 tons of seed per week. Undoubtedly (allowing for wage fluctuations, common to both systems), the cost of extraction by the solvent method has been considerably reduced during the past few years. This has been brought about by increased production per unit (usually considered as 4 pots), reduced solvent losses, cheaper solvent, and less consumption of steam.

Owing to the fact that the system lends itself to increased output without labour interference, there is every incentive to a still further increase per plant unit.

[illegible] the production of crude edible oil, the question [illegible] suitable solvent is important. It has been proved by experience that for the higher quality oils, the solvent must comply with certain definite requirements. The unsatisfactory solvents and crude distilling plants used in the early days did much to retard the progress of this system of oil extraction.

For the extraction of oil from seeds a solvent should contain no traces of any compound capable

of undergoing chemical change during the extraction process. It should have a close range of distillation, not too low to encourage loss, nor so high as to require a final temperature of evaporation injurious to the oil. It should not be soluble in water and it should have a distinctly different gravity from water. A table showing the characteristics of some of the available solvents is appended:—

Solvent	B.P. (° C.)	Sp. Heat	Latent Heat cal. 1-gram	Price per gall s.	d.
Ether	34·6	0·33	90	4	0
Carbon disulphide	46·2	0·24	83·8	3	7
Chloroform	61·2	0·23	58·5	25	2
Alcohol (methylated spirit)	78·1	0·6	205	3	1
Carbon tetrachloride	76·7	0·2	51	6	2
Benzol (pure)	80·3	0·41	93·4	1	7
Benzol (commercial)	79–125	0·408	95	1	3
Trichlorethylene	87	0·233	56·6	5	3
Petroleum spirit	100–120	0·425	73·5	1	6
Tolual (pure)	110·8	0·404	—	1	10
Turpentine	0·59	0·41	74	4	10

For general suitability there has up to quite recently been nothing comparable to the specially prepared petroleum spirit. It has a satisfactory boiling point, and a sufficiently close range to place it on an equality with the constant boiling solvent. Further, the standard grade which has been proved to be suitable for the extraction of edible oils, can be obtained at a reasonable price. Unfortunately, it is inflammable, and its use adds considerably to the insurance charge on plant and buildings, especially in a congested district and owing to the special precautions which have to be taken in the arrangement of artificial lights it is difficult to obtain good plant illumination.

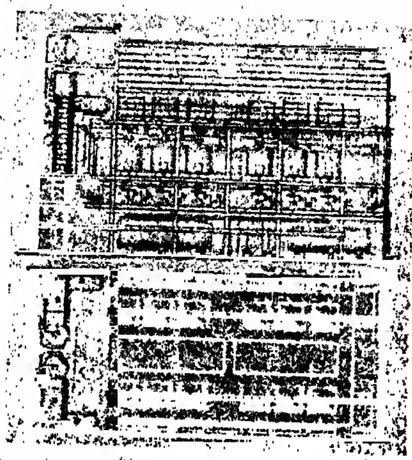
Within recent times, trichlorethylene has come into prominence for the extraction of oil from seeds, and it would now appear to be conclusively proved that in addition to being non-inflammable, it possesses in use the following advantages compared with petroleum spirit (benzene):—It has greater penetration; solvent losses are smaller; there is increased production per plant unit, and lower steam consumption for evaporation.

There is considerable difference of opinion as to the suitability of this solvent for the production of edible oils; this can only be decided when the solvent comes into more extended use.

The high cost of trichlorethylene compared with that of benzene is against it coming into rapid general use for oil seeds. The cost of solvent with plants using benzene is not now such a serious matter as formerly, when losses were anything up to 7 gallons per ton of seed; and solvent cost 2s. 6d. per gallon. The modern plant with a solvent loss of 3 gallons (benzene) per ton of seed and obtaining solvent at 1s. 6d. per gallon is not likely, on the face of it, to look very favourably on trichlorethylene at 5s. 3d. per gallon. To arrive at a fair comparison the conditions appertaining to the particular plant likely to use it must be taken into account. Further, in order to make perfectly sure that full benefit may be derived from the higher working efficiency of trichlorethylene, the capacity of the plant details must be checked. It is frequently stated that more patent specifications are drawn up for rotary pumps than any other appliance, but the number for solvent plants must be a good second. It is astonishing how few of these patents have been put into actual working. The type of extractor pot used appears to be fairly common and has a capacity of 2 to $2\frac{1}{2}$ tons of seed. It is stationary and the meal is agitated by means of stirrers fixed to a vertical shaft.

In other details of the plant there is considerable variation. There are also several methods of washing the seed with solvent.

For the extraction of oil by the solvent process, the seed is reduced by milling in a similar manner to seed being prepared for the pressing process. The milling does not, however, require to be so intensive, in fact, very finely milled seed, which will pack



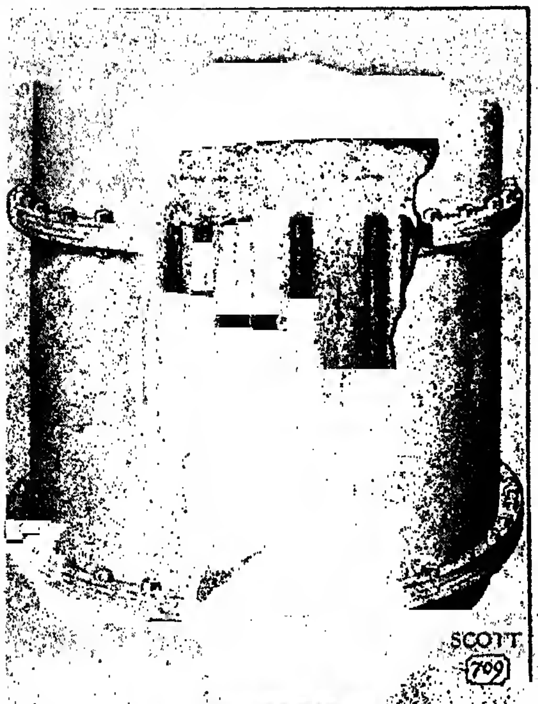
Solvent Extraction Plant
FIG. 5

close, interferes with the draining of the charges of solvent, and is one of the causes of the trouble known as "zoning"—one or more portions of a charge of seed acting as separate extractors.

It is well known that if a charge of seed is washed with successive washes of clean solvent, the amount of oil in the solvent is less and less—as the number of washings increase the solvent is used less and less efficiently. The last washings contain so little oil, they could be used to better advantage as solvent for a fresh charge of seed. This is done in the counter-current method of washing. In this method of working each charge of solvent is used on seed containing more and more oil, or in other words, each charge of seed is treated with solvent containing successively less and less oil. Finally the solvent washes a fresh charge of seed, is fully concentrated and removed to the still for separation. Originally the method was operated on the continuous system, a number of extractors being connected in series. Eventually the discontinuous method came into use, as it was found that by keeping the solvents of

different concentration entirely separate, the same degree of extraction could be obtained with a less initial volume of clean solvent.

The well-known experiment with the glass beads coated with a soluble substance, demonstrates the wisdom of the change and that the only way to obtain a high percentage extraction with a given volume of solvent is to use it in batches and to drain off one batch before applying the next. This is the principle on which plants using petroleum spirit are operated. There are plants in use at the present time working on the discontinuous counter current system. The batches of solvent in each extractor are in rotation pumped from one pot to the next in sequence. The modern plant, although differing in the method of transferring the batches of solvent, retains the advantage of the counter-current method in that it is worked on the gradual enrichment system.



Circulation in Scott Stripping Still

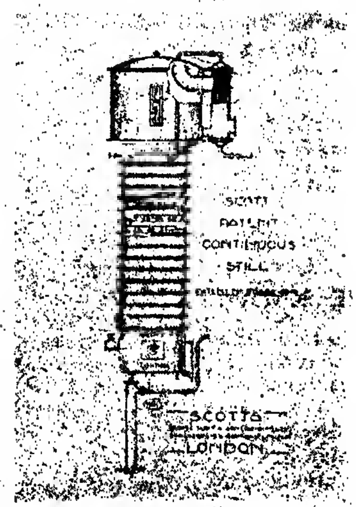
Fig. 6

The modifications in the method of transferring the solvent are due to the obvious disadvantages of the older arrangement, which makes the plant very rigid in operation. The transfer of the batches of solvent direct from one extractor to another by means of a pump makes the system very non-elastic, for if there is delay in carrying out an operation in the progress of one of the extractors, the progress of two other extractors is delayed. Further, the withdrawal of the solvent by means of a pump frequently zones portions of the charge.

The modern plant shown in Fig. 5 is so arrange that the extractors are entirely independent, eac batch of mixed solvent drains by gravity to a tan containing solvent of similar concentration.

In a large plant arranged for rapid manipulatio it is necessary to return the solvent to the store fc re-use, as quickly as possible. Further, the separa tion of the oil and solvent should be effected by th least possible consumption of steam. It is no usual to employ a stripping still in which the bul of the solvent is driven off by closed steam. I order to avoid risk of discolouring the oil due t over-heating, a stripping still should be arranged fc rapid circulation, and should have no pockets c stagnant liquor in contact with the heating surfac The circulation of a well-known type of strippin still is shown in Fig. 6.

The last trace of solvent should be removed fro the oil by means of open steam, the oil (with trac of solvent) is transferred from the stripping still t the finishing still (Fig. 7), and the solvent con pletely driven off. The complete plant consistin of stripping and finishing stills is shown in Fig. 8.

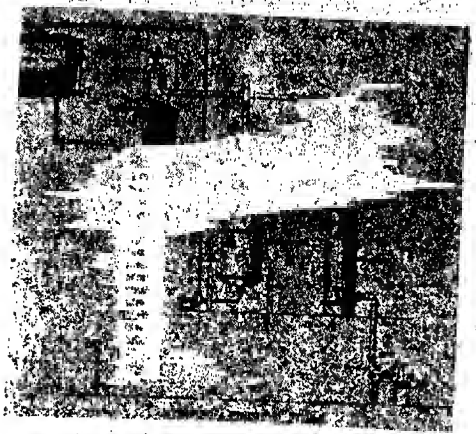


Finishing Still

Fig. 7

In making a comparison of the two systems extraction the advantage of the solvent method i point of oil yield stands out very prominent. Tl average oil in press cakes being 6–6½ per cent., i solvent-extracted meal 1·5 per cent. With sec residue which cannot be used for cattle food ar practically refuse, the high yield of oil given l the solvent system leaves it without a competit in the treatment of such seeds. Where the sec residue is required in the form of a straight feedir cake, then the solvent system cannot compete, bu if the cake is to be ground and used as an ingredie for compound mixing, then when treating certa seeds the solvent plant producing a meal residue h an advantage.

Due to the varying methods of operating pressing plant it is somewhat difficult to arrange units for the purpose of comparison with a unit solvent



Stripping and Finishing Stills
FIG. 8

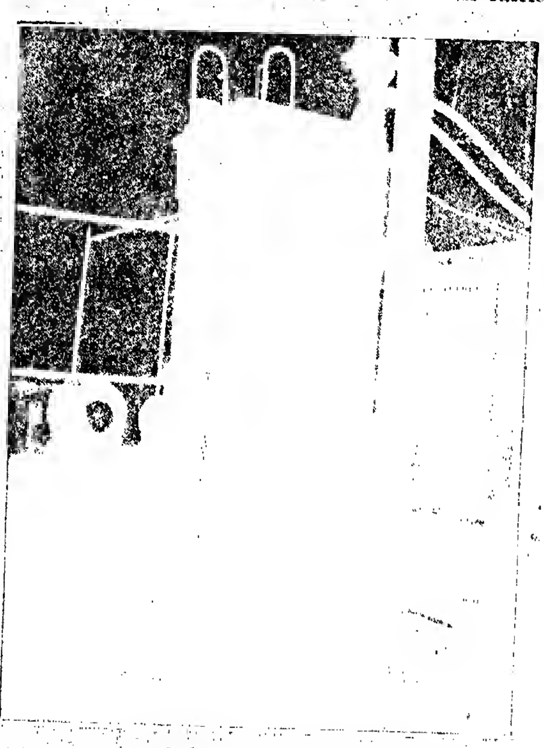
plant. Taking the unit solvent plant as four extractors the following appears to be a fair average :—

	Output Tons per week	Men required per shift
Cage presses (mov. box)	270–300	5–6
3 Batteries of A.A. press.	270	10
4 Extr. solvent plant	260–280	3–4

THE KNOWLES COLUMN CELL

A very serious drawback to the use of electrolytic cells for the production of hydrogen in large volumes has always been the great floor space required, so that the cost of housing electrolytic-hydrogen plants of large capacity has always been a serious item of capital expense. With recent developments in the synthetic ammonia and similar industries the question of floor space has become very prominent, not only on account of the exceptionally large plant required, but also because such plants have usually to be installed where much expensive excavating work is necessary to provide a level area for the cell room, the source of power being usually hydro-electric and the site for the works nearly always in mountainous districts. Previous to the introduction of the Knowles column type cell, floor area has only been reduced by increasing the depth of the electrodes and running them at very high current densities, a practice which reduces the life of the cell and increases its internal resistance, resulting eventually in a serious loss of efficiency. Even with cells having exceptionally deep electrodes run at very high current densities the floor area cannot be very greatly reduced and anything saved in the initial cost of the buildings is lost in the far greater cost of upkeep of plant.

The Knowles column plant, on the other hand, has electrodes of only moderate depth running at low current density and yet occupies only a fraction of the floor area required by any other make of plant. The general design of each cell does not depart in any way from the best principles of electrolytic-cell design, but the superimposed arrangement adopted is, however, entirely novel and enables a plant of large capacity to be installed on an exceptionally small area. Fig. I. illustrates the original experimental cells, a design which has since been considerably altered; only two cells are shown, but in practice the cells are erected ten high. The current passes directly from each cell to the cell above, without any external connexions, the polarity being reversed as it passes out from one cell to the next, and the only electrical connexions required are to the bottom of the lowermost cell and to the cover of the upper cell of each column. Upstanding electrodes on the base of one cell alternate with electrodes hanging from the base of the cell above, and form the anodes and cathodes, respectively, of each cell unit. Abestos diaphragms suspended from the dividing or bell plate surround the hanging electrodes and prevent the gases from mixing. The containing tank, the inner surface of which carries



The Original Experimental Cells
FIG. 1

an electrode, is built up of four iron castings bolted together and is designed to carry the weight of the cells above. All the tanks are identical and interchangeable, so that any tank may be used for the

bottom cell without risk of failure from the weight above. The base of the tank to which the electrodes are fixed is bolted on a projection to form an electrolyte-tight and gas-tight joint. Suitable electrolyte-separator, gas-offtake and feed water pipes are provided, and the tanks of adjacent cells are insulated from one another by special jointing rings which form a gas-tight joint. There is no possibility of a short circuit occurring between adjacent tanks owing to any electrolyte which may drip from a faulty pipe connexion on the cell above. Owing to the weight of the cells and electrolyte, no bolts are necessary to make the joint between the tanks gas-tight, and erection or dismantling therefore simply consists in lifting one cell complete with electrodes from the cell below. Straight copper bars bolted on both sides of lugs extending the whole length of the electrodes carry the current between the top cells and bottom cells of adjacent columns.

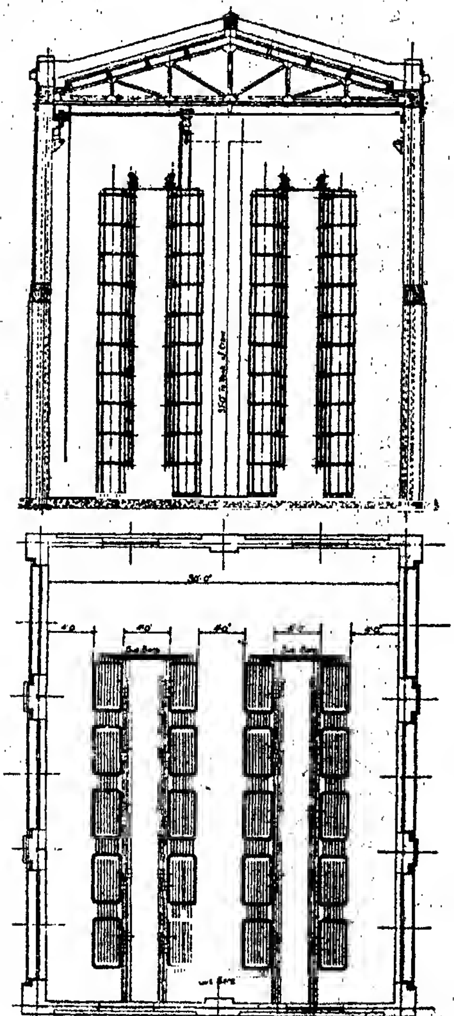
The same quality of steel plate which has proved so durable in the earlier pattern of cell is used for the electrodes in this cell, the section of the electrodes throughout being ample to carry the current for which the cell is designed without appreciable loss. The anodes, which in one column are the upstanding electrodes and in the next the depending plates, are treated with nickel by a special process which ensures entire freedom from corrosion and also reduces over-voltage. For the diaphragms asbestos cloth of close weave and free from flaws, to ensure complete separation of the gases, is employed, and the material lasts not less than three to five years. Material chosen for its lasting qualities and high insulating power in the presence of caustic soda is used for the joints between the cells and the base plate and tanks. Since the tank walls do not carry any current, the electrical conductivity of the cast iron used is unimportant and it is possible to use a quality specially suited to withstand large crushing stresses.

Comparing on the basis of equal efficiency and taking a 1000 kw. plant generating 7200 cb. ft. of hydrogen per hour, the Knowles column cells occupy less than one-third of the area taken by several other cells, despite the fact that the current density is low and the depth of the electrodes is less than in any other cell considered.

The multi-electrode construction permits cells to be built for any current from 1600 amperes upwards by simply increasing the number of electrodes per cell without departing from the standard design. Normally the cells run at 2·25 volts per cell, but can run at any voltage up to 25, at which figure the gas production is 50 per cent. above normal. The voltage may also be reduced to 2 volts per cell, representing a decrease in current consumption of 40 per cent. below normal, and a corresponding decrease in the gas output. This flexibility in operation is of great importance where the cells are to be used in connexion with "off-peak" power schemes where the power available varies greatly during the day.

Safety devices make the cells practically fool-proof in operation and only pure gases can pass into the offtake pipes under any conditions of pressure and electrolyte level. Both gases are of exceptional purity and the oxygen is guaranteed to be not of less than 99 per cent. and the hydrogen of 99·5 per cent. purity. Test runs carried out over long periods show that the average percentage purity is oxygen 99·6 and hydrogen 99·9.

A typical layout for a plant of 4780 kw. capacity generating 31,100 cb. ft. of hydrogen at maximum output is shown in Fig. 2. The cells are arranged in 20 columns, each consisting of ten cells, the total



Arrangement of 200 Knowles Patent Column Cells

Fig. 2

area of the cell room, including gangways being only 1200 sq. ft. A large plant of this type is now under construction of Bussi, Italy, for the Società Italiana di Elettrochimica.

FORTHCOMING EVENTS

Feb. 4. SOCIETY OF CHEMICAL INDUSTRY, *London Section* Joint meeting with the *Chemical Engineering Group*, The Engineers' Club, 39, Coventry Street, London, W. 1, at 8 p.m. "The Manufacture of Potash and Other Salts from Leucite," by Prof. J. W. Hinchley. To be preceded by an informal dinner.

Feb. 4. THE INSTITUTE OF CHEMISTRY, *Manchester Section*. Annual Social Meeting, to be held at The Grand Hotel, Manchester, at 7 p.m.

Feb. 4. BIRMINGHAM UNIVERSITY CHEMICAL SOCIETY, Chemical Lecture Theatre, Edgbaston, Birmingham, at 5.30 p.m. "Glass and its Chemical Nature," by D. G. Skinner.

Feb. 4. INSTITUTION OF RUBBER INDUSTRY, The Kelvin Room of the Engineers' Club, Coventry Street, W., at 8 p.m. "The Use of Rubber Latex in the Manufacture of Boards, Leather and Linoleum Substitutes, and as to the Vulcanisation of these Products," by F. Kaye.

Feb. 4. ROYAL SOCIETY OF ARTS, John Street, Adelphi, W.C. 2, at 8 p.m. "Colloid Chemistry" (Cantor Lecture), by E. K. Rideal, M.B.E.

Feb. 5. SOCIETY OF CHEMICAL INDUSTRY, *Edinburgh and East of Scotland Section.* Annual Dinner with the local Section of the Institute of Chemistry.

Feb. 5. SOCIETY OF CHEMICAL INDUSTRY, *Birmingham and Midland Section*, University Buildings, Edmund Street, Birmingham, at 7.15 p.m. "Some Studies in the Kinetics of Oil Hydrogenation," by E. J. Lush, M.A.

Feb. 6. THE INSTITUTE OF PHYSICS, Chemical Society's Rooms, Burlington House, Piccadilly, London, W. 1, at 5.30 p.m. "The Physicist in Metallurgy," by C. H. Desch, F.R.S.

Feb. 6. SOCIETY OF PUBLIC ANALYSTS. Annual General Meeting, Chemical Society's Rooms, Burlington House, W., at 8 p.m. "Osmium Tetroxide as a Reagent for the Estimation of Tannins and their Derivatives," by C. A. Mitchell; "The Composition and Examination of Beef and Malt Wine," by G. D. Elsdon, B.Sc.; An Apparatus for Fat Extraction and Solvent Recovery will be demonstrated by S. A. de Lacy. Informal Dinner will be held at 6.30 p.m., at St. James's Restaurant, 178, Piccadilly, W. 1.

Feb. 7. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section*, The Chemical Department, The University, Bristol, at 7.30 p.m. Meeting held under the scheme of co-operation with the Chemical Society. "Current Chemical Research at Bristol University," by Profs. F. Francis and J. W. McBain.

Feb. 7. THE CHEMICAL SOCIETY, Burlington House, Piccadilly, W. 1, at 8 p.m. "The Solubility of the Aminophenols," and "Abnormal Benzene Derivatives," by N. V. Sidgwick and R. K. Callow.

Feb. 7. ROYAL INSTITUTION OF GREAT BRITAIN, 21, Albemarle Street, W. 1, at 5.15 p.m. "Crystalline Structure of Organic Substances," by Prof. Sir W. Bragg. Also on February 14, 21 and 28.

SOCIETY OF CHEMICAL INDUSTRY

THE ANNUAL MEETING

A meeting was held on January 28 in the Town Hall, Liverpool, to make arrangements for the Annual Meeting of the Society, which is to be held in Liverpool in July.

The Rt. Hon. the Lord Mayor of Liverpool, Mr. Arnold Rushton, J.P., said it gave him particular pleasure to preside over the meeting. The Society of Chemical Industry was formed in 1881, largely through the zeal and enterprise of local chemical manufacturers, one of the pioneers of the work being the late Dr. E. K. Muspratt, the great friend of Liverpool: he did great work for the City, and was very prominent in the formation of this Society. I understand that among your other notable members were Dr. Mond, Mr. Eustace Carey, Mr. John Gray, and to-day we are fortunate that Lancashire also provides the present President, whom we are delighted to see here, Dr. E. F. Armstrong, of Warrington. Your Society has progressed very much in the last forty years and now has 5000 members, with eighteen branches spread over the United Kingdom, Australia, Canada and the United States, and in 1907 you were incorporated by Royal Charter, so that you have gone along very famously indeed. It is customary to hold the Congress in one or other of the leading cities of this country, and this is the fifth occasion that Liverpool has been favoured. You know as well as I do what the objects of your particular Congress will be, and of course it will include the bringing together of all those who are interested in Chemistry as an industry, the reading of technical papers, social intercourse and everything good for the Society of Chemical Industry and its members. I can assure you that in addition it will have the co-operation of the civic authorities, and the Lord Mayor particularly will do everything possible to make it a success. You require, also, the co-operation of other societies and other branches of industry in this great city. Mr. Sandeman Allen, the Chairman of the Chamber of Commerce, regrets very much that he is unable to be with us, but sends a message saying they are only too anxious to do everything they can to enhance the success of the Congress. We want, also, the representatives of our University, and I am sure they will co-operate, also other sections of the business community. I think from what I have heard that everything points to a most successful Congress. I have much pleasure in calling on the President to give us a statement and possibly to move a resolution.

Dr. E. F. Armstrong then said: After the very illuminating statement we have heard about the past of our Society, it needs but few words to make the position quite clear. It is hardly necessary in Liverpool to emphasize the importance of the chemical industry to shipping and all that it means: the chemical industry is the most important one on Merseyside. Our Society, the Society of Chemical Industry, caters for those engaged in the chemical industry in the very widest sense. Our membership is open to directors, commercial as well as technical,

to process managers, to the works chemists, research chemists, to the whole academic profession, consulting, and analytical chemists, and to any others who happen not to be included in the previous category. Including in our ranks all engaged in the chemical industry and in the practice and profession of chemistry, it can claim to be representative. We can also claim to be essentially democratic. Our objects and aims are simple; they are so to advance the practice and the science of chemistry as to give social service to the community; they are to advance the interests, professional and otherwise, of our individual members, to bring the latest knowledge to them by means of our publications, and, what is perhaps as important as anything, to bring them together and to get them to know one another. From that point of view our annual meetings are of particular importance, and we owe them to the invitation, year by year, of our constituent Sections. On more than one occasion we have enjoyed the hospitality of Liverpool, and it has always been memorable. At our annual meetings we have the Presidential Address, technical papers, and every opportunity for that mutual intercourse which is so important. I feel sure that our meeting in Liverpool this year has so much tradition behind it, so many famous names have been connected with the Section, that nothing can prevent this meeting being as great a success as its forerunners, and I am sure that, under the able chairmanship of Mr. Edwin Thompson (the Chairman of the Liverpool Section of the Society) it will be a success. I would like to move that the gentlemen present, and those invited but prevented from coming, be asked to form a General Committee for the purpose of initiating this meeting in July next. I do not think the duties of the General Committee will be very onerous, but it will be very valuable to have such as Committee.

Mr. John Gray seconded the resolution, and it was passed unanimously. It was then proposed by Sir Max Muspratt, Bart., and seconded by Mr. W. H. Roberts (and carried unanimously), that about forty gentlemen be asked to form the Executive Committee.

Professor I. M. Heilbron proposed that the following should be the officers of the Executive Committee: Mr. Edwin Thompson, Chairman; Mr. W. H. Roberts, Vice-Chairman; Dr. Alfred Holt, Hon. Treasurer; Mr. E. Gabriel Jones, Hon. Secretary. Prof. Bannister seconded the proposal, and it was passed unanimously.

Mr. Edwin Thompson then moved that the meeting should express a vote of thanks to the Lord Mayor for so very kindly presiding at this meeting. When this meeting was mentioned to him he at once said that he would take a great interest in it, and he very kindly offered to entertain the members when they visited Liverpool, and he threw himself wholeheartedly into it. A very cordial vote of thanks for so kindly presiding at this meeting was accordingly proposed.

Dr. G. C. Clayton, M.P., said it gave him the very greatest pleasure to second this vote of thanks to the Lord Mayor, and that he felt satisfied and confident that with the Lord Mayor's assistance it would be a very memorable gathering in Liverpool.

The Lord Mayor, in acknowledging the vote of thanks, wished the Congress all luck and every success.

OFFICIAL NOTICES

ANNUAL REPORTS OF THE PROGRESS OF APPLIED CHEMISTRY

Vol. VIII is now in preparation and will be issued very shortly. The price of the book is 7s. 6d. to members of the Society, and 12s. 6d. to non-members. Vol. I is out of print, but copies of Vols. II, III, IV, V, VI, and VII may be obtained by members at 4s. 6d., 5s. 6d., 5s. 6d., 8s. 3d., 7s. 6d., and 7s. 6d., and by non-members at 7s. 6d., 10s. 6d., 12s. 6d., 15s., 12s. 6d., and 12s. 6d. respectively. If Vols. II, III, IV, V, VI, and VII are ordered at the same time as Vol. VIII, the set may be obtained by members for £2 2s. 6d., and by non-members for £3 15s. The appropriate remittance must accompany every order. The books are sent to purchasers post free.

AMERICAN CHEMICAL SOCIETY

The Council of the Society of Chemical Industry will be glad if any members of the Society, who expect to be in the United States in April next, will kindly act as delegates of the Society at the Annual Meeting of the American Chemical Society, which will be held in Washington, D.C., on the 21st of that month.

The General Secretary will be glad to hear from any members of the Society who can make it convenient to be present at the meeting, and he will gladly forward their names to the Secretary of the American Chemical Society.

EDITORIAL NOTICES

The Society as a body is not responsible for statements and opinions appearing in the JOURNAL.

Members of the Society, and others, are invited to submit original articles, news, notes and other relevant information to the Editor of *Chemistry & Industry*. Such contributions should be clearly written (preferably typewritten with double spacing), and be accompanied by a stamped and addressed envelope. They will be paid for if inserted. Sources of information should always be given, not necessarily for publication.

Hon. Secretaries of Local Sections and of other Societies are asked to forward notices and reports of meetings as early as possible, and publishers to send books for review, direct to:—THE EDITOR, *Chemistry & Industry*, SOCIETY OF CHEMICAL INDUSTRY, CENTRAL HOUSE, FINSBURY SQUARE, E.C. 2. [Telephone: Clerkenwell No. 2429.]

Hon. Secretaries of Local Sections and of other Societies are asked to note that announcements of forthcoming events cannot be inserted in the next issue of the JOURNAL *unless they are received not later than Tuesday in any week.*

Matters relating to the Transactions and Abstracts, including Papers intended for insertion as Communications, should be addressed to THE EDITOR OF TRANSACTIONS, at the same address.

LIVERPOOL SECTION

On January 18 a joint meeting with the Liverpool and North-Western Section of the Institute of Chemistry was held in the rooms of the Overseas League, Mr. Edwin Thompson in the chair.

Mr. S. P. Leigh gave an address on "Some Aspects of British Chemical Trade Abroad," in which he said it was sometimes useful to look at the trade in British heavy chemicals from the point of view of the consumer abroad. China is already a very big market, but its consumption per head is on a very low scale; with 350 million inhabitants a comparatively small increase in the consumption per head would add enormously to the volume of trade. Labour costs in China are remarkably low, but any large industrial expansion would undoubtedly tend to adjust these to the levels of the outside world. There are especial possibilities for the extended use of fertilisers in China. One great asset in this market is the conservatism of the Chinese buyer, who, provided an article is good, will refuse all substitutes.

In the Tropics, the ice, mineral-waters and soap industries are found universally, and all consume chemicals. From China to Burma, the Chinaman is the master of the soap industry. He manufactures on a very small scale and displays a genius in keeping low his manufacturing costs. The soap works are sometimes built almost entirely of caustic-soda drums, which gives an added importance to the always vital matter of packages.

During the war, the heavy chemical market in Java was captured by Japan and the United States, but we have subsequently recovered the bulk of our share of this business, partly owing to the varying quality of Japanese goods.

In South America, the United States was the chief supplier during the war. We have since largely recovered our position, and we have more now to fear from German than from American competition. The Germans still have large funds available for overseas trade expansion, and are already exploiting them on a large scale. Having lost their Colonies, and with their immigration to the United States strictly limited, South America is the only suitable outlet for their surplus population. The inevitable increase of the numbers of Germans in South America which will thus result during the next few years will have a most important influence on the trend of business in these markets, and we shall have to use our utmost efforts, backed by our existing goodwill, and our large capital investments, if we are to maintain our position.

In India, among many possibilities, there are two which stand out as offering opportunities for an enormous expansion in chemical business in that market in the future. The first is the disinfection, by chloride of lime or liquid chlorine, of the rivers, particularly the Ganges, in which the sacred bathings of the Hindus are performed. These, at the present time, play a great part in the spread of infectious disease. The second is the increased use of fertilisers. The yield per acre of many crops in India is very low, and the soil undoubtedly requires added plant food. Before this can be generally adopted, however, the Indian Government will have to find some means of freeing the farmer from the tyranny of the money-lender, to whom he usually has to pay all his available means.

In Australia the rapidly increasing complexity of social and industrial life has resulted in a widening of the scope of demand for chemicals, but for many years the main outlet for these products will be found in the great primary agricultural industries.

The part which British industry played in the victory of the Allies in the great war is fully appreciated by our customers throughout the world, and has resulted in the enhanced prestige of British industry and British products, which we must maintain by every means in our power.

NOTTINGHAM SECTION

At the meeting held on January 23, two papers were read on "The Microscope as an Aid to Analysis." The chair was taken by Mr. H. Droop Richmond. In the first paper Mr. Woodhouse described investigations carried out at the Stanton Iron Works, and gave an account of the microscope as an aid in determining factors which cannot always be arrived at by the use of analysis alone. The process of preparing samples of iron for microscopical examination was first outlined, followed by results of typical examinations of various manufactures of iron. An excellent set of microphotographs was shown, illustrating the various differences in the crystalline structure of the above substances. Chemical analysis often showed an apparently abnormal value, say, for phosphorus or silicon, but a microscopical examination would often save much time in confirming the chemical result, thus saving a more tedious second analysis. The physical structure of "chilled iron" and "white iron" was practically the same, yet the microscope clearly showed that there was a definite difference between the two, and a brief discussion of the equilibrium diagram of the iron-carbon system during cooling indicated the cause of this difference.

Mr. R. W. Sutton, B.Sc., A.I.C., read a paper by Mr. S. R. Trotman, M.A., F.I.C., on the same subject, with particular reference to the use of the microscope by the practising chemist. Metallurgical and research chemists made use of the microscope chiefly for the specific examination of the structure of metals and alloys, and for the classification of crystals, whereas the chemist in practice depended upon microscopical examination for elucidating a great variety of technical problems, *e.g.*, the quantitative determination of (1) fat in milk, or of fatty acids in soap; (2) foreign ingredients in foodstuffs and food accessories; (3) constituents of mixtures of unknown origin and constitution; qualitative examination and identification of (4) minute amounts of substances such as the causes of discolorations and damage in textiles; (5) substances separated during the course of analysis, such as crystals obtained from a trace of alkaloid. In most of these problems as in a host of others, constant use was made of the microscope—perhaps with the polariser—but with very little apparatus, although macerating agents, selective

stains and chemicals were required. As examples, the detection of the adulteration of ground oats and sumach was described.

Instances were cited in which supplementary microscopical examination greatly assisted chemical examination. Thus the detection and identification of adulterants in foodstuffs such as chicory in coffee, and husks in cocoa, were made very much easier by use of the microscope. The solving of problems connected with textile materials would be impossible without microscopical examination, and slides were shown, illustrating how cotton fibres, of which the cuticle was destroyed, developed characteristic globular swellings when treated with Schweitzer reagent.

In the subsequent discussion Mr. Adams emphasised the importance of the microscope in the engineering works, and observed that microscopical examination of a steel practically gave its autobiography. As an example, where chemical examination revealed nothing, he mentioned the elongation of an axle, which microscopical examination showed had been caused by heating, followed by quenching. In the railway service the cause of failure in metals such as copper, white or bearing metals, was clearly shown by the microscope, which is indispensable in any engineering laboratory. Mr. Pentecost referred to stains in fabrics, such as silk taffeta, the cause of which could not be traced chemically. Examination under the microscope, however, revealed that the "stain" was an optical effect, due to fracture of silk fibres. The only way to avoid such damage was to prevent friction during any part of the process.

Mr. Meek explained a recent application of the microscope to detect the appearance and disappearance of certain alkaloids during growth of plants such as the opium poppy. Mr. Wood referred to the use of the microscope in leather manufacture. Miss Wright spoke of the use of the microscope in the examination of paints and pigments, and Mr. Rome outlined the use of the microscope in water analysis.

The Chairman then touched upon some of the uses of the microscope not referred to in the papers. It was a simple matter to ascertain immediately by microscopical examination the source of a sample of kieselguhr and its suitability for various uses such as a filtering material. The detection of crime by microscopical examination of bloodstains was another aspect; also examination of dust in clothes often gave valuable information as to its origin.

GLASGOW SECTION

A joint meeting with the local section of the Institute of Chemistry was held on January 25, in the Institute of Engineers and Shipbuilders, Glasgow, Mr. J. H. Young in the chair. An interesting address, with lantern illustrations was delivered by Mr. F. W. Harris, F.I.C., of the Glasgow Corporation, on "Modern Methods of Sewage Purification."

In introducing the subject a historical survey was given with special reference to the progress made with the sewage purification and disposal schemes of Glasgow. The Glasgow sewage was first treated, for example, at the Dalmarnock works, with precipitants such as sulphate of alumina and lime and thereafter allowed to settle in septic tanks. The clear sewage from the tanks was then passed through filters composed of pieces of whinstone of varying size, and finally discharged into the river Clyde. A full account was given of the biological filtration systems and of the methods of bio-aeration. The experimental activated-sludge plant installed at the Shieldhall works was described in detail and the methods adopted in sewage purification to speed up the oxidation of the organic matter were discussed in relation to the activities of the protozoa and other organisms.

After an adjournment for refreshments, a very full discussion took place. References were made to the difficulties encountered through the introduction of wastes from various factories and to the necessity for regulations to control the nature of these wastes. The question of the disposal of the sludge and its fertilising value was mentioned. The "activated sludge" had a superior value but there were great difficulties involved in its use owing to its high moisture content. Unfortunately the physical condition of the material greatly altered when it was dried.

Mr. Harris was cordially thanked for his paper and it was announced that an invitation had been extended to members of the sections to visit the Sewage Purification Works of the Glasgow Corporation.

BRISTOL SECTION

At the recent meeting of the above Section, Mr. Osman Jones, of Messrs. Harris', of Calne, read a paper on "The Chemical Technology of Canned Foods." After touching upon the purposes of canning, Mr. Jones confined his remarks chiefly to the technology of canned meats.

The safety of canned goods was emphasised and illustrated by the fact that, in spite of the enormous number of canned rations issued during the war, complaints due to spoilage were practically unknown. After describing the equipment of the canning factory and the high state of cleanliness maintained, the can itself was dealt with, particularly the methods of testing the tinplate used, and the methods for hermetically sealing the cans. In one important type of can, now much used, the contents did not come into contact with a soldered joint. Apart from the selection of good raw material, the vital need was shown for ensuring sterile conditions during filling and processing the material. The elaborate methods for testing the finished article and for preventing spoilation due to bacteria, were treated very fully.

The paper led to an excellent discussion, and a hearty vote of thanks was accorded to the speaker.

On January 23, members and associates visited the Brislington Factory of Messrs. Jas. Robertson and Sons, Ltd., Preserve Manufacturers. The party was shown the various plant and processes for the

manufacture of Golden Shred Marmalade, which was seen to consist only of the juice and shredded outer skin of oranges, together with white sugar. Mr. Robertson personally explained the processes and afterwards entertained the party to tea. A hearty vote of thanks to the Directors and Members of the staff for their courtesy and kindness was proposed by Mr. Jones, and seconded by Mr. Boorne.

The Annual Dinner of the Section will be held jointly with the Institute of Chemistry, at the Royal Hotel, College Green, Bristol, on Saturday, February 16. The President of the Society and other distinguished chemists hope to be present.

MIDLAND VARNISH AND PAINT MANUFACTURERS' ASSOCIATION

The fifth annual dinner took place on January 17, at the Queen's Hotel, Birmingham, Mr. S. K. Thornley presiding. The Council of the National Federation of Associated Varnish, Paint and Colour Manufacturers' Associations had held a meeting in Birmingham on the same day, and nineteen members, including the President, Mr. Mark Harrison, were the guests of the Midland body. In recognition of his long and valued services to the Midland Association a silver rose bowl was presented on behalf of the members to Mr. Thornley by Mr. Lloyd Matthison (this year's President), who pointed out that Mr. Thornley had also filled the office of President of the National Association and had been chairman of the Joint Industrial Council for the Varnish and Paint Industry.

Replying to the toast of the "City and Industries of Birmingham" (proposed by Mr. J. J. Gittings), the Lord Mayor said he was optimistic regarding the future of Midland trade; it was certainly improving.

Mr. P. M. Sturge, submitting the toast, "The National Association," referred to its work in various phases, especially mentioning the industrial classes connected with the varnish, paint and colour trades, which were held at the Birmingham Central Technical School. These classes were held in the evening, were well attended, and were proving of great value. Scientific and technical education was essential if British industry were to compete successfully with other industrial nations in the international markets.

Mr. Mark Harrison, in response, alluded with satisfaction to the happy relationship existing between employers and employed in the varnish, paint and colour industry. In recent years it had been almost alone in its freedom from strikes, threats of strikes, and serious labour troubles. Employers and workers, he said, had met each other in a fair and generous manner.

Mr. Gilbert Vyle, President of the Birmingham Chamber of Commerce, replying to the toast "Our Guests," proposed by the chairman, stated that the trade of applied paint, varnish and colour had altered little in the way it was conducted, the only exception being, perhaps, in a few industrial processes in which they had speeded up the method of application. Protection was the oldest law in nature, and the Varnish, Paint and Colour Manufacturers' Association was amongst the greatest protectionists, because it stood between us and decay, red rust and dissolution.

CORRESPONDENCE

SILICA GEL

SIR,—In your issue of December 7, Mr. J. Arthur Reavell takes exception to my statement that drying of gases is "a pre-requisite" of the employment of silica gel in solvent recovery operations, for the simple reason that commercial installations for the recovery of benzol from coke-oven gases are now in operation without any attempt being made to dry the gases.

I should like to point out that this alleged discrepancy between fact and statement is more apparent than real. Mr. Reavell will not deny that silica gel is an excellent dehydrating agent. May I ask how gases are to be passed through a silica-gel absorber without being dried in the process? It is wholly immaterial whether a separate drier containing silica gel (or other dehydrating agent) is employed prior to the benzol absorption tower, or whether a portion of the silica gel in the absorption tower itself is the means of removing the water. The fact is that if the gases are not dried previously, *a definite portion of the absorbent gel must be allocated to the absorption of water.* Such water absorption occurs in the first portion of the absorber, and the benzol is taken up by the residual gel capacity remaining available. For all practical purposes my original statement stands, but I am quite content to broaden it by substituting the word "requisite" for "pre-requisite."

The quantitative effect of the presence of water vapour upon the over-all efficiency of silica gel, in comparison with high-grade gas absorbing carbon has been dealt with in our published experimental data, referred to in my letter of November 23; and need not be reviewed here. These comparisons were based upon samples purchased by us at $3.00 per lb. from the Silica Gel Corporation in the United States. It was particularly specified that the samples should be suitable for "benzol absorption." We should be very interested if Mr. Reavell would inform us whether the absorption capacities reported by us upon these samples show them to be materially inferior to the gels used in the English installations of which he speaks. If not, the conclusion is inevitable that the recovery of benzol from coke-oven gases is commercially practicable with solid absorbents of a relatively low absorptive capacity in comparison with the standards required of gas absorbent carbons now manufactured for the recovery of gasoline from natural gas. However, I do not wish to be misunderstood as saying that absorptive capacity is the sole technical consideration in choosing an absorbent material, or that certain processes may not be worked out in which other properties of silica gel would compensate for its inferior absorptive capacity.

When Mr. Reavell speaks of activated carbons having been in use for so many years without substantial progress, he falls into a common error which is the fault of the nomenclature in use. Activated gas absorbent carbons of the types we are now discussing originated with silica gel during

war investigations and are an equally distinct technical novelty. If the kakologophobia of our pseudo-Parisian commentator upon the idiosyncrasies of "English As She Is Spoke," should cause the discovery or suggestion of some word of real distinction and beauty to replace the phrase "activated carbon," which now means all things to all men, he would be the recipient of much gratitude.

I should like to take this opportunity to express my appreciation of the extremely courteous and fair restatement of his position on this subject made by Mr. Rex Furness in your issue of November 30. The object of my letter was to protest a prejudgment of the issues between the two absorbents, not myself to prejudge them: also to clarify subsequent discussions by emphasising the fact that silica gel and carbon adsorbents are not alike but fundamentally different and that nothing but confusion can result from assuming a relationship which does not exist. The technical problems associated with their industrial development are materially different and each will have to stand upon its own feet. In view of these differences it seems unlikely that both absorbents will continue indefinitely to occupy closely related fields but rather that their typical applications will become more and more divergent.—Yours faithfully,

N. K. Chaney

Union Carbide and Carbon Research Laboratories, Inc.

New York

Jan. 12, 1924

SMOKELESS FUEL

Sir,—If you will kindly allow me the space, I will do my best to answer "Vulcanus's" questions in your issue of the 18th. inst., though I may be unable to emulate his exalted style. Of course I cannot tell what Mrs. Editor's remarks on the subject may have been, and all I can do is to try and tabulate what may be a housewife's objections and present them in the question-and-answer form.

Is "Coalite" easy to light?

Yes, quite, and it requires no attention, and burns to the last atom.

Is there much ash to remove?

Very little, and the grate requires less cleaning, and chimney-sweeping is avoided.

How about dirt?

There is no dirt; there may be a little fine ash, but that is quite clean and excellent for keeping moths out of carpets and such things.

Is there any special trouble about it?

No, but reduce the draught as much as possible, so as to get full benefit of the radiant heat, and then you will find that a ton of "Coalite" goes as far and gives as much heat as two tons of the very best domestic coal, which costs the same per ton.

Now for "Vulcanus's" own questions.

You can get "Coalite" from Messrs. Hoare Gothard and Bond, Ltd., but supplies at present are not what they should be; still, supplies ought to increase rapidly from the end of February onwards.

"Coalite" is suitable in all cases where Welsh steam coal, anthracite, or any class of bituminous coal can be employed; the draught must be damped down as soon as fuel is well alight, so as to get full advantage of the intense radiant heat.

On the subject of boiling water, perhaps the best reply is a paragraph from Professor Smith's report on a test carried out between "Coalite" and the very best Welsh steam coal.

"The results are eminently satisfactory. From lighting the fires all cold, full steaming was obtained in half the time with 'Coalite' as with coal. While, after banking-up, vigorous steaming occurred in 7 minutes with 'Coalite,' as against 25 minutes with coal. Indeed, although the 'Coalite' 'bank-up' lasts two hours as against 1¾ hours only with coal, steaming ceased entirely before the end of this period with coal, while it continued freely all the time with 'Coalite.' During the banked-up period the average steaming was 44 per cent. greater with 'Coalite' than with coal, the fires having equal depths and being in equally good condition at the beginning of the "bank-up.'"

N.B.—Low-temperature carbonisation is the only method, barring water-power, by which electrical supply can be produced cheaply.—Yours faithfully,

F. A. Wilson

London

Jan. 23, 1924

A QUERY

Sir,—I have reached a stage in some experiments I am doing where I am held up, and wish you would assist me. I require a substance which will burn with a luminous flame, after the fashion of magnesium, and also (if a solid) a solvent for same, which will deposit it unchanged on evaporation. Magnesium will do perfectly if you can recommend a suitable solvent. Trusting that I have made my requirements clear, and that you will be able to help me, I thank you, and remain, yours sincerely,

John R. Charlt[illegible]

Gloucester

January 26, 1924

CARBON MONOXIDE HAZARDS FROM TOBACCO SMOKE

Tests were made to determine (a) the amount of carbon monoxide present in a non-ventilated room in which tobacco smoke was liberated by smoking, and (b) the extent to which it was absorbed by the smokers. The percentage of carbon monoxide present was never greater than 0·02 per cent., and the percentage of carbon monoxide saturation of the blood was not greater than 5 per cent. Tests made to determine why a smoker does not absorb more carbon monoxide into his blood, showed that concentrated smoke does not reach the alveoli of the lungs, and that the maximum average concentration of carbon monoxide drawn into the lungs would not be greater than about 0·01 per cent.—(*J. Ind. Hyg.*, *Jan.*, 1924.)

PERSONAL AND OTHER NOTES

The Society of Chemical Industry has decided to confer the Messel Medal this year upon the Rt. Hon. Viscount Leverhulme. Lord Leverhulme has for very many years been a dominant figure in a great industry which has important chemical connexions; his wide outlook on social questions and his singular grip on the essential factors regulating the relations of the workers to the industry in which they are engaged are well known. He has for some considerable time been interested in the work of the Society, and his letter to this *Journal*, wishing it success at the moment the change was decided upon, will be fresh in the minds of our readers. Lord Leverhulme has taken an active part in many schemes of co-partnership, thrift, hygiene and social welfare, and has been the President of a number of organisations dealing with these subjects. He will deliver the Messel Lecture in Liverpool next July, and this occasion will no doubt provide him with an opportunity of expressing those pithy and shrewd observations which have in the past delighted his audiences, and are only possible to a man with great knowledge of human nature and experience in many branches of activity. Lord Leverhulme's career has been a romance as well as a success, and in spite of the immense amount of work he achieves he has found time to interest himself in art, in politics, and in the scientific work of the industry in which he and his many companies are engaged.

Dr. J. N. Greenwood, of Sheffield, has been appointed professor of metallurgy at the University of Melbourne.

Dr. R. H. Clark, of the Department of Chemistry, University of British Columbia, is the new Hon. Secretary of the Canadian Pacific Section of the Society of Chemical Industry.

Mr. J. C. Pearce has been appointed Director of Research to the British Cast-Iron Research Association in succession to Dr. P. Longmuir, who has had to retire on account of ill-health. Mr. J. E. Fletcher has been appointed consultant to the Association.

According to *The Times*, Prof. Niels Bohr has received $40,000 (about £8000) from the Rockefeller International Education Board, which "he may use to modernise his laboratory and to buy new instruments."

* * *

The death is reported of Prof. R. R. Thompson, O.B.E., M.Sc., professor of oil technology at Birmingham University. Prof. Thompson, who was about 0 years of age, had recently been appointed adviser to the British West Indian Petroleum Syndicate.

It is with deep regret that we have to announce the sudden death of Mr. A. C. Flint, who has been Assistant Secretary of the Chemical Engineering Group since soon after its inception. He also acted as assistant secretary of the Institution of Chemical Engineers durng its formation, and up to the present. The members of both these organisations have the highest appreciation of the work he has done and his loss will be most grievously felt. He leaves a wife and two children.

UNITED STATES

The Patent Office

The number of applications for patents which still await examination has been reduced from 74,256 on September 21 to 65,010 on December 21. Similar reductions have been made in the number of applications for designs and trade marks, so that applications for patents now pass through in nine months instead of fifteen, designs in ten weeks instead of eight months, and trade marks applications in seven weeks instead of five months.—(*Chem. and Met. Eng.*, *Jan.* 14, 1924.)

Fuller's Earth in 1922

The output of fuller's earth in the United States reached its highest point in 1922, the production by 15 operators totalling 138,944 short tons, worth $2,289,719, an increase in quantity and value of 32 per cent, and 16 per cent, respectively, compared with 1921. Occurrences of fuller's earth are found in many States, but during 1922 only eight States were producing, Florida retaining its position as the chief producing State. Imports increased by 8 per cent, to 10,569 t., thus making the apparent consumption 149,513 t.

GERMANY

The German Chemical Society

A note in the current number of the *Chemisch Weekblad* (Jan. 19, 1924) states that a member of the Dutch Chemical Society resident in America has sent the following letter to the German Chemical Society :—

"I am in receipt of your request for subscription remittance for the year 1924. From it I see that you assume the right to ask for additional subscription if costs of printing would further increase. I cannot help but feel that your attitude is absolutely wrong.

"First of all, a membership of a society is an agreement with a mutual character. If you assume a right there should be also a right on the side of the members, that is, that the subscription should be decreased in case cost of printing decreases. Moreover, the increase in the membership fees should be limited to a certain amount, whereas according to your circular they are unlimited.

"Furthermore, I think it absolutely wrong to bring up the question of rights in this connexion. This is just another slip of the German mind, and it seems very hard for you as a nation to learn. If you get into trouble without your fault you should not trust to rights. Has the famous expression 'a scrap of paper' not been found out by your countrymen? Better to trust to friendship and good relations and that they will, if you deserve it, help you through your difficulties. I had no objections to sending you $3.00 a few days ago, because you requested assistance of your foreign members in order to get through your troubles. Since you bring up the point of having a right to do so, the best attitude for me and I hope for many others will be to leave you alone.

"For the above mentioned reasons I do not want to take a subscription to your publications for the

next year. I am just sending you the membership fee amounting to $2.00, and if you do not change your attitude I would remind you of the fact that the abstracts of the American Chemical Society at present are certainly as excellent as the abstracts of the German Chemical Society and, in addition, are printed much better, which, of course, is a great attraction. I know that conditions make it impossible for you to use similar paper and type, but circumstances such as this should certainly make you very careful in bringing up the question of 'rights' where apparently no rights exist and some modesty could be well applied."

Explosion at Merseburg

The Times reports that, on January 24, a violent explosion, recalling that at Oppau in 1921 (*cf. J.*, 1921, 381 R), occurred at the Leuna works, near Merseburg, 15 workmen being killed, a number injured, and various buildings wrecked. The cause of the disaster is not stated, but it is said that a high-pressure container blew up in the department devoted to the manufacture of ammonia products.

GENERAL

Kelvin Centenary

As the centenary of Lord Kelvin's birth will occur on June 26, the Royal Society has convened a committee, under the presidency of Sir Richard Glazebrook, F.R.S., and including representatives of the societies devoted to the promotion of physical science, to make arrangements to celebrate the occasion in a fitting manner. Many British and foreign scientists and engineers will be attending conferences at the British Empire Exhibition at that time, and so July 10 and 11 have been selected for the Kelvin centenary celebrations. There will be a memorial address by Sir J. J. Thomson at a meeting for the reception of addresses from delegates, a dinner presided over by Lord Balfour, and, it is hoped, a reception by the Royal Society at Burlington House. There will also be an exhibition of apparatus and, if possible, a memorial volume will be issued.

The World Power Conference

This conference, organised by the British Electrical and Allied Manufacturers' Association, in co-operation with various technical, scientific and industrial bodies, both British and foreign, will be held at the British Empire Exhibition from June 30 to July 12. Classified into divisions, comprising power resources (I), production (II), transmission and distribution (III), utilisation (IV), and general economics (V), the conference will provide much of interest to the chemist, as special sections are devoted to the preparation of fuels and their utilisation, as well as to electrochemistry and electrometallurgy. The Secretary of the Chemistry and Physics Section is Mr. H. Talbot, B.Sc. (representing the Chemical Engineering Group), and Mr. S. S. Ogilvie, B.A., is Secretary of the Gas and Fuel Section. The fee for membership of the Conference is £2, which entitles the applicant to free admission to the British Empire Exhibition and the Conference Halls during the Conference. Further information can be obtained from the Secretary, World Power Conference, 36 Kingsway, London, W.C. 2.

REVIEW

COAL TAR DISTILLATION AND WORKING-UP OF TAR PRODUCTS. By ARTHUR R. WARNES. *Third edition, rewritten and enlarged. Pp. xv+511. London: Ernest Benn, Limited,* 1923. *Price* 45*s*.

The writer regrets that he is unable to agree with the author that the additional chapters added to the third edition are an improvement, for he is disappointed to find that the very excellent matter of the first edition appears to be nearly obscured by the additions and elaborations of the third.

At the same time, to the industrious reader, the book is a very rich mine of information, from which, with more or less labour, some very valuable and practical ideas on the art of distilling tar may be extracted. This, of course, is inevitable, as Mr. Warnes' long experience in the tar industry has given him opportunities of collecting data and making observations which he has not neglected, and if, when he comes to write another edition, he will exercise a judicious pruning knife and rearrange the beds and borders of his garden, we may look forward, at last, to having a book, written by a native of that England where tar distillation had its origin, of which we may be entirely proud.

If the author will permit him to do so, the writer would like to make a few suggestions as to the direction in which improvements might be made. He would suggest that the chapters on the geology and botany of coal hardly concern the practical tar distiller, neither does that on stripping gas, though the latter is perhaps a little more cognate to the subject; he would therefore plead for their curtailment, if not entire deletion. Then, again, he feels that the book would be read more easily if the order in which the various subjects are arranged were made to take some more logical sequence, and not jump as it does from the distillation of tar to the extraction of carbolic acid, then to benzol and pyridine, back to naphthalene and anthracene, and to pitch, finally ending with creosote.

The excellent 100 pages devoted to tarworks' tests is somewhat unevenly distributed, and 25 per cent. of the total seems a good deal to allot to the highly important, but still single, subject of the determination of benzene, toluene, etc. in mixtures.

In the next edition, which it is earnestly to be hoped will appear without undue delay, it would perhaps be better to give a little more attention to proof reading, and so avoid some ambiguities and an occasional error; for example, it is usual to write C_nH_{2n+2} etc. as the general formula of the various series, and not $C_nH_{2n}+2$, as appears in the present edition.

The writer has expressed his views very frankly, because he feels that Mr. Warnes has not given himself time to do entire justice to his subject and to himself, and that with a very little greater expenditure of time and thought he could have done so very much better.

W. H. COLEMAN

'ARLIAMENTARY NEW

HOUSE OF COMMONS

Imports of Dyestuffs

In reply to Lieut.-Com. Kenworthy, Viscount Wolmer gave the following statistics of dyestuffs imported during 1923 :—

	Cwts.	£
Dyes and dyestuffs (except dye woods and raw dyeing substances) and extracts for dyeing and tanning :—		
Intermediate coal-tar products used in the manufacture of dyes (including aniline oil and salt, and phenylglycine)	1,349	17,010
Finished dyestuffs obtained from coal tar :—		
Alizarine	8,409	72,761
Indigo, synthetic	8,274	13,243
Other sorts	39,474	917,721
Extracts for dyeing :—		
Cutch	48,395	69,475
All other sorts	72,904	310,852
Indigo natural	757	26,915

—(Jan. 22)

Adjournment

The House has adjourned until February 12.

COMPANY NEWS

BENZOL & BY-PRODUCTS, LTD.

At the fourth annual meeting the chairman, Sir H. D. Bax-Ironside, said that the profits of working for the last 18 months were £47,934, after deducting charges and adding to reserves. Preference dividend had absorbed £7920, and the balance of £40,013 had been carried forward (the preceding accounts showed a loss of £44,500). Fixed assets totalled £315,778, compared with £419,846, £18,888 having been written off as depreciation and £89,918 provided by reducing the capital. Trading since last September showed a progressive increase. The tar distillery was, for the first time, almost working at capacity, there was an increased output at the colliery, and a shaft was to be widened. The company's by-products were well sold for several months ahead. It was proposed to pay, at an early date, an interim dividend on the preference shares in excess of the fixed half-yearly dividend of 3 per cent. The report and accounts were adopted.

NICKEL CORPORATION

The accounts for the year ended March 31, 1923, show a loss of £1,981, which has been transferred to the International Nickel Co., Ltd.

COMMERCIAL GAS CO.

Dividends for the 6 months ended December 31, are recommended at the rates of £6 per cent. per annum on the 4 per cent. and on the $3\frac{1}{2}$ per cent. stocks. These compare with £5 16s. and £5 15s. per cent., respectively for the previous year.

...IDLAND BANK, LTD.

At the ordinary general meeting on January 25, the Chairman, the Right Hon. R. McKenna, reviewed the economic situation, and showed how the amount of money in existence varied with the amount of deposits in the banks. He then explained the difference between a legitimate increase in the amount of money and inflation. Unproductive borrowing led to inflation, but a loan to increase production was self-liquidating, provided the repayment of past loans balanced the extension of new ones. Indications were that we were nearing the end of a trying period, although full peace had not yet been restored, and he looked forward with confidence to the future.

An account of the financial situation of the Midland Bank has already appeared in the issue of *Chemistry and Industry* dated January 11 (p. 52).

ENGLISH CHINA CLAYS, LTD.

Dividend on preference shares is announced to be 7 per cent. per annum for the half-year ended December 31, 1923.

SOUTH METROPOLITAN GAS CO, LTD.

The directors recommend a dividend of $5\frac{3}{4}$ per cent. for the year 1923, carrying forward £254,510, compared with a dividend of $5\frac{1}{2}$ per cent. and a carry-forward of £236,400 for 1922.

GAS LIGHT & COKE CO., LTD.

Subject to audit of the accounts, it is proposed to pay dividends of £4 per cent. on the 4 per cent. consolidated preference stock, £3 10s. on the $3\frac{1}{2}$ per cent. maximum stock, and £5 6s. 8d. on the ordinary stock. The carry-forward is £227,295.

EXTINCTION OF MINE FIRES BY LIQUID CARBON DIOXIDE

Mr. C. L. Jones, Industrial Fellow of the Mellon Institute, has sent a reprint of a paper describing experiments on the extinction of coal-mine fires by means of liquefied carbon dioxide. The method has been tried before, but with results varying from success to failure. In the experiments described, carbon dioxide from cylinders was discharged into the mine, the area on fire having been isolated by brick stoppings. The effect of the carbon dioxide is to prevent inward leakage of air, so that if each pound of gas so introduced prevented the entry of an equivalent volume of air, the generation of roughly 600 B.Th.U. is prevented. After all flame was extinguished, water was used to enable the mine to be opened without delay. The results of the experiments show that carbon dioxide should be used where the fire can be sufficiently restricted by stopping, so that prohibitive amounts of gas are not consumed. Further, with the use of the gas, a saving is effected, because the mine can be opened more quickly, depreciation of the mine due to roof-falls, etc., is decreased, and less coal is wasted.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

The comparatively healthy state of the Chemical market continues, and business is very steady with few outstanding features attracting attention. Prices are firm.

Acetic Acid, 40% tech.	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5½d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports. Good business continues.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid. In fair request.
Sod. Bisulphite Powder 60/62%	£19—£20 10s. per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb. Very quiet.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included.

RUBBER CHEMICALS

The demand for rubber chemicals remains somewhat slow, and values are slightly lower.

Antimony Sulphide—	
Golden	5½d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide	4s. per lb.
Carbon Bisulphide	£24—£26 10s. per ton according to quantity.
Carbon Black	Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 8½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.
Carbon Tetrachloride	£56 per ton, drums free.
Chromium Oxide	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	4d.—6½d. per lb. Fairly brisk demand.
Lamp Black	40s. per cwt., barrels free.
Lead Hyposulphite	7½d. per lb.
Lithopone	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according to quality.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep	3s. 4d.—3s. 6d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade and there appears a more healthy prospect in the charcoal market.

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Demand active.
Grey	£22 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according to grade and locality. Market quiet.
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. " " 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. 6d. per gall. 60% O.P. Dull market.
Solvent	5s. 6d. per gall. 40% O.P. Dull market.
Wood Tar	£5—£6 per ton according to grade. Demand not very brisk. Ample supplies.
Brown Sugar of Lead	£42 per ton. Demand more active.

TAR PRODUCTS

Acid Carbolic—	
Crystals	8½d. per lb. Some business passing at lower prices.
Crude 60's	2s.—2s. 3d. per gall. Little business passing. Market weaker in sympathy with crystals.
Acid Cresylic, 97/99	1s. 11d.—2s. 2d. per gall. Steady business.
Pale 95%	1s. 10d.—2s. 1d. per gall. Good demand.
Dark	1s. 7d.—1s. 11d. per gall. Steady business.
Anthracene Paste 40%	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	9d.—10d. per gall. Very quiet.
Unstrained	8d.—9d. per gall.
Benzole—	
Crude 65's	8d.—10d. per gall. ex works in tank wagons.
Standard Motor	1s. 1d.—1s. 2d. per gall. ex works in tank wagons.

Benzole, Pure .. .. 1s. 4½d.—1s. 7d. per gall. ex works in tank wagons.
Toluole—90% .. .. 1s. 3d.—1s. 4d. per gall.
Pure .. .. 1s. 8d.—1s. 10d. per gall.
Xylol .. .. 2s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 1½d. per gall. Firm. Fair business passing.
Middle Oil .. } 9d.—10d. per gall. according to grade and district. Market very firm. Demand good.
Heavy .. ..
Standard Specification
Naphtha—
Solvent 90/160 .. 1s. 0½d.—1s. 2d. per gall. } rather more business.
Solvent 90/190 .. 1s. 1d.—1s. 3d. per gall.
Naphthalene Crude—
Drained Creosote Salts £7 10s.—£8 per ton. Demand maintained.
Whizzed or hot pressed £10—£14 per ton. Quiet and weak.
Naphthalene—
Crystals .. .. £18 per ton.
Flaked .. .. £18 per ton.
Pitch, medium soft .. 85s.—90s. per ton. Nominal. No sellers.
Pyridine—90/140 .. 16s.—17s. per gall. More stable with fair business.
Heavy .. .. 11s.—12s. Firmer with better demand.

INTERMEDIATES AND DYES

Business in dyestuffs has improved appreciably since the holidays. Prices are very firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. 4s. 6d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 11d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 6d. per lb. Better demand.
Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 8½d. per lb. naked at works.
Aniline Salts .. .. 9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl [illegible]% .. 1s. 3d. per lb.
p-Chlorphenol .. 4s. 3d. per lb. d/d.
p-Chloraniline .. 3s. per lb. 100% basis.
o-Cresol 29/31° C. .. 5½d.—6d. per lb. Demand quiet.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Market quiet.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Market quiet.
Dichloraniline .. .. 2s. 2d. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethyaniline .. .. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £82 per ton d/d.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 3s. 3d. per lb. d/d.
Monochlorbenzol .. £63 per ton.
β Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. 1s. 5d. per lb. d/d.
β Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 5s. 3d. per lb. d/d.
p-Nitraniline .. .. 2s. 5d. per lb. d/d.
Nitrobenzene .. .. 5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol .. 2s. per lb. 100% basis d/d.
Nitronaphthalene .. .. 11½d. per lb. d/d.
p-Nitrophenol .. .. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol .. 4s. 6d. per lb. 100% basis.
m-Phenylene Diamine .. 4s. 6d. per lb. d/d.
p-Phenylene Diamine .. 10s. 6d. per lb. 100% basis d/d.
R. Salt .. .. 3s. per lb. 100% basis d/d.
Sodium Naphthionate .. 2s. 7d. per lb. 100% basis d/d.
o-Toluidine .. .. 7d.—8d. per lb.
p-Toluidine .. .. 3s. 10d.—4s. 5d. per lb. d/d.
m-Toluylene Diamine .. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The market is stagnant as buyers are holding off in view of the great uncertainty as to the future of pharmaceutical chemicals.

Acid, Acetic 80% B.P. .. £50 per ton.
Acid, Acetyl Salicylic .. 3s. 6d.—3s. 10d. per lb. Steady demand.
Acid, Benzoic .. .. Commercial acid dearer at 2s. 9d. per lb. B.P. quality remains unobtainable.
Acid, Boric B.P. .. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric.. .. 18s.—20s. per lb.
Acid, Citric .. .. 1s. 5½d. per lb., less 5% for ton lots. Demand fair.
Acid, Gallic .. .. 3s. per lb. for pure crystal. More inquiry.
Acid, Pyrogallic, Cryst... 6s. per lb., for 28 lb. lots.
Acid, Salicylic .. .. 2s. 4d.—2s. 6d. per lb. Market weaker.
Acid, Tannic .. .. 3s. 3d. per lb. for B.P. quality.
Acid, Tartaric .. .. 1s. 1½d. per lb. less 5%. Fair demand.
Amidol .. .. 9s. per lb. d/d.
Acetanilide .. .. Declined to 3s. per lb., but supplies still short.
Amidopyrin .. .. 14s. per lb. Demand negligible.
Ammon. Benzoate .. 3s. 9d. per lb. Much cheaper.
Ammon. Carbonate B.P. £35 per ton.
Atropine Sulphate .. 12s. 6d. per oz. for English make. Market neglected.
Barbitone.. .. .. 17s. per lb.
Benzonaphthol .. .. 5s. 6d. per lb. Supplies scarce. Some dealers quote more.
Bismuth Salts .. .. A steady market. Prices according to quantity:
Bismuth Carbonate .. 12s. 9d.—14s. 9d. per lb.
" Citrate .. .. 11s. 4d.—13s. 4d. "
" Salicylate .. 10s. 2d.—12s. 2d. "
" Subnitrate .. 10s. 9d.—12s. 9d. "
Borax B.P. .. .. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—
Per lb.
Potassium .. .. 9½d.—10d. } Market steady.
Sodium .. .. 9½d.—10d.
Ammonium .. .. 11d.—1s.
Calcium Lactate .. 2s. 9d. per lb. for best English make. Market firmer in view of shrinkage of imports.
Chloral Hydrate .. .. 4s.—4s. 3d. per lb. Firmer tendency.
Chloroform .. .. 2s. per lb. for cwt. lots.
Creosote Carbonate .. 6s. 6d. per lb. Little demand.
Guaiacol Carbonate .. 13s. per lb. for small stocks available. Slightly weaker.
Hexamine .. .. 3s. 9d.—4s. per lb. for foreign makes. Forward position very firm.
Homatropine Hydrobromide .. 30s. per oz.

Iron. Ammon. Citrate, B.P. 1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—
Light Commercial .. £36 per ton net.
Magnesium Oxide—
Light Commercial .. £72 10s. per ton, less 2½%.
Heavy Commercial .. £27 per ton, less 2½%.
Heavy Pure .. .. 1s. 6d.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—
A.B.R. recryst. .. 56s. per lb.
Synthetic .. .. 26s.—35s. per lb., according to quantity. English make.
Mercurials .. .. Firm and likely to advance.
Red oxide .. .. 4s. 11d.—5s. 1d. per lb.
Corrosive sublimate .. 3s. 8d.—3s. 10d. „
White precip. .. .. 4s. 6d.—4s. 8d. „
Calomel .. .. 4s. 1d.—4s. 3d. „
Methyl Salicylate .. 2s. 10d. per lb. for carboys. Quiet.
Methyl Sulphonal .. 21s. per lb.
Methylene di-tannin .. 7s. 6d. per lb. In good demand.
Paraformaldehyde .. 3s. 6d. per lb., without much inquiry.
Paraldehyde .. .. 1s. 7d. per lb.
Phenacetin .. .. 7s. 3d. per lb. Orders falling off.
Phenazone .. .. 8s. per lb. Weaker.
Phenolphthalein .. .. 8s. per lb. Price shaded for quantity. Ample supplies.
Potass. Bitartrate—
99/100% (Cream of Tartar) .. .. 88s.—90s. per cwt., less 2½%. Demand improving.
Potass. Citrate .. .. 1s. 8d.—2s. per lb.
Potass. Ferricyanide .. 3s. per lb.
Potass. Iodide .. .. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite .. 7½d. lb., 1-cwt. kegs included.
Potass. Permanganate .. 9d. per lb. for B.P. crystal English make. In good demand.
Quinine Sulphate .. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin .. .. .. 6s. 3d. per lb. Firmer, though in little demand.
Salol .. .. .. 3s. 9d. per lb.
Silver proteinate .. 9s. 6d. per lb.
Sod. Benzoate, B.P. .. 3s. 3d. per lb. In better supply.
Sod. Citrate, B.P.C., 1923 1s. 10d.—2s. per lb., according to quantity.
Sod. Hyposulphite—
Photographic .. .. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst. 37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside .. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt) .. 87s. 6d. per cwt. Market quiet.
Sod. Salicylate .. .. Powder 2s. 11d. per lb., Crystal at 3s. per lb., and good flake at 3s. 6d. per lb. Scarce on spot. Forward position distinctly firmer.
Sod. Sulphide—
Pure recryst. .. .. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous £27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal .. .. .. 18s. 6d. per lb.
Tartar Emetic .. .. 1s. 4d. per lb.
Thymol .. .. .. 13s. 6d.—13s. 9d. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS.

Acetophenone .. .. 12s. 6d. per lb. Dearer.
Aubepine .. .. .. 13s. 6d. „ Slightly cheaper.
Amyl Acetate .. .. 3s. „
Amyl Butyrate .. .. 7s. 3d. „
Amyl Salicylate .. .. 3s. 6d. „
Anethol (M.P. 21/22° C.) 3s. 9d. „
Benzyl Acetate from Chlorine-free Benzyl Alcohol 3s. 3d. „
Benzyl Alcohol free from Chlorine .. .. 3s. 3d. „
Benzaldehyde free from Chlorine .. .. 3s. 3d. „
Benzyl Benzoate .. .. 3s. 9d. „ Slightly cheaper.
Cinnamic Aldehyde Natural .. .. 21s. 6d. „ Cheaper.
Coumarin .. .. 21s. „ Dearer.
Citronellol .. .. 19s. „
Citral .. .. .. 10s. „
Ethyl Cinnamate .. 10s. „
Ethyl Phthalate .. .. 3s. 9d. „
Eugenol .. .. .. 11s. „
Geraniol (Palmarosa) .. 37s. 6d. „
Geraniol .. .. .. 10s.—17s. 6d. per lb. Much dearer.
Heliotropine .. .. 8s. 6d. per lb.
Iso Eugenol .. .. 15s. 9d. „
Linalol ex Bois de Rose .. 20s. „
Linalyl Acetate .. .. 20s. „
Methyl Anthranilate .. 8s. 6d. „
Methyl Benzoate .. 6s. „
Musk Ketone .. .. 52s. 6d. „
Musk Xylol .. .. 19s. „
Nerolin .. .. .. 4s. „
Phenyl Ethyl Acetate .. 10s. „
Phenyl Ethyl Alcohol .. 16s. „
Rhodinol .. .. .. 60s. „
Safrol .. .. .. 1s. 10d. „
Terpineol .. .. .. 2s. 6d. „
Vanillin .. .. .. 25s. 3d.—26s. 6d. per lb.

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. .. .. 14s. 6d. per lb.
Anise Oil .. .. .. 1s. 11d. „
Bergamot Oil .. .. 13s. 9d. „
Bourbon Geranium Oil .. 32s. 6d. „ Weaker.
Camphor Oil .. .. 75s. per cwt.
Cananga Oil, Java .. 9s. 4½d. per lb.
Cinnamon Oil, Leaf .. 5¾d. per oz.
Cassia Oil, 80/85% .. 10s. per lb.
Citronella Oil—
Java 85/90% .. .. 4s. 7½d. „
Ceylon .. .. .. 4s. „
Clove Oil .. .. .. 9s. 3d. „ Weaker.
Eucalyptus Oil 70/75% .. 2s. 4½d. per lb.
Lavender Oil—
French 38/40% Esters 24s. 6d. per lb.
Lemon Oil .. .. 3s. „ Advanced.
Lemongrass Oil .. 2¾d. per oz.
Orange Oil, Sweet .. 12s. 6d. per lb. Advanced.
Otto of Rose Oil—
Bulgarian .. .. 34s. per oz.
Anatolian .. .. 26s. per oz.
Palma Rosa Oil .. .. 22s. 6d. per lb.
Peppermint Oil—
English .. .. 70s. per lb.
Wayne County .. 16s. 6d. per lb.
Japanese .. .. 13s. 9d. per lb. Advanced.
Pettigrain Oil .. .. 9s. 6d. per lb.

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W.1.) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number.

British India: Plain and corrugated galvanised sheets (95); *Egypt*: Steel (Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, S.W.1., Ref. No. E.S.R. 49-3/2); *New Zealand*: Leather (96), Builders' hardware, crockery (97); *Switzerland*: Steel (108), leather (21675/F.W./M.C./2); *United States*: Rubber (114).

Trade Information

Thomas Tyrer and Co., Ltd., of Stirling Chemical Works, Stratford, London, E. 15, has issued a list of current prices of the well-known Stirling brand of chemicals, ranging from the common acids, alum, and nickel powder to mercurials, codeine, cerium oxalate and many fine chemicals. Terms of sale are given in the list, which should be consulted by every buyer.

British Drug Houses, Ltd., has issued a further edition of the valuable "B. D. H." catalogue of chemical products, which continues to grow in range and utility. Amongst the specialities are standard lactose for bacteriology, "A. R." acids of well-defined purity, a long list of indicators and buffer solutions for determining hydrogen-ion concentration, and a useful selection of test solutions and reagents.

A. Gallenkamp and Co., Ltd., has issued Part II of the catalogue of apparatus for industrial research. All kinds of apparatus—vacuum distillation, furnaces, centrifuges, electrolytic apparatus, calorimeters, viscometers, etc.—are listed, so that the catalogue should find a place in all research laboratories.

Lime is truly one of the "key" materials in chemical industry, and it is strange that consumers have, in the past, rarely insisted on having the best quality for their particular purpose. The Callow Rock Lime Co., Ltd., 810/11, Salisbury House, London, E.C. 2, however, have issued a valuable little booklet, entitled *Chemical Lime*, with the aim of demonstrating the importance of a pure standard lime to the chemical industry, and showing how the company produces such a lime. Methods of burning, the common impurities, and their effects, and the physical condition of lime, are discussed in short, but pithy, paragraphs, each conveying information that should be most useful to the consumer. After a chapter on "hydrate of lime," comes a long list of the uses of lime: in the manufacture of alkali, bleaching powder, ammonia, for softening and purifying water, depilation of hides, paint and distempers, for the hydrolysis of oils, etc., in making sodium soaps, as a flux, in brick making, and a number of chemical and other processes. The pamphlet concludes with a discussion of the physical and chemical properties of Callow Rock lime, compared with those of other limes. It is pleasant to see this Cinderella among chemicals treated with such respect, and it would pay consumers to do the same.

Carbonate of Ammonia is a well-known chemical, but its use in the bakery trade, in which it is known as "volatile salts," or "Vol," cannot be very widely known, though it is, perhaps, the most active member of that class of aerating agents known as "baking powders." Usually such powders contain sodium bicarbonate with tartaric acid, cream of tartar, or a phosphate, but although these materials produce good aeration, they leave a residue, a disadvantage not shared by carbonate of ammonia, which is converted completely to gas during baking. In addition, it has the advantages of purity, invariable composition, and greater gas-yielding power, whilst no gas is evolved until the mixture is in the oven, so that maximum aeration is produced when it is most wanted. To show the value of carbonate of ammonia as a baking powder, Messrs. Brotherton and Co., the well-known ammonia and tar distillers, of City Chambers, Leeds, have produced a most cheery pamphlet in gay covers, replete with recipes for making cakes, scones, and biscuits, all having been worked out by an expert baker. All these recipes require the use, as an ingredient, of carbonate of ammonia, which has been sold by Messrs. Brotherton as the Balloon Brand Carbonate, and has a reputation dating back over 30 years.

Boilermaking has reached a high degree of perfection, and as it is often associated with the manufacture of tanks, piping, cupolas, gas coolers and general plate work, it is of interest to note the catalogue illustrating the products of H. and T. Danks (Netherton), Ltd., Netherton, Dudley. This firm specialises in the erection of completely equipped boiler-houses—an advantage to the purchaser, in that one contractor is responsible for all the work—but its manufactures include steam receivers and other pressure vessels, superheaters, water softeners, vulcanising cylinders and steam-jacketed pans. Attention should be drawn to the "Danks" patent sectional water-tube boiler, which is particularly suited for erection in difficult or cramped positions, and is arranged so that sediment will be deposited, not in parts that should be free from it, but at the bottom in the rear sections, whence it is blown out.

Evaporation is one of the commonest of industrial operations, and in many chemical and manufacturing processes it is often the most important stage. Yet, from what one hears, far too much evaporation is conducted on an unsatisfactory basis whether scientific or economic, although highly efficient apparatus is available, and the theory of the process is well advanced. The firm of Blair, Campbell and McLean, Ltd., Govan, Glasgow, has manufactured all types of evaporating plant since 1838, and therefore has ample experience to place at the service of clients. A particular feature of this firm's productions is complete plants for the manufacture of sugar, glue, dyewood extracts, malt extracts, wood distillation products and various chemicals. The firm has designed many types of evaporators to meet practically all conditions, those in general use being the

Multiplex and Simplex patent film evaporators, the standard vertical evaporators, and special types for salting liquors. All these are illustrated and described in the company's catalogue of "Evaporating Plant," which contrasts the different types, discusses their operation and efficiency, and draws attention to special points. Those interested in the subject should consult the catalogue, if only for the figures showing performance and for the notes on the complete chemical plant which Messrs. Blair, Campbell and McLean supply, in addition to much other chemical plant of all kinds.

Export of Phosphates from Morocco

Exports of phosphates from Morocco in 1923 totalled 190,860 tons, distributed as follows:—France, 24,875 t.; Spain, 6136 t.; Portugal, 4707 t.; Great Britain, 17,493 t.; Holland, 51,504 t.; Belgium, 5199 t.; Czechoslovakia, 4394 t.; Sweden, 8648 t.; Italy, 11,622 t.; the local consumption amounting to 218 t.

French Company News

The Société de Pechelbronn has, since 1917, been extracting by means of wells and the monthly production from these wells alone has risen from 2800 tons at the beginning of 1923, to 3500 t. This process has confirmed the favourable estimates of the probable reserves in the Société's field, which covers 44,000 hectares (1 hectare = 2·47 acres), which are far from being exhausted by the 3500 borings put down so far. The replacement of borings by wells has shown the possibility of withdrawing from the soil, oil which cannot be extracted through borings; thus, after the exhaustion by borings and pumping, there still remains 2 to 3 times as much oil as has already been extracted. For example, No. I area has produced 91,106 t. since the sinking of wells in 1917, up to April 30, 1923, whereas the total production of the area exploited from 1887 to 1917 by 14 borings, which were supposed to have exhausted it, only reached 78,214 t. It is now estimated that this area will produce from 95,000 to 100,000 t. annually, by the exploitation of a deeper layer. It has now been decided to use a new method of treatment for the crude oils, which will permit of products of much higher commercial value than were previously attained.

The Société Alsacienne de Cokeries Alcok is erecting new coke ovens, and the gas produced will be utilised for town lighting by the Société du Gaz de Strasbourg, which is interested in the former company.

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DIAMONDS. *Pp. iv*+15. *Price* 1*s. net.*
MONAZITE. *Pp. iv*+7. *Price* 6*d. net.*
TALC. *Pp. iv*+11. *Price* 9*d. net.*
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JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

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EDITORIAL

IN the year 1920 the Society of Chemical Industry and the Federal Council for Pure and Applied Chemistry discussed, on various occasions, the possibility of having a building, in some central position in London, which would accommodate, under one roof, the chemical societies and organisations which are now scattered all over the metropolis. It was hoped that such a building would be of great value to the science and industry, and that the effect of the scheme would be to add to the social life of chemists and save a great deal of time, energy and money. The late Lord Moulton drew up an appeal to chemists, the draft of which was privately circulated in the spring of 1921, but his death deprived chemists of a leader whose help and influence would have been of the greatest possible service to the chemical community. Since his death an appeal has been circulated, with the object of collecting in the first place a smaller sum, so as to lead the way to the larger scheme and to provide funds to entertain the foreign guests at the meeting of the Union Internationale in Cambridge last summer; after paying the Cambridge expenses the fund now consists of £150 Victory Bonds, £300 War Loan, £150 Funding Loan, £250 Conversion Loan and £200 India Stock. One thing has hitherto been lacking, a handsome donation to start the list of subscriptions. Such a gift not only encourages those who are engaged in circulating the appeal, but it stimulates others to follow the generous example. It is an example to the wealthy to give largely, and to those who are not wealthy to give the sums they can afford. The building, which is still a dream, every day becomes more nearly a reality, and though it may be long before the noble structure which chemistry deserves is erected, some building adequate to the present necessities of the industry and profession, and suitable for the accommodation of at any rate some of the most important societies, is quite possible even if the realisation of the full scheme must be postponed to a later date.

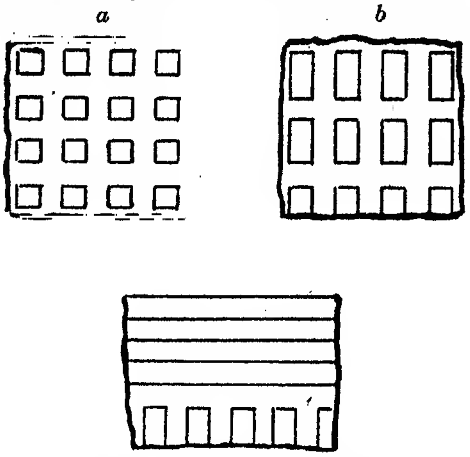
The generosity of the late Mr. W. J. Leonard has now given us that indispensable start which has hitherto been lacking. By a codicil dated in August, 1921, Mr. Leonard has set aside a sum of Five Thousand Pounds towards a scheme for the provision for the Society of Chemical Industry by themselves or in conjunction with other Chemical Societies, of a building and accommodation to form a Central Institute and Club for Chemists. The gift is conditional upon the carrying into effect of a definite scheme within seven years from the date of Mr. Leonard's death, and the exact terms of the bequest are too long for inclusion in an editorial note. At last we have a great opportunity, and it remains for us to take advantage of it. If we make the necessary effort, the success of the scheme is now assured. We shall now feel that during the next five or six years we must concentrate some portion of our energy on the realisation of this scheme. Half-a-dozen men can be of great help in this connexion, but the united effort of the great mass of chemists is necessary for complete success. There must be some thousands of chemists who can afford half-a-guinea a year for four years for such an object, and hundreds of chemists who can afford two or three guineas a year for this period of time. In the course of the next three or four years we shall successfully appeal to the great firms who can look on such a question with wise and large-minded views. When we appeal to them, it is very desirable that we shall be able to convince them that we who are the rank and file do not shirk from our own very agreeable duty. The President of our Society has on several occasions spoken of the co-operation of our various organisations; he has dealt with the matter in many different parts of England and Scotland, and it is worth while for our readers to turn again to the reports of his Presidential and other addresses which have appeared in our *Journal*. The man who has an opportunity of doing a good deed and does not take advantage of it does not remain *in statu quo*, he is just a shade lower in his own estimation. So, we fancy, says Carlyle or some other philosopher,

INDUSTRIAL FILTRATION

Part I.—British Chamber and Frame Presses

By S. G. URE, M.A., B.Sc., M.I.Chem.E.

Filtration, the separation of solid matter held in suspension in a liquid by passing the liquid through a porous medium upon which the solid matter is retained, has very wide application in industry. Sometimes the problem consists in removing very



Drainage Systems for Filter Plates
FIG. 1

small amounts of solid matter from very large volumes of liquid, whilst in other instances the problem may be reversed. Naturally, therefore, the design and the medium used to effect filtration will vary considerably.

In chemical works in this country industrial filtration is effected to a large extent in machines known as chamber or frame filter-presses and it will be, therefore, with this type of plant that this article deals.

The chamber press consists of a number of recessed plates, carried on a suitable framing, and placed so that the recesses of two adjacent plates form a chamber when the plates are pressed together. In the frame type of filter press flat plates are used and the chamber is formed by inserting hollow frames between the plates.

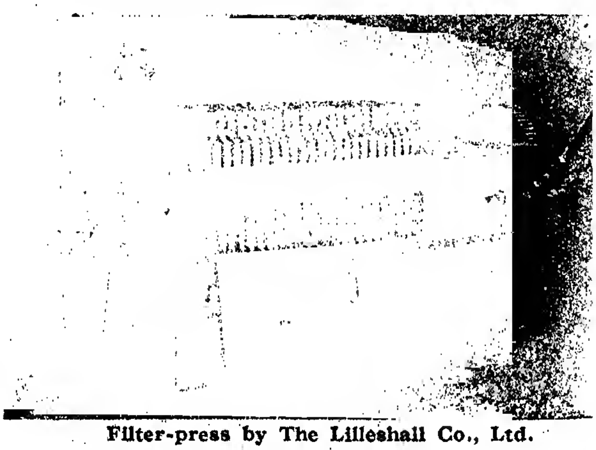
The liquor to be filtered is admitted to these chambers either through holes formed in the plates themselves or through ports in the frame which communicate with a passage situated at the outer edge of the frame and plates or in lugs formed on the outside of the plates and frames.

The filtering medium is placed over these plates and in order to provide adequately for its support and at the same time supply a suitable drainage system for the liquid passing through the medium, the central portions of these plates are corrugated. Figure 1 shows three well known types of corrugations. Type (a) is that adopted by S. H. Johnson and Co., Ltd., and is known as the pyramid drainage surface. It consists of a series of truncated square pyramids, the upper area in contact with the cloth being a square of about ¼ inch edge, whilst the depth of the grooves forming the sides of the pyramid is about 1/16 of an inch. That of Manlove Alliott and Co., Ltd., is a rectangular area about ¼ of an inch broad by ½ an inch long as shown in figure 1 (b), the long edges of the areas being vertical. The Premier Filterpress Co., Ltd., adopts a series of parallel grooves. Those at the top and bottom of the plates are cut horizontally and extend right across the plate. In the central portion of the plate between these horizontal grooves are a series of vertical grooves, the arrangement being as shown in figure 1 (c).

Sometimes perforated plates are used but these are occasionally objected to on the ground that they are difficult to clean, and being usually made of a different material from the press-plates are liable to excessive corrosion produced by electrolysis.

The object of all these devices is to produce a suitable support for the cloth with the minimum reduction in free filtering surface, and at the same time to provide a series of channels, by means of which the filtrate can be rapidly conveyed to the outlet. To prevent unequal stresses being put upon different portions of the filtering medium care is taken to ensure that all surfaces, in contact with the medium, lie in one plane. The edges of these surfaces are carefully rounded to prevent them cutting the filtering medium.

The outer rims of the plates, which in recessed plates extend considerably above the cloth supporting surface, but in plates for frame presses rise only slightly above this surface, are carefully machined on both sides of the plates. Every effort is made by press makers to ensure that the surfaces of the rims on each side of the plates and frames are parallel, for on this factor depends the closing of the press



Filter-press by The Lilleshall Co., Ltd.
FIG. 2

without leaking joints between the plates or plates and frames. The Lilleshall Co., Ltd., uses a disc grinder to face up the rims of plates and frames and guarantees an accuracy within plus or minus three-thousandths of an inch in the thickness of plate or frame.

At the bottom of each plate and connected with the grooves on either side of the plate by ports is

a hole through which the filtrate leaves the press. This hole may be fitted with a bib outlet, or a cock outlet or communicate with a closed delivery outlet passage cast in the plates and frames or in lugs attached thereto. When thorough washing of the cake is necessary, cocks must be fitted on these outlets.

Sometimes it is necessary to filter the liquor at a definite temperature above or below normal room

Filter-press by Messrs. Manlove, Alliott & Co., Ltd.
FIG. 3.

temperature. In these cases the filter plates may be cast hollow or have coils cast in the plates. This necessitates the provision of a supply channel with communicating ports through which the heating vapour or cooling liquid may be admitted to these coils or spaces, as well as an outlet channel for the removal of the condensed vapour or spent cooling liquid.

In some cases, this heating arrangement is unnecessary, the press being warmed by heating fluid admitted to the chambers before filtration commences. When the filter-press has been thoroughly warmed up the hot liquor to be filtered is admitted and if this is slightly above the minimum required temperature it is sufficient to make good the radiation losses from the press. When hot filtration under pressure has to be employed care should be taken to prevent supersaturation, etc., of the hot liquors leaving the filter-press, on account of rapid evaporation under reduced pressure. In order to eliminate troubles of this kind, it is necessary to have a closed outlet system so as to produce a suitable back pressure. This arrangement, however, will throw extra work on the pumping system. If the solid material in the filter-press has to be washed, this operation may be effected in two ways. These are known as "simple washing" and "thorough washing." In simple washing the wash water is admitted through the same channel as the liquor which has been filtered. In this case the flow of wash water through the cake will be in the same direction as the flow of the liquor. For satisfactory results with this method it is necessary that the cake should not be fully formed in order that the wash water may have access to the bottom as well as the top of the cake. This factor has the disadvantage of reducing the capacity of the filter press. As no special provision is required for the admission or removal of the wash water, the same openings being used as for the filtrate, this method can be adopted in filter presses not specially designed for washing the precipitates when an occasional washing is required.

In the thorough washing method the washing water is fed into the filter press, through a separate channel. This channel is connected by passages to the corrugated surfaces on either side of each alternate plate. The outlet cocks on the bottom of these plates are closed and the wash water is forced through the filtering medium, through the whole thickness of cake, through the filtering medium on the opposite plate, and out through the outlet cock on this plate, which is left open. Unfortunately this necessitates the flow of wash water through one medium, and one-half of the filter cake in the reverse direction from the flow of the liquor from which the cake was formed.

With this method of washing it is necessary to make provision for the escape of any air which may be in the filter press. If this is not done the air will prevent the wash water penetrating the upper portion of the cake, so that the top portion of the cake remains unwashed, and the lower portion is washed excessively.

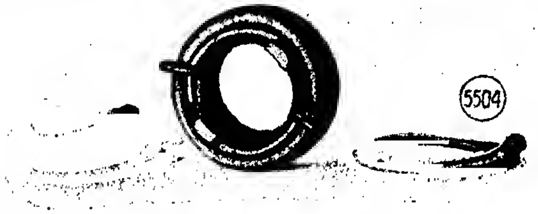
When the filtrate outlet is used as the wash-water outlet, even when air release has been provided, there is always the danger that the washing water may follow paths of least resistance through the cake, and thus cause unequal washing. To overcome this tendency the modern method is to place the wash-water supply channel at the bottom of the plate, the outlet for the washing water being arranged at the top of the plate. In this way the washing water floods the cake, thus producing uniform washing, and at the same time no special provision need be made for the removal of the air which can escape through this washing water outlet. With this arrangement provision must be made for closing all the openings through which the filtrate leaves the filter press.

Washing is employed either to recover valuable liquor adhering to the solid particles, or to free the particles from liquor adhering to them. In the first case it is usually advantageous to use the minimum amount of washing liquid, in order to keep this liquor as concentrated as possible; whereas in the second case where the filtrate is the valueless product of the filter press, the amount of washing water used will only depend upon how far the solid particles have to be washed free of the adhering liquid, and on the time which can be economically given to washing the precipitate in this manner. The time required to wash the precipitate to a required degree of purity will depend on the rate of flow of the washing liquid, and the nature of the liquid to be removed.

The rate of flow of the washing water will depend on the size and shape of the particles forming the precipitate, and on the pressure which is used to drive the wash water through the cake. Should it be necessary to dry the cake before removal from the filter press, provision must be made for the admission and removal of the drying gas, which is usually air.

This can usually be done through some of the existing channels.

The arrangement of these passages on the plates and frames of a filter press permits of a large number of variations. In the catalogue of S. H. Johnson and Co., Ltd., there are 15 varieties of plates of the recessed type, and about 22 varieties of flush plates



Bayonet Fitting of Messrs. Manlove, Alliott & Co., Ltd.
FIG. 4

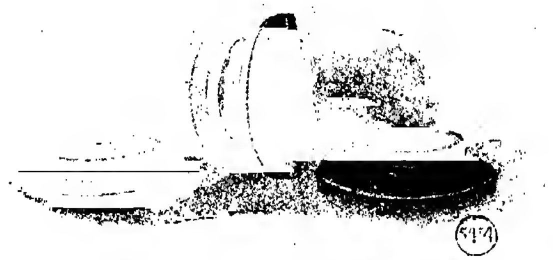
and frames. In the flush plate and frame type it is customary to form the supply and discharge channels or passages by a series of holes drilled in external lugs cast on the plates and frames. When this arrangement is adopted, a considerable wastage of filtering medium would arise if the filtering medium were extended so as to form the jointing material between these lugs.

In order to prevent this wastage of filtering material the joints are usually made by one or other of the following methods. One method consists in covering the lug with a cuff made of the same material as the filtering medium. Holes are cut in the cuff to correspond with the holes in the lug. In the second method the holes in the lugs of the frames are drilled larger than those in the lugs on the plates. Into these enlarged holes are fitted rubber rings. In cross-section, this rubber ring is channel-shaped in form, the flanges of this channel pointing towards the centre of the holes. The length of the rubber ring equals the thickness of the frame, and leakage is prevented by the fluid in the passage pressing these rubber flanges against the plates. Another method is to form the joint by means of a rubber ring which fits into a groove cut in the lug a short distance from, and concentric with, the passage.

The filtering medium covering these plates may consist of paper, cotton cloths, muslin and, for the filtration of strong alkali liquors, woven metal cloth, usually made of monel metal. Filtration through such fabrics should consist of the accumulation of the solid particles to be filtered on the surface of the medium. Particles which enter into and are retained by the cloth increase the resistance to the flow of liquid through the cloth, and therefore the time required for filtration. The true filtering medium is a layer or film of solid particles deposited on the surface of the cloth by the first portion of the liquor being filtered. This being so, the modern tendency is to use thin cloths, thereby lessening the possi[illegible] of the retention by the cloth of any particles which may penetrate its surface. Thin cloths possess two slight disadvantages, namely structural weakness, and the tendency to produce a large amount of cloudy filtrate before a sufficient deposit has been formed on the surface to act as the filtering medium.

The first of these disadvantages may be overcom by backing the cloth with some supporting fabri having meshes sufficiently wide not to interfere wit the free flow through the cloth.

The cloudy filtrate produced at the beginning o the run can be collected and returned to the sam press, or passed through another press kept speciall for that purpose. To prevent this cloudy filtrat filter aids have been adopted. These filter aid consist of sawdust flour, calcium sulphate, calciu carbonate, pulverised bone black, kieselguhr an proprietary articles such as Filter-cel, etc. A filte aid should possess the following properties: (a) i should mix with water, or the material being filtered so as to remain in suspension, and thus produce a uniform layer on the filter cloth; (b) its chemica composition must be such that it is inert or harmles to the materials being separated; and (c) it shoul provide a free filtering medium. The actual coatin of the cloth can be effected in three ways. In th first method a solution of the filter aid is pumped int the press until a clear filtrate is obtained. When th filtrate has become clear the contents of the press ar drained off. With this method compressed air mus be used to hold the coating of filter aid on the clot during the draining of the filter press. After drainage the press can be filled with the liquor to be filtered.



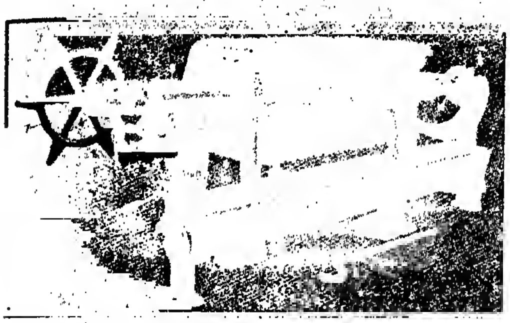
Screw Fitting of Messrs. Manlove, Alliott & Co., Ltd
FIG. 5

This method occupies a longer time and entail more attachments to the filter-press than either o the two following methods. The second metho consists in mixing the filter aid with some filtrat obtained from a previous batch, the quantity use being just sufficient to fill the press. After mixing this liquor is introduced into the press, gravitationa feed being usually employed for this purpose. Whe the filter-press is filled with the liquor containin the filter aid the regular liquor to be filtered i pumped in, and in forcing the contents of the filte press through the cloths, coats them with the filte aid. With this method neither drainage nor com pressed air systems are necessary. The third metho is usually employed when the solids are present i the liquor to be filtered only in relatively smal amounts. In this case it is found practical to mi requisite amount of filter aid directly into th [illegible]red liquor. The amount of filter aid use sh[illegible] be such that its volume far exceeds the volum of the solids in the material to be filtered.

Cotton filter cloths are usually made in thre varieties, namely, square weave, twill weave an

chain weave, but, as cotton is a cellulose product, porous weaves are liable to become dense on wetting. These cloths, being absorbent, are liable to fail at the gasket area on account of the filtrate not being washed out of the cloth at this area by the washing water. Painting this portion of the cloth with a tar base paint will render it non-absorbent and so increase the life of the cloth.

In clothing a filter press of the recessed plate type, two cloths are sewn together round the edges of the



Premier Filter-press, showing Angle-Lever Closing Gear (Premier Filter-press Co., Ltd.)
FIG. 6

holes cut in the cloths to correspond to the hole in the plate through which the liquor enters the chamber. One cloth is then rolled up and passed through this feed hole in the plate, and after unrolling is used to cover the reverse side of the plate. The top edge of each cloth is then attached to the top edge of the plate by clips or hooks. In this way the cloths hang in the correct position until the press is closed, when, as the cloths form the jointing material between the plates, the rims of the plates will retain the cloths in the correct position. Sometimes this sewing together of two cloths at the feed opening is dispensed with, and then the cloth is firmly clamped to the plate round the feed opening by a bayonet or screw fitting (Figs. 4 and 5).

In the plate and frame type of filter press the cloth is cut slightly longer than double the depth of the plate, and is hung over the top of the plate in such a manner that one-half of the cloth hangs down and covers one side of the plate, the other half covering the other side.

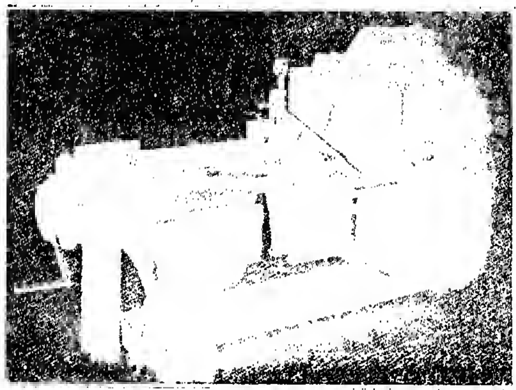
If the various feed and outlet holes are formed in the outer edge of the plates and not on lugs attached thereto, corresponding holes must be cut in the cloths so that they are concentric with these feed and outlet holes. Here, again, the cloths or filtering medium form the jointing material between the plates and frames.

Another point upon which a considerable amount of ingenuity has been displayed by various makers is the closing gear. The objects aimed at in this mechanism are: (a) to exert such a pressure, which must be applied uniformly round the joints between plates and frames, that leakage will be prevented; and (b) that the filter press can be properly closed, or fully opened to allow of the discharge of the cakes, in the least possible time and with the minimum labour.

The simplest form of closing gear consists of a screw, acting through a nut carried in the back standard of the filter press. One end of this screw presses against the centre of the follower plate, and the other end is fitted with the gear, through which the screw is rotated. This turning gear may consist of a ratchet and pawl device on the smaller sizes of filter press. On the larger sizes pinions and tooth wheels, helical wheels, worm and screw gear are employed. The Premier Filterpress Co., Ltd., in small sized machines, carries this centre screw in a rotating nut mounted on the back standard. By this device, as soon as the end of the screw is free from the follower plate, the screw can be tilted out of the way. Another type of closing gear consists of a rack and pinion, the rack being attached to the follower by a flexible joint and the pinion being mounted on the back standard. The pressure is applied by nuts operating on the side rods which are screwed to suit the nuts, and distance pieces are provided so as to minimise the travel of these nuts.

Another type of closing gear consists of the angle lever arrangement shown in Fig. 6. In this type two angle levers are used; the fulcrum situated at the end of the shorter arm is attached by a pin to bosses cast on the head of the press. The side rods are attached to the other ends of the shorter arms, whilst the outer ends of the longer arms are connected by a right and left-handed screw working in swivolling nuts carried by these arms. A hand wheel rotates this screw and operates the gear.

Numerous hydraulic closing devices have been adopted. These usually consist of a hydraulic cylinder carried on the back standard of the filter press, the ram of this cylinder thrusting directly on a



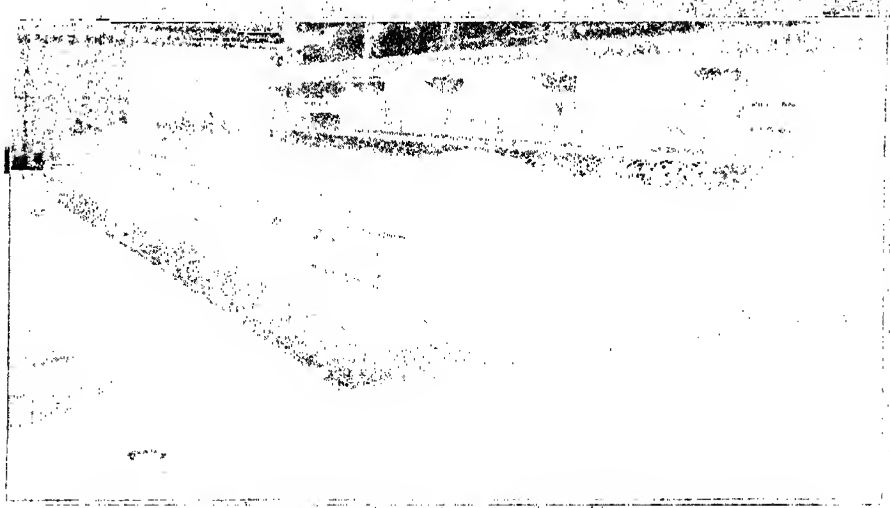
Pyramid Filter-press, showing Hydraulic Closing Gear (S. H. Johnson & Co., Ltd.)
FIG. 7

central boss of the follower. A small hydraulic hand pump is usually provided to give the pressure required for tightening the filter press. S. H. Johnson and Co., Ltd., has a patent hand hydraulic tightening gear which is illustrated in Fig. 7. A small hydraulic cylinder complete with pump, etc., is mounted on the follower. A closing screw carried on the back standard can be rapidly run out until it comes into contact with the ram of the hydraulic cylinder.

Pressure is then applied to the ram, and since the latter cannot move, the cylinder moves forward against the follower. A lock nut on the screw can then be screwed into position, thereby eliminating the necessity of maintaining the hydraulic pressure during filtration, etc. When hydraulic closing gear is adopted in the larger sizes of filter-press, it is customary to provide additional mechanism for the withdrawal of ram and follower when the pressure has been released. These devices may be either of the counter-balance weight or the hydraulic type.

The number of chambers in the filter press varie from six in the smallest to sixty in the largest sizes.

A. F. Craig and Co., Ltd., is at present engaged on a large order for a series of filter presses, speciall designed for the filtration of paraffin wax. This type of press has been developed in America, and has been used solely in connexion with wax extraction in oil refineries, and this is the first time that similar filter presses, embodying the salient features of their American prototypes, have been manufactured in this country. Each of these filter presses possesses five hundred filter plates, each four feet in diameter. The oil is fed into the filter press at a pressure of 500 lbs. per sq. in. in order to obviate the old and expensive method of subsequent pressing in vertical hydraulic presses. The hydraulic cylinder is designed to work at a pressure of 800 lbs. per sq. in.



Filter-presses for Paraffin Wax by Messrs. A. F. Craig & Co., Ltd.

FIG. 8

The materials used in the manufacture of filter-presses naturally depend upon the chemical properties of the substances to be filtered. Usually the standards, head and follower, are made of cast iron, and the side rods of steel. In special cases where cast iron would corrode rapidly or damage the filtered product, the facings of the head and follower as well as the plates and frames, may be made of gun-metal, bronze, aluminium, antimonial lead, or wood. By far the greater number of plates and frames, however, are made of cast iron, on account of its cheapness and durability. When wood is employed it is necessary, when the filter press is not in use, to close the filter press and fill it with water to prevent warping of the plates and frames. Recently the firm of Manlove, Alliott and Co., Ltd., has carried out an interesting series of experiments to find out the effect upon the stresses, by prolonged immersion in different acids, at different concentrations. Usually pine is the wood employed in the manufacture of plates and frames, but where discolouration of the filtrate is to be avoided maple wood is to be preferred.

Standard frame and plate filter-presses vary in size when made of cast iron from plates 12 inches square, to plates 51 inches square, and when made with wooden plates and frames from rectangles 18 in. by 12 in., to 46 in. by 33 in.

As the working pressure plays an important part in filtration operations, the plant for its production requires consideration. In forming a cake the pressure should be applied gradually, until the maximum is reached, and this should be maintained as constant as possible throughout the remainder of the filtering period. If ram or plunger pumps are used the pressure is liable to fluctuate, thus compressing the cake and altering the resistance to the flow of liquid through it. Trouble, too, is often experienced with this type of pump, due to grit being deposited on the valve seats. To maintain a uniform pressure and to overcome valve troubles, montejus have been adopted, but these usually occupy a large floor area, and requiring compressed air for their operation, are often expensive to run. An economical type of pressure-producing plant has been found to be the rotary displacement pump, which occupies little floor space, has positive action, does not suffer from valve troubles, and does not tend to agitate the liquor unduly, like the centrifugal pump if the pump

capacity exceeds the outflow of the press, and supplies the liquor to the filter press free from pulsations. With this type of pump, however, provision should be made for by-passing any excess liquor back to the suction tank.

The complete cycle of operations required for filtration consists of :—(*a*) coating the filtering medium with the filter aid if this is used ; (*b*) filtering the liquor ; (*c*) washing the cake if required ; (*d*) drying

Filter-press by Pratchitt Brothers

FIG. 9

the cake if necessary ; (*e*) opening machine, discharging the cake, and examining the filter cloths ; (*f*) closing the machine in readiness for handling the next batch. For efficient working the time occupied in filtration should occupy as large a percentage of the total cycle as possible, and the time of the other operations should be as small as possible.

As will be seen a large number of factors, as well as the quantity of material and its chemical nature, come into play in the successful design of filter presses. Realising this several manufacturers of filter presses have installed at their works semi-scale laboratories, in which information necessary for successful design can be obtained by actual tests on the material to be filtered, under conditions similar to those prevailing in the full-sized plant.

Thanks are due to Messrs. S. H. Johnson and Co., Ltd., Manlove, Alliott and Co., Ltd., The Premier Filter Press Co., Ltd., A. F. Craig and Co., Ltd., The Willeshall Co., Ltd., Pratchitt Brothers, Bruce and Hyslop, Ltd., Brinjes and Goodwin, Ltd., and other makers, for their courtesy in giving information and granting the use of their illustrations.

The late Mr. W. Prescott, head of Messrs. Prescott and Co., cotton brokers, Liverpool, who left estate valued at £135,182, bequeathed "a sum of £20,000 to the Liverpool University for the founding of a chair of agriculture or of some cognate subject, such as agricultural chemistry, the study of crops, or kindred lines of investigation."

FORTHCOMING EVENTS

Feb. 12. INSTITUTION OF PETROLEUM TECHNOLOGISTS, The Royal Society of Arts, John Street, Adelphi, W.C. 2, at 5.30 p.m. "Electricity Applied to the Winning of Crude Petroleum with Special Reference to the Yenangyoung Field, Burma," by C. H. McCarthy-Jones.

Feb. 12. ROYAL PHOTOGRAPHIC SOCIETY, *Scientific and Technical Group*, 35, Russell Square, W.C. 1, at 7 p.m. "A New Density Meter," by F. C. Toy, D.Sc., and S. O. Rawling, B.Sc.

Feb. 12. ROYAL INSTITUTION OF GREAT BRITAIN, 21, Albemarle Street, W. 1, at 5.15 p.m. "The Respiratory Pigments in Animal Life," by Prof. J. Barcroft. Also on February 19 and 26.

Feb. 13. UNIVERSITY OF LONDON, University College, Gower Street, W.C. 1, at 6 p.m. "The Contributions of Sir Francis Galton to Photography," by K. Pearson, F.R.S.

Feb. 13. ROYAL SOCIETY OF ARTS, W.C. 2, at 8 p.m. "The Preservation of Timber from the Death Watch Beetle," by H. M. Lefroy.

Feb. 13. INSTITUTE OF METALS, *North-East Coast Section*, Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. "Propeller Brass," by A. Logan.

Feb. 14. INSTITUTE OF METALS, *London Section*, 85-88, The Minories, Tower Hill, E. 1. "Metals for Lamp Manufacture," by W. B. Clarke.

Feb. 14. MANCHESTER COLLEGE OF TECHNOLOGY CHEMICAL SOCIETY, at 4.30 p.m. "Osmosis and Osmotic Pressure," by Prof. J. S. Haldane, M.D., F.R.S.

Feb. 14. SOCIETY OF DYERS AND COLOURISTS, *London Section*, The Dyers' Hall, Dowgate Hill, E.C., at 7 p.m. "Staining and Dyeing," by Prof. J. F. Thorpe, C.B.E., D.Sc.

Feb. 14. OPTICAL SOCIETY. Annual General Meeting, Imperial College, South Kensington, S.W. 7, at 7.30 p.m.

Feb. 15. INSTITUTE OF METALS, *Swansea Section*, Metallurgical Department, University College, Singleton Park, Swansea, at 7.15 p.m. "Fatigue and the Elastic Limit," by Prof. C. H. Desch, D.Sc.

Feb. 15. SOCIETY OF CHEMICAL INDUSTRY, *Swansea Meeting*, Technical College, Mount Pleasant, Swansea, at 7.15 p.m. "Paper," by Messrs. L. Taverner and H. J. Williams.

Feb. 15. WEST OF SCOTLAND IRON AND STEEL INSTITUTE, Royal Technical College, George Street, Glasgow, at 7 p.m. "Recent Advances in the Study of Corrosion," by J. Newton Friend.

Feb. 15. SOCIETY OF DYERS AND COLOURISTS, *Manchester Section*, 36, George Street, Manchester. "Some Physical Properties of Yarns," by A. E. Oxley, M.A.

Feb. 15. ROYAL SOCIETY OF ARTS, W.C. 2, at 4.30 p.m. "Salt Manufacture in India and China," by Sir R. M. Dane, K.C.I.E.

Feb. 16. THE BRITISH ASSOCIATION OF CHEMISTS, *London Section*. Annual Dinner, Engineers' Club, Coventry Street, W. 1.

Feb. 16. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section*. Annual Dinner to be held jointly with the local section of the Institute of Chemistry at the Hotel, College Green, Bristol.

BUREAU OF CHEMICAL ABSTRACTS

As already announced, the Bureau of Chemical Abstracts was formed in the latter part of 1923, as the result of a joint agreement between the Councils of the Chemical Society and the Society of Chemical Industry, with the object of co-ordinating and, if possible, unifying the abstracts hitherto published separately by the two Societies. The work of the Bureau is in the hands of a Committee consisting of four representatives from each Society, with Prof. J. C. Philip as Chairman.

The Bureau was, at an early stage, called upon to deal with the position created by the resignation, through ill-health, of Mr. A. J. Greenaway, who was connected, for a long period of years, with the publications of the Chemical Society. His experience, fortunately, is at the disposal of the Bureau in its re-organisation of the production of abstracts.

The Bureau has now arranged for a single homogeneous editorial staff, which will, in future, be responsible for the preparation and production of the abstracts both in pure and applied chemistry. The chief Editor, who will be responsible for the organisation of the scheme and the general control of the abstracts, is Mr. T. F. Burton, who for the past nine years has been Editor of the Transactions and Abstracts issued by the Society of Chemical Industry.

The further decision has been reached that the abstracts in each particular section should, as far as possible, come under the review of an Assistant-Editor, with special knowledge of the subjects covered by the section. The Bureau has, accordingly, appointed the following as Assistant-Editors :—H. M. Dawson (General and Physical chemistry), A. A. Eldridge (Inorganic and Analytical chemistry), W. E. Garner (General and Physical chemistry), H. J. Page (Biochemistry), E. H. Rodd (Organic chemistry; aromatic division), A. Shonk (Applied chemistry), E. E. Turner (Organic chemistry; heterocyclic division), H. Wren (Organic chemistry, aliphatic division).

It is felt that this move in the direction of securing unity in editorial and technical control represents a distinct step towards the achievement of the objects of the Bureau.

SOCIETY OF CHEMICAL INDUSTRY

LONDON SECTION

On February 4, a meeting was held in the Engineers' Club, jointly with the Chemical Engineering Group, to hear a paper by Prof. J. W. Hinchley on "The Manufacture of Potash and Other Salts from Leucite." Dr. Bernard Dyer presided, supported by Mr. J. A. Reavell, M.I.M.E., M.I.Chem.E., and there was a very good attendance.

Owing to pressure on our space it has been found impossible to give an account of the meeting in the current issue, but the paper will be given in full in the forthcoming issue of *Chemistry and Industry.*

MANCHESTER SECTION

A meeting was held on February 1, and Dr. Ernest F. Ehrhardt read a paper, entitled "Reminiscences of Dr. Caro." Dr. H. Levinstein presided, and about 40 were present.

Dr. Heinrich Caro was born in 1834, and when he left college, in Germany, he became a calico printer in Mulheim, Alsace. Later he was sent to England by his employers to buy machinery, and was then so favourably impressed that he determined to return to this country as soon as possible. So about 1855–6 he came to Manchester, remaining there 12 or 13 years before returning finally to Germany.

The name of Dr. Caro was frequently used as a sort of fetish. Frequently, when the question of educating industrial chemists was discussed people would advocate the adoption of the German system, and instance Dr. Caro as one of its best products. Dr. Caro, however, was never educated as a chemist, for, although he did learn the elements of chemistry, he was essentially a calico printer. The dyestuffs industry was only just born when he commenced his business career, and it was from this point of view that he studied the science.

While in Manchester he was engaged by Messrs. Roberts, Dale and Co. to do some chemical analysis, according to his own statement, for a remuneration of £1 per week, whereas another account places it at 30s. The difference in the two amounts would probably be considered substantial at that particular period. It was a modest beginning for a man who subsequently became a German "millionaire." Aniline colours had been invented by Perkin, who had produced his famous mauve. Caro also began to interest himself in the same direction in a manner which might possibly be considered somewhat singular. At that time nitrobenzene was used for scenting soap for barbers, and Caro made his first product from this scent. He tried printing aniline on cotton, and hit upon an aniline-black process for printing cotton black. This success so impressed Roberts, Dale and Co. that they took him into partnership. He remained with the firm for 10 years, and then returned to Germany, with a competency, for the purpose of undertaking research work at the University of Heidelberg. At that particular period the author of the paper happened to be churchwarden in the English church of Heidelberg, and was present at the first christening there, which was that of Caro's eldest daughter.

The Mannheim-Ludwigshafen factory (Badische Anilin u. Soda Fabrik) was then in its infancy, and its managers constantly consulted Caro, finally persuading him to join their undertaking as head of the research department. He stayed with them 25 years, and then took a seat on the Board. He was a difficult man to get on with, and was constantly quarrelling with his colleagues. Having served his first term of five years as a director, he was, in consequence, not reappointed, but was "promoted" to the Supervisory Board, a sort of committee of inspection appointed by the shareholders.

While Caro was in Manchester, Roberts, Dale and Co. had installed a new plant for the manufacture

of oxalic acid. A friend of the firm came to them who had discovered a way of making the acid by bubbling coal-gas, as it was supplied in those days, through nitric acid. Caro investigated the process, and it was soon obvious that it would prove more expensive than the use of sawdust which was then the usual raw material for the manufacture of oxalic acid. Caro, however, noticed that in bubbling the coal-gas through the nitric acid a little nitrobenzene was formed. This was the raw material for making aniline, and, in those days, was very expensive. Roberts, Dale and Co. were at once appalled at the prospect of nitrobenzene being made in that way, thus causing oxalic acid to become a by-product, and their oxalic acid plant to become worthless. The process was promptly condemned, and a discreet silence maintained about it. Many years later the matter became of importance in Germany. The German tar distillers combined and put up the prices of benzene and other crude products to the dyestuffs factories. Caro remembered his old Manchester experiment, and began a repetition of it in his writing-room on the window sill. While the experiment was proceeding, a visit was paid by Prof. Witt, a German who had also been in Manchester, and who had become a professor at the Heidelberg Polytechnic. Caro drew the window curtains to hide the beaker, and then went out with Witt, forgetting all about his experiment. The gas bubbled through the beaker all night. Next morning Caro found there was a little oxalic acid in the nitric acid, but not sufficient to be of any importance. What was important, however, was that on the top of the nitric acid there was quite considerable layer of oil, and upon analysis it proved to be benzene containing a little nitrobenzene. The action of the nitric acid on the benzene in the gas had produced nitrobenzene, and this had acted as a solvent and scrubbed the gas of its benzene. It was thus demonstrated that coal-gas contained a considerable quantity of benzene. Further experiments were made with more suitable solvents, a counter-alliance was entered into with the gasworks undertakings, and, in the end, the combine of the profiteering tar distillers was routed.

Caro always emphasised the element of chance in discoveries. His invention of the commercial process for making alizarin was an instance. The first production of artificial alizarin had been by the Geneva chemists, Graebe and Liebemann. They made dibromanthraquinone which they melted with caustic alkali. They had repeatedly tried to use cheap vitriol for the process, instead of expensive bromine, but had failed. The result was commercial failure. The Badische Anilin u. Soda Fabrik had acquired a considerable quantity of anthraquinone which was apparently wasted. Caro set to work to find some use for it. He made a dye from carbolic acid by treating the carbolic acid with vitriol and oxalic acid, and then decided to make the same experiment with anthraquinone instead of carbolic acid. The experiment was made in a porcelain dish in the laboratory, and as the acid mixture got hotter the oxalic acid decomposed and volatilised. The experiment was a failure. Just then, Caro was called away, forgetting to remove the flame from under the porcelain dish. The vitriol went on boiling in his absence, and, upon his return, the laboratory was full of fumes, the mixture in the dish had evaporated to dryness, and there was a partly charred crust of material around the upper edge of which was a thin pink line. The boiling sulphuric acid had acted on the anthraquinone to give a sulpho-acid, whilst the charring had decomposed some of the sulpho acid into alizarin, which, with a trace of alumina from the porcelain dish, gave the pink line. This started Caro again on the sulphuric acid process. He took the strongest fuming acid available, and worked at a high temperature, obtaining anthraquinone, sulpho-acids, alizarin, and its isomers, from it. At this particular period, W. H. Perkin (later Sir William Perkin) was also working independently at the same problem and solved it, but Caro had the good luck to get his patent into the English Patent Office one day before Perkin. Caro's patent was 1938, June 25, 1869, and Perkin's patent was 1948, June 26, 1869. But for Caro's good luck, the English market for alizarin, which was the principal and almost the sole one, would have been closed to the German manufacturers.

A paper on "The Dehydration of Alcohol by Means of Glycerin," by Prof. E. Knecht, Ph.D., M.Sc., Tech., and E. F. Muller, B.Sc., Tech, was read by Prof. Knecht, who stated that it was well known that pure glycerin readily took up a certain proportion of water, which it retained tenaciously at the boiling point of water, and even beyond that temperature. It was considered of interest to ascertain whether this property might be utilised for the dehydration of ordinary alcohol, with a view to working out a rapid and convenient process for the preparation of absolute alcohol. In a preliminary experiment some ordinary alcohol of about 92 per cent. strength was mixed at random with glycerin and distilled from a water bath; pure alcohol came over, though it was fairly obvious that this would be the result. In order to ascertain to what extent pure alcohol is retained by pure glycerin at 100°, a quantitative distillation was carried out. To this end absolute alcohol was mixed with 25 per cent. of pure glycerin, the mixture being distilled from a water bath, and the distillate collected in a flask provided with a loosely-fitting cork. The following quantities were taken: 40 g. absolute alcohol, 10 g. pure glycerin. The mixture was distilled until no more liquid came over at the temperature of the water bath, and yielded 37·8 g. alcohol recovered, so that 2·2 g. had remained in the glycerin, this being equivalent to 5·5 per cent. of the alcohol taken. By heating the residue in the flask to 180° a further recovery of 2·15 g. alcohol was effected, and there was practically no loss. The method gave a satisfactory product with very little trouble, and in sufficiently good yield to be of some practical value in the laboratory.

Dr. J. M. Francis, chief chemist to Parke, Davis and Co., Detroit, died on January 9. Otto J. Laist, a chemist who had done much work in the refining of glycerin, died on January 2, aged 89.

OTTAWA SECTION

A meeting was held in the University Club, Ottawa, on January 10, Dr. Macintyre in the chair, and there was a good attendance. The minutes of the last meeting were read and approved. The financial statement for the year 1923 was read and showed a balance on hand of $112·86. The motion by Dr. Shutt and Col. Janson that the report be adopted was carried.

Dr. Shutt called attention to Russell's book, "The A B C of the Atom" and the chairman referred at some length to "Die Methoden der Organischen Chemie," by Weyl. Mr. N. Van Patten, Librarian at Queens University and formerly of the Massachusetts Institute of Technology, then addressed the meeting on Chemical Literature. He said that in attempting to speak of chemical literature and its uses some attention should be paid to the historical background, with emphasis on the continuity of the science. In 1872 a manuscript was discovered at Thebes which treated of the practice of medicine and the preparation of pharmaceuticals. The date of the manuscript was placed in the 16th century B.C., and it was the earliest medical work on record. Chemistry was known in the early period around the 16th century as the sacred art, and its practice was confined to the Priesthood. Its literature was written in an obscure and figurative language, and was made up of a wonderful conglomerate of science, religion, astrology and symbolism. Reference was made to the records of Chinese and Arabian alchemy. During the Middle Ages the schools and libraries were controlled by the clergy and practically all works of alchemy were the production of persons attached to the Church, such as Roger Bacon, born in 1214, Raymond Lully, a Friar born in 1235, and Albertus Magnus, a Bishop, born in 1193.

Geber stated the qualifications necessary to a chemist as diligence, patience, learning, temperate disposition, slowness to anger and a full purse. "For this Science agrees not well with a man poor and indigent." Reference was then made to the work of several of the early alchemists. Modern journal literature has increased in volume until we now have in excess of 2000 journals, and perhaps as many more serial publications devoted to chemistry and chemical technology. The Columbian Chemical Society existed in Philadelphia as early as 1811, and such societies have multiplied greatly, so that we have a large number of such societies dealing with general and specific phases of the science.

Mr. Van Patten then outlined a method of investigating literature relative to a particular subject and suggested that it would be well if all such inquiries could be done by librarians or chemists specialising in such work. This is now being done in a number of corporations such as the General Electric Co., General Chemical Co., etc., and the practice has proved decidedly worth while, and such library activities are more than paying their own way. Some libraries, such as that at the Massachusetts Institute of Technology, have a system of keeping members of the staff, students and subscribers informed regularly on subjects of special interest to them and information is supplied on any special subject desired. The speaker hoped that Queens Library would soon be able to render a much needed service to Canadian scientists. Reference was made to Bulletin No. 36 of the National Research Conference containing a list of publications in chemistry and chemical technology and to the pamphlet printed by Chemical Abstracts, giving a list of all the chemical journals abstracted. Comprehensive reference was then made to the standard works on the various phases of chemistry and to reports and official publications on these subjects.

A very interesting discussion followed the address, during which Mr. Van Patten explained the Dewey decimal system of classification and also referred to the United States Libraries of Congress Classification. Mrs. O'Gilvie gave an interesting short account of the system used in the Mines Branch Library (a modification of the Dewey System.) The manner of working up information on a specific subject brought forth an interesting discussion between Mr. Elworthy, the chairman, and Dr. Wilson. Dr. Macintyre referred to Notes on Chemical Literature and its use compiled by Marion E. Sparks.

YORKSHIRE SECTION

Dr. L. L. Lloyd presided at the fourth meeting of the Session, held in Leeds on January 28, when a paper by W. B. Atkin and G. W. Douglas on "Proteins as Chemical Compounds" was read.

In consequence largely of the work of Procter and Wilson in Leeds and of Loeb in America, proteins are no longer regarded simply as "colloids," and peculiarities in their behaviour towards acids and alkalis, hitherto "explained" by adsorption and other vague terms are gradually being eliminated. In truth the solubility in acid and alkali is due to chemical combination.

Gelatin, according to Procter, forms salts with acids capable of ionising and variations in swelling are correlated with osmotic pressure effects, whilst Loeb demonstrated their amphoteric character with an isoelectric point at p_H 4·7. The titration results of Harris and Hopkins with lysine with the corrections introduced showed clearly how their curve for lysine was made up of two neutralisation curves, and gelatin was examined by the authors in a similar manner.

Carefully purified gelatin (which does not set to a jelly, but is gradually precipitated), was made up to 1 per cent., and titrated with acid and alkali at 25° C., using a hydrogen-electrode apparatus, and correcting for hydrolytic effects. The gelatin was neutralised by hydrochloric acid at p_H 3·65, corresponding to a combining weight of 1100 and by caustic soda at p_H 5·65, combining weight 3000. Further, after p_H 7, there is evidence that soda is being attached, in other words, the gelatin is behaving like a weak polybasic acid. These results were shown to be in agreement with calculations made from the results of Dakin's work on the nature of the gelatin molecule.

NOTTINGHAM SECTION

At a joint meeting with the Society of Dyers and Colourists (Midlands Section) held on January 30, a paper entitled "The Progress of Research in the Ionamine Dyestuffs," by A. G. Green, F.R.S., and K. H. Saunders, B.A., B.Sc., was read by Mr. K. H. Saunders.

Ionamine dyestuffs were obtained by causing aldehyde bisulphites to combine with aminoazo compounds, to form alkyl omega sulphonates of the type $PhN_2C_6H_4NH.CH_2SO_3Na$. In the dye bath hydrolysis occurred with the liberation of the free base which dyed the yarn in fabric. The two chief advantages of these dye bases were their solubility in water, and their miscibility with direct cotton colours, so that a great variety of effects could be obtained with union goods. The first ionamines produced ranged from yellow to orange, and extension of the work to obtain deeper shades involved use of diazotisation and development. The technical difficulties involved in such treatment were enhanced by the slowness with which both nitrous acid and developer penetrated the fibre, often necessitating warm coupling baths.

The fastness of the original Ionamine B dyes was satisfactory, and research was directed towards extending the range of colours by producing dyestuffs which were insoluble in water, possessed an affinity for cellulose acetate and contained a free amino group, to which could be attached the solubilising alkyl omega sulphonic group. The production of blue dyestuffs was aimed at, as it has always been found difficult to obtain blue dyes possessing an affinity for cellulose-base silk. The gallocyanine bases possess this property and it was found possible to prepare the corresponding alkyl omega sulphonates of this class. These dyestuffs were of even penetration and fast to soap, but extremely fugitive to light. Attention was then turned to alkyl omega sulphonates of the aminoanthraquinone class, and successful results were obtained in the production of dyes which penetrated evenly into the twist and were fast to light; further, as cotton was not stained these dyestuffs were suitable for unions. In discussing the application of Ionamine dyes, it was observed that difficulties arose in the dye house that did not occur in the laboratory. The causes of the defects of "barring" (alternate bars of light and dark shades) were considered and remedies suggested.

Describing the phenomenon of "phototropy," the speaker said that if a portion of a piece of yellow dyed cellulose acetate was shielded from the light for a few minutes, and the shield then removed, a lighter patch was seen, which quickly darkened to the original colour. No satisfactory explanation had been found to account for this peculiar effect, and so far a pure greenish-yellow dyestuff entirely free from phototropy had not been obtained.

The Ionamine dyestuffs had now been obtained in the primary colours, and by mixing, almost any shade (except black) can be produced.

The other method for dyeing cellulose acetate silk is by using insoluble compounds, which were held in colloidal solution by such dispersing agents as Turkey Red oil. This method would seem to be accompanied by a larger number of difficulties than the Ionamine process.

The lecture was illustrated by many dyed patterns showing the range of direct dyeing Ionamines, both alone and in conjunction with direct cotton colours.

In the discussion Mr. Pomphrey inquired how the Ionamine-dyed cellulose acetates compared with the fastness of wool colours to chlorination and stoving. Mr. Pentecost asked whether the cellulose acetate was constant in composition, or whether different samples responded differently. Mr. Wolstenholme mentioned some samples dyed a good black with Ionamine A black, but others (in the same bath) were bronzed, and had to go back into the bath again. Mr. L. S. Pentecost enquired whether the lustre could be restored to a "blinded" fabric. Mr. H. B. Mayfield referred to the different shades sometimes obtained, when dyeing slack and stiff varieties of cellulose acetate. Mr. Ellis mentioned that phototropic effects were also noticed with certain red and orange dyestuffs.

In reply, Mr. Saunders stated that fastness varied considerably, according to the particular type of Ionamine dyestuff, and also according to the chemical used. In stoving it was probable that the cellulose acetate would be injured before the colouring matter. There was a noticeable difference in the quality of different batches of cellulose acetate. Thus sometimes it was found possible to force compounds with higher molecular aggregations into the cellulose than at others. The "blinding" during developing was due to the dyestuff crystallising out, and it was not possible to restore the original lustre. The bronzed effects when using Ionamine A black were probably due to insufficient diazotising.

CANADIAN PACIFIC SECTION

The Canadian Pacific Section held a meeting on November 7, in the Board of Trade Building, Vancouver, B.C.

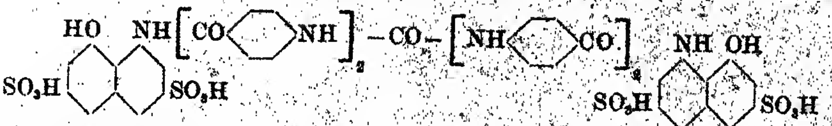
Dr. W. F. Seyer of the Chemistry Department, University of British Columbia, spoke upon the "Chemistry of Lubrication," and reviewed the work of Towers, Regnault, Southcomb, and Wells and Deely, as well as the recent work of Hardy. Their results led to two conceptions of lubrication—boundary lubrication and flooded lubrication, oiliness being a physical property which determined the efficiency of substances as lubricants under boundary conditions. He then described experiments carried out by himself, using Hardy's method of measuring the coefficient of friction, and gave a number of results obtained with mixtures of organic compounds whose chemical composition and viscosities were similar to that of mineral and vegetable lubricating oils.

Mr. E. J. Hunt, of the firm of Chance and Hunt, Oldbury, has been appointed a Justice of the Peace for the County of Worcestershire.

CORRESPONDENCE

"BAYER 205"

Sir,—In the editorial of the third number of this year, which I have only just seen, you mentioned "Bayer 205," which, from your remarks, had evidently been reviewed in *The Times*, and there described as a compound of carbon, hydrogen, etc., without indication of constitution. You qualified this latter by saying that so far nothing more seemed to be known in this country, and while this is quite true, an indication of the type of compound was given as



in an article in the issue of September 23, 1922, of the *British Medical Journal*, page 568. It was there suggested that Bayer 205 was a derivative of this. You may, of course, have information later to the contrary, but with the exception of this I have seen no detailed account at all. A short historical survey is included, and an article covering, in a general way, compounds of specific action (including Bayer 205) is given on p. 807 of the same Journal.

This may, I hope, be of interest to your readers, as it is an extremely important branch of the subject, and if any other references are available they would be appreciated.—I am, Sir, etc.,

Eric Dow

Physiological Institute,
University of Glasgow
February 4, 1924

INDUSTRIAL AND MEDICAL RESEARCH.

Sir,—In my article, "The Epilation of Skins," which you were good enough to publish last week, I mention that some of the experiments might be of service to cancer research. It may interest your readers to explain this connexion, as it shows how industrial research can help medical research as well as *vice versa*. It is practically certain that cell-proliferation leading to a growth is immediately caused by nitrogenous bases which contain the N—C=N grouping. These bases are produced in the living body by chronic injury (irritation) in a tissue and probably by bacterial invasion of the site. The intermediate stages were not realised fully until the leather research was made in the tannery. Here the great importance of the two enzymes became apparent. The amino substances are produced by a histo-protease set free by the injury and by a parasite-protease as a result of the infection. The importance of the position of equilibrium was also revealed by the researches in the tannery (which were completed in 1919), and cases of cancer are being treated experimentally on this principle.—I am, Sir, etc.,

H. C. Ross

113, Mount Pleasant, Liverpool
January 30, 1924.

LEAD SMELTING IN GREAT BRITAIN

Sir,—Mr. C. A. Klein, in his review of J. A. Smythe's "Lead, Its Occurrence in Nature," etc., states that in this country the lead produced by smelting does not exceed one-fifth of the total quantity of metal used for all purposes. Surely this figure is much too high. For a good many years before the war our output of lead from British concentrates was roughly 20,000 tons a year, and our imports 220,000 tons; allowing for imported ores and exported lead we may take it that one-tenth is a more correct figure than one-fifth. In 1922 the figure was about one-twentieth, but this was a year of great depression in home mining, and the returns must be considered abnormal.—I am, Sir, etc.,

H. L. Terry

36, Brook Road, Fallowfield,
Manchester
February 4, 1924

HIGH PRICE OF REPRINTS

Sir,—In reviewing reprints of two General Discussions recently held by the Faraday Society, your reviewers, while approving of the policy of the Society in making these Reports generally available, expressed the hope that their high price would not impede their circulation among scientific workers. The kind reception accorded by you to these Reports is greatly appreciated by the Council of the Society, but may I be permitted to say a word in explanation of their high price?

The price of any book is largely determined by its circulation. In the case of a Society like the Faraday Society, which, in spite of its small membership, publishes a large amount of scientific material, the price of the *Transactions* is necessarily high. Reprints from the *Transactions* must be priced accordingly, lest non-members who purchase the reprints should receive them on better terms than members through whose subscriptions publication is rendered possible.

It is unnecessary to say that we desire a wide publicity for our Reports of General Discussions, but they can be produced at a cheaper rate only if the Society receives a far greater measure of support from British chemists and physicists than is at present the case.—I am, Sir, etc.,

Robert Robertson,
President, Faraday Society

10, Essex Street, Strand, W.C.
February 5, 1924

We regret to announce the death of Mr. W. E. Moulsdale, chairman of Cope Brothers, Ltd., tobacco manufacturers, who had been a member of this Society since 1917. Mr. Moulsdale was an engineer by profession, and was interested in educational work.

PERSONAL AND OTHER NOTES

On February 1, a bust of Prof. H. B. Dixon, F.R.S., was unveiled in the Chemical Theatre of Manchester University to commemorate his valued service to the University from 1886 to 1922. After the Vice-Chancellor, Sir H. Miers, had paid tributes to Prof. Dixon as scientist, man of letters and mountaineer, the bust was unveiled by Dr. H. G. Colman, one of Prof. Dixon's early students, many colleagues and past students being present. In the course of his reply, Prof. Dixon said his aim had been to foster research and not allow Manchester to fall behind the German schools of chemistry.

Mr. S. Stewart, F.I.C., has recently retired after over 27 years' service as works chemist to Messrs. Michael Nairn & Co., Kirkcaldy. To mark the occasion, the directors and staff gave Mr. Stewart a handsome present and a letter expressing the general goodwill which he has earned.

Sir Richard Glazebrook, F.R.S., has been appointed by the Chancellor of Cambridge University a member of the Court of the University of Liverpool.

G. W. Jones, assistant gas chemist to the U.S. Bureau of Mines, has been promoted to the post of associate chemical technologist to carry out research on explosives. He succeeds Dr. J. L. Sherrick, who has retired to take up the manufacture of gelatin.

The Council of the Institution of Electrical Engineers have made the third award of the Faraday Medal to Dr. S. Z. de Ferranti, a past President of the Institution. The Faraday Medal is awarded by the Council of the Institution not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering, or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution. Dr. Ferranti was a pioneer in the supply of electricity, and his early grasp of the fundamental principles of electric power supply have had a profound influence, not only in this country, but all over the world.

The scheme for fellowships in chemical science in memory of the late Sir William Ramsay has now come to full fruition. At the present time sixteen fellowships for chemical science are being held in the Universities or Colleges of the United Kingdom. The awards for the present session are as follows, the University or College which has been selected by the fellow for his research appearing after the name in each case:—British: Dr. Samuel Coffey (University College, London); Dr. R. W. Lunt (University College, London); and Dr. A. F. Titley (Oxford); Glasgow: Mr. J. A. Mair (Glasgow), and Mr. T. S. Stevens (Glasgow); Canadian: Dr. E. H. Boomer (Cambridge); Danish: Mr. K. Hejendahl (Liverpool); Dutch: Dr. C. F. van Duin (St. Andrew's), and Dr. T. Kalff (Liverpool); French: Dr. H. Weiss (Royal Institution, London); Italian: Dr. A. Nasini (Cambridge); Japanese: Dr. N. Kameyama (University College, London); Norwegian: Mr. Gunnar Weidemann (Cambridge); Spanish: Dr. Miguel Crespi (University College, London); Swedish: Mr. A. W. Bernton (Oxford), and Dr. J. Lublin (Cambridge). The total value of the annual amount of the fellowships that is awarded is £5007, of which £3500 is provided by grants from Dominion and foreign sources.

CANADA

New Artificial Silk Plant

It is announced that Courtaulds, Ltd., has purchased 240 acres of land near the St. Lawrence river, Ontario, as a site for a new artificial silk plant. Three plants belonging to the firm are already working in the United States, but the Canadian plant will have advantages in the export trade that factories in the neighbouring country do not possess.

BRITISH INDIA

Indian Mineral Output in 1922

The following table has been drawn up from a report on the mineral production of India during 1922 by the Director of the Geological Survey, India:—

	Amount	1921	1922
Chromite	tons	22,777	34,762
Coal	,,	19,010,986	19,302,947
Copper	,,	30,764	23,089
Diamonds	carats	171·39	126·1
Gold	oz.	433,722·59	438,015·04
Graphite	tons	—	25
Iron	,,	625,274	942,084
Jadeite	cwts.	7,724·7	3,815
Lead	tons	39,214	33,717
Magnesite	,,	19,000	20,000
Manganese	,,	474,401	679,286
Mica	cwts.	31,570·1	32,488
Monazite	tons	125	1260
Petroleum	gall.	299,500,000	305,683,227
Ruby, Sapphire Spinel	carats	231,160	193,915
Salt	tons	1,653,898·2	1,533,679
Saltpetre	,,	11,672·9	15,893·7
Silver	oz.	4,205,584	3,555,021
Tin ore	tons	1874·7	1701·6
Tungsten	,,	943	898·3
Zinc	,,	18,061	4000
Alum	cwts.	6632	3380
Asbestos	tons	242	—
Barytes	,,	2392·2	1691
Bauxite	,,	3987	1999
Clay	,,	104,748	199,266
Fuller's Earth ..	,,	13,539	2807
Gypsum	,,	40,645·5	33,801
Ilmenite	,,	400	—
Ochre	,,	6702	5812·7
Soda	,,	28	10
Steatite	,,	906	2010
Zircon	,,	160	—

The number of mineral concessions granted during 1922 amounted to 672, as against 651 in 1921; of these, 562 were prospecting licences and 110 were mining leases.—(*Ind. Tr. J., Jan.* 3, 1924.)

FRANCE

National Fuel

The Ministry of Agriculture has issued a circular stating that the name of "National Fuel" can be applied only to mixtures of hydrocarbons and alcohol containing for each 100 volumes of hydrocarbon more than 95, and less than 105, volumes of alcohol. The mixture must also possess certain physical properties which are defined in the circular.

Funds for Laboratories

The Chamber of Commerce of Lyons, wishing to celebrate the centenary of Pasteur, has opened a fund for the benefit of the laboratories of Lyons, and already 680,000 francs has been contributed. Each year a part of the capital, amounting to about 120,000 francs, will be distributed amongst a certain number of the laboratories in Lyons, and the scientific directors have been invited to communicate each year what results have been obtained.

Salt and Potash Production

The production of salt has risen from 90,530 tons in October, to 100,768 t. in November. The French potash mines produced 94,775 t. of potash, equivalent to 22,747 t. of K_2O, and consisting of crude salts (12 to 16 per cent.), 42,480 t.; manure salts (20 to 22 per cent.), 25,254 t.; manure salts (30 to 40 per cent.), 16,039 t.; chloride (over 50 per cent.), 11,002 t.

Technical Conference on Ceramics

A Conference of Ceramic Industries will be held in May in Paris. As with the meeting last year, the conference will discuss questions such as the firing of ceramic products in furnaces with natural or induced draught, natural and artificial drying, and the best power systems for ceramic industry.

UNITED STATES

Expansion in the Glass Industry

According to a recent article (*Chem. & Met. Eng., Dec.* 31, 1923), the glass industry in the United States will be considerably expanded during 1924, as over $18,000,000 is to be expended on extensions and other improvements. New plants are to be erected by the Libby-Owens Glass Co., at Ohio, by the National Plate Glass Co., at Ottawa, Ill., and at Blairsville, Pa., and improvements and extensions are to be made by the Clarksburg Glass Co., the Wheeling Glass Manufacturing Co., W.Va., the Westmoreland Specialty Glass Co., Pa., the Weston Glass Co., W.Va., and the Sneath Glass Co., Ind.

GENERAL

Nitrogen Fixation in Czechoslovakia

A Bill is shortly to be laid before the Czechoslovakian Parliament, to encourage the nitrogen-fixation and fertiliser industries, either by a reduction of, or exemption from, taxes. Germany has hitherto been the chief source of supply of nitrogenous fertilisers, and it is proposed to develop the Czechoslovakian industries to ensure home supplies, as deliveries from Germany are obtained with difficulty.

Metallurgy in Belgium

During December 40 blast furnaces were alight in Belgium, there being no increase in number, compared with November. The production was: cast iron, 209,350 metric tons; raw steel, 206,700 t.; castings, 5950 t.; finished steel, 189,340 t.; finished iron, 16,640 t.; zinc, 13,790 t.

The output of coal fell from 2,088,810 tons in November, to 1,985,810 t. in December, but coke production rose from 369,100 t. to 372,150 t.

REVIEWS

Metals and Metallic Compounds. By U. R. Evans, M.A. *Vol. I. Introduction, Metallography, Electro-Chemistry. Pp. xii+468. Price* 21*s. Vol. II. Metals of the 'A' Groups. Pp. xi+396. Price* 18*s. Vol. III. The Transition Elements. Pp. xii+270. Price* 14*s. Vol. IV. Metals of the 'B' Groups. Pp. xii+350. Price* 18*s. London: E. Arnold & Co.,* 1923.

The author's intention in writing this book was not to conform to the traditional practice of giving long "catalogues of salts and empirical accounts of metallurgical processes," no doubt necessary in books of reference, but to present the subject in a form suitable for continuous reading. His aim is to take advantage of recent fruitful research work in metallography, crystallography, electrochemistry, colloid chemistry, and geo-chemistry to approach the subject of metals in a new spirit, to correlate cause and effect and to introduce such theoretical views as will serve to connect the known facts in an ordered sequence.

The first volume is of a generalised character, beginning with an introduction of 135 pages in which the author has given, in condensed and non-mathematical form, the elementary principles of general chemistry, physics and geology; a knowledge of which, in the body of the book, the reader is assumed to possess. This introduction, admirably clear and concise and especially valuable to those whose memory needs refreshing or who, for some reason or other, are not sufficiently familiar with the most recent advances of the subject, closes with a chapter entitled "Some general considerations involved in metallurgy," wherein the author touches upon such essentially practical matters as the preliminary treatment of ores, crushing, grinding, concentration by gravity, magnetism and flotation, etc., in each case defining the objects in view and the theory of the operation. The body of volume I. is divided into two parts "The Study of the Ionic State" (Electro-chemistry). The latter includes chapters on the colloidal state in metals and metallic compounds, electro-deposition, the corrosion of metals and radio-activity.

Volumes II, III, and IV deal with the individual metals, the space devoted to each being divided into three main sections. In the first, the pure chemistry of the metal and its compounds are discussed and a summary is given of the methods of analysis. The second section deals shortly with the terrestrial occurrence of the metal in question, and the third section is of a technical character, dealing with the metallurgy, technology and uses.

The author has covered a prodigiously wide field and, on the whole, he is to be congratulated on the judgment shown in the selection and condensation of his matter. The book is well printed, copious references are given throughout and author and subject indices are provided at the end of each volume.

I.—PERFUMES AND SYNTHETICS WITH SPECIAL REFERENCE TO SYNTHETICS. *By* W. A. POUCHER. *Pp.* xi+462. *London: Chapman and Hall, Ltd.,* 1923. *Price* 21s.

II.—THE PREPARATION OF PERFUMES AND COSMETICS. *By* J. P. DURVELLE. *Translated from the fourth French edition, by* E. J. PARRY, B.Sc. *Pp.* viii+420. *London: Scott, Greenwood and Son,* 1923. *Price* 21s.

III.—PERFUMES AND COSMETICS: THEIR PREPARATION AND MANUFACTURE. *By* G. W. ASKINSON. *Pp.* xiii+302. *London: Crosby, Lockwood and Son,* 1923. *Price* 30s.

The great fascination of the study of perfumes has led many chemists to carry out exhaustive investigations on the subject, so that the art of the perfumer is gradually acquiring a more scientific basis. It will be of interest to consider the books under review together, as they can be taken to represent standard practice in France, the United States and England.

I. Mr. Poucher has divided his subject into three parts, of which the first is a dictionary of the more important raw materials of the "chemist-perfumer." In Part II, chapters are devoted to the production of natural perfumes, the fixation of perfumes, and accounts of flower perfumes, fancy perfumes and toilet waters. Part III treats of a wide variety of cosmetics. Throughout the book, formulæ are plentiful and there are excellent illustrations. The new synthetic perfumes are treated at length, and the book, with its practical bias and freedom from excess of scientific detail, will undoubtedly be a valuable aid to the practical perfumer. Where so much is good it is disappointing to find that the wording of the scientific matter is too often loose and unsatisfactory. Apart from this, the work, which is handsomely produced and well printed, can be safely recommended as a practical guide.

II. In this book, a translation of the latest edition of the well-known work originally published under the title "Nouveau Guide du Parfumeur," raw materials are discussed in the first 87 pages, and the remainder of the work is devoted to the manufacture of perfumed products. The aim is a practical one and numerous formulæ are given, the chemical treatment being clear and adequate. By the use of concise statements, a surprisingly large amount of information, scientific and practical, is given, and the book everywhere reveals the thorough acquaintance of both author and translator with the perfumery industry. A commendable feature is the frank discussion of the value of cherished ingredients in various toilet preparations, some useless, some dangerous, and this should do good. An excellent work.

III. This book opens with a short history of perfumery, and after discussing the chief natural perfumes it treats of chemicals used in perfumery, methods of provided and the manufacture of perfumes and cosmetics. Some concluding chapters are contributed by various authors, who give advice on the place of synthetics in perfumery, the use of fixatives, storage and ageing, soap perfuming, and the advertisement and marketing of the finished preparations. Formulæ that have "withstood the tests of use" are given in quantity, and information regarding the source and character of perfumery materials is provided to enable the user to make a suitable choice. The artistry required in the preparation of perfumes is constantly kept before the reader, and there are many useful practical hints. The work has already reached its fifth edition, and it should prove both stimulating and helpful to those interested in the industry.

TEXTILINDUSTRIE. *By* PROF. P. KRAIS. *Technische Fortschrittsberichte. Fortschritte der Chem. Technologie in einzeldarstellungen, edited by* PROF. B. RASSOW. *Part III. Pp.* 156. *Dresden and Leipzig: Theodor Steinkopff,* 1924. *Price,* 4.50 *marks.*

This volume is one of a series of monographs dealing with progress in different departments of chemical technology, and such monographs are welcome because they provide halting places in the march of technical science, and opportunities of reflecting on the effect of different researches on industrial developments.

In this country important research on textiles is being carried out by research associations in Manchester, Leeds and Belfast; some of the results being published in the *Journal of the Textile Institute,* and abstracted in this *Journal.* In the volume under review some of these researches receive attention. In writing such a monograph, however, the difficulty lies in choosing a suitable time for considering past work, and this point is emphasised in the chapter on mercerisation, wherein many important recent researches are not mentioned, and this omission leaves the chapter without interest. Also in this chapter certain industrial developments are mentioned, some of which are of interest, and others of little interest, their mention only serving to indicate that the author of the volume is not thoroughly in touch with industrial changes. In other parts of the book it is also noticed that what one might call a commercial sense of proportion is lacking.

The constitution, morphology, strength, lustre, spensing qualities and other properties of textile fibres are discussed. German researches and patents receive full consideration; those of other countries not such full treatment. Ten pages are devoted to progress in artificial silk manufacture, 48 pages to dyeing, 7 to printing, and 15 to finishing.

The chapter on bleaching is of little interest. The use of warm hypochlorite solutions, the occurrence of chloramines during the bleaching of cotton goods, the preparation of hypochlorite solutions by electrolyses, and the bleaching actions of perborates and peroxides are discussed at length, whereas these subjects are of little interest to those technologists engaged in the bleaching industry.

The volume is interesting to read and ought to repay the time spent on it; its appearance suggests to your reviewer that after ten volumes of *Annual Reports* issued by this Society have appeared, monographs should be prepared for some sections, dealing with the progress during the ten years' period. For instance, the excellent annual *résumés* of the literature dealing with fibres would yield a useful monograph dealing with the ten years' period.

S. H. HIGGINS

CHEMISCHE GRUNDBEGRIFFE. *By* PROF. A. BENRATH. *Translated by* JETHRO BITHELL, M.A. *Bilingual Series. Edited by* J. E. MANSION. *Pp.* 80+80. *London: George G. Harrap & Co., Ltd.*, 1924. *Price* 2*s*.

This neatly printed little book is an adaptation of the plan, long familiar to students of the classics, of printing text on one page with the translation on the opposite page. Purists will doubtless take exception to such a method of acquiring a knowledge of a foreign language, but used in conjunction, as the author advises, with a grammar, the book will not only enable the student to widen his German vocabulary with more ease, but will hlep him to attain to that psychological acquaintance which is essential before understanding of any foreign tongue can even approach completeness. In the present volume, Prof. Benrath's interesting essay on the fundamental ideas of chemistry is used as text, and Mr. Bithell provides the translation so that the chemist is provided with interest as well as instruction. The translation appears to be reasonably well done, though occasional phrases such as "Brown's motion," "The Laws of Gas," seem a little strange. It is to be hoped that this "Bilingual Series" will encourage scientists to study other languages than their own, if not for the acquisition of new knowledge, certainly for the acquisition of that broader outlook on human affairs which is essential to make the "full man."

COMPANY NEWS

JOHN KNIGHT, LTD.

The report for the year ended November 30 last shows a net profit of £147,166, compared with £151,316 in the previous year. With £68,017 brought in, £215,183 becomes available, and the directors again propose to pay a dividend of 30 per cent. for the year on the ordinary shares, carrying forward £69,183.

JURGENS, LTD.

For the six months to December 31 last, a dividend is announced of 7 per cent., less tax on the 7 per cent. (guaranteed) cumulative preference shares.

BORAX CONSOLIDATED, LTD.

It is proposed to pay a final dividend of 1s. 6d. per share ($7\frac{1}{2}$ per cent.), and a bonus of 6d. per share ($2\frac{1}{2}$ per cent.) less tax, on the deferred ordinary shares, making 15 per cent. for the year ended September 30, 1923.

MOND NICKEL CO., LTD.

An interim dividend of 5 per cent., less tax, has been declared on the ordinary shares, and of $3\frac{1}{2}$ per cent. less tax on the preference shares.

MAGADI SODA CO., LTD.

At the extraordinary general meeting held on January 28 it was found impossible to carry the scheme for the reconstruction of the company. The result of a poll on the scheme will be declared later.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

The comparatively healthy state of the Chemical market continues, and business is very steady with few outstanding features attracting attention. Prices are firm.

Acetic Acid, 40% tech.	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw. Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	$5\frac{1}{4}$d. per lb.
Potass. Chlorate	3d.—$3\frac{1}{4}$d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports. Good business continues.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid. In fair request.
Sod. Bisulphite Powder 60/62%	£19—£20 10s. per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb. Very quiet.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included

RUBBER CHEMICALS

The demand for rubber chemicals remains somewhat slow, and values are slightly lower.

Antimony sulphide	Expected to advance in sympathy with the crude metal.
Golden	$5\frac{1}{4}$d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide	4s. per lb.

Carbon Bisulphide .. £24—£26 10s. per ton according to quantity.

Carbon Black .. Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.

Carbon Tetrachloride .. £55 per ton, drums free.

Chromium Oxide .. 1s. 2d. per lb.

Indiarubber Substitutes, White and Dark .. 4d.—6½d. per lb. Fairly brisk demand.

Lamp Black .. 40s. per cwt., barrels free.

Lead Hyposulphite .. 7½d. per lb.

Lithopone .. £22 10s. per ton.

Mineral Rubber "Rubpron" .. £15 10s. per ton f.o.r. London.

Sulphur .. £10—£12 per ton, according to quality.

Thiocarbanilide .. 2s. 9d. per lb.

Vermilion, pale or deep .. 3s. 4d.—3s. 6d. per lb.

Zinc Sulphide .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade and there appears a more healthy prospect in the charcoal market.

Acetate of Lime—

Brown .. £14 10s. per ton d/d. Demand active.

Grey .. £22 per ton.

Liquor .. 9d. per gall. 32° Tw.

Charcoal .. £7 5s.—£9 per ton, according to grade and locality. Market quiet.

Iron Liquor .. 1s. 7d. per gall. 32° Tw.
1s. 2d. " " 24° Tw.

Red Liquor .. 10d.—1s. per gall. 14/15° Tw.

Wood Creosote .. 2s. 7d. per gall. Unrefined.

Wood Naphtha—

Miscible .. 5s. 6d. per gall. 60% O.P. Dull market.

Solvent .. 5s. 6d. per gall. 40% O.P. Dull market.

Wood Tar .. £5—£6 per ton according to grade. Demand not very brisk. Ample supplies.

Brown Sugar of Lead .. £42 per ton. Demand more active.

TAR PRODUCTS

Acid Carbolic—

Crystals .. 8½d. per lb. Some business passing at lower prices.

Crude 60's .. 2s.—2s. 3d. per gall. Little business passing. Market weaker in sympathy with crystals.

Acid Cresylic, 97/99 .. 1s. 11d.—2s. 2d. per gall. Steady business.

Pale 95% .. 1s. 10d.—2s. 1d. per gall. Good demand.

Dark .. 1s. 7d.—1s. 11d. per gall. Steady business.

Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.

Anthracene Oil—

Strained .. 9d.—10d. per gall. Very quiet.

Unstrained .. 8d.—9d. per gall.

Benzole—

Crude 65's .. 10½d.—1s. per gall. ex works in tank wagons.

Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.

Pure .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.

Toluole—90% .. 1s. 3d.—1s. 4d. per gall.

Pure .. 1s. 8d.—1s. 10d. per gall.

Xylol .. 2s. 3d. per gall.

Creosote—

Cresylic 20/24% .. 11½d. per gall. Firm. Fair business passing.

Middle Oil ..
Heavy ..
Standard Specification
} 9d.—10d. per gall. according to grade and district. Market very firm. Demand good.

Naphtha—

Solvent 90/160 .. 1s. 0½d.—1s. 2d. per gall.
Solvent 90/190 .. 1s. 1d.—1s. 3d. per gall.
} rather more business.

Naphthalene Crude—

Drained Creosote Salts £7 10s.—£8 per ton. Demand maintained.

Whizzed or hot pressed £10—£14 per ton. Quiet and weak.

Naphthalene—

Crystals .. £18 per ton.

Flaked .. £18 per ton.

Pitch, medium soft .. 80s.—85s. per ton. Nominal. No sellers.

Pyridine—90/140 .. 16s.—17s. per gall. More stable with fair business.

Heavy .. 11s.—12s. Firmer with better demand.

INTERMEDIATES AND DYES

Business in dyestuffs has improved appreciably since the holidays. Prices are very firm.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 9d. per lb.

Acid H. .. 4s. 6d. per lb. 100% basis d/d.

Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.

Acid Neville and Winther 5s. 11d. per lb. 100% basis d/d.

Acid Salicylic, tech. .. 1s. 6d. per lb. Better demand.

Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.

Aluminium Chloride, anhyd. .. 1s. per lb. d/d.

Aniline Oil .. 8½d. per lb. naked at works.

Aniline Salts .. 9d. per lb. naked at works.

Antimony Pentachloride 1s. per lb. d/d.

Benzidine Base .. 4s. 8d. per lb. 100% basis d/d.

Benzyl Chloride 95% .. 1s. 3d. per lb.

p-Chlorphenol .. 4s. 3d. per lb. d/d.

p-Chloraniline .. 3s. per lb. 100% basis.

o-Cresol 29/31° C. .. 5½d.—6d. per lb. Demand quiet.

m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Market quiet.

p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Market quiet.

Dichloraniline .. 2s. 2d. per lb.

Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.

p-Dichlorbenzol .. £75 per ton.

Diethylaniline .. 5s. per lb. d/d., packages extra, returnable.

Dimethyaniline .. 2s. 5d. per lb. d/d. Drums extra.

Dinitrobenzene .. 9d. per lb. naked at works.

Dinitrochlorbenzol .. £82 per ton d/d.

Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.

66/68° C. 1s. 2d. per lb. naked at works.

Diphenylamine .. 3s. 3d. per lb. d/d.

Monochlorbenzol .. £63 per ton.

β-Naphthol .. 1s. 1d. per lb. d/d.

α-Naphthylamine .. 1s. 5d. per lb. d/d.

β-Naphthylamine .. 4s. per lb. d/d.

m-Nitraniline .. 5s. 3d. per lb. d/d.

p-Nitraniline .. 2s. 5d. per lb. d/d.

Nitrobenzene .. 5¼d.—5½d. per lb. naked at works.

o-Nitrochlorbenzol .. 2s. per lb. 100% basis d/d.

Nitronaphthalene .. 11½d. per lb. d/d.

p-Nitrophenol .. 1s. 9d. per lb. 100% basis d/d.

[illegible] .. 4s. 6d. per lb. 100% basis

m-Phenylene Diamine	4s. 6d. per lb. d/d.
p-Phenylene Diamine	10s. 6d. per lb. 100% basis d/d.
R. Salt	3s. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 7d. per lb. 100% basis d/d.
o-Toluidine	7d.—8d. per lb.
p-Toluidine	3s. 10d.—4s. 5d. per lb. d/d.
m-Toluylene Diamine	4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

The market is stagnant as buyers are holding off in view of the great uncertainty as to the future of pharmaceutical chemicals.

Acid, Acetic 80% B.P.	£50 per ton.
Acid, Acetyl Salicylic	3s. 6d.—3s. 9d. per lb. Steady demand.
Acid, Benzoic	Commercial acid dearer at 2s. 9d. per lb. B.P. quality remains unobtainable.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	18s.—20s. per lb.
Acid, Citric	1s. 5½d. per lb., less 5% for ton lots. Demand fair.
Acid, Gallic	3s. per lb. for pure crystal. More inquiry.
Acid, Pyrogallic, Cryst.	6s. per lb., for 28 lb. lots.
Acid, Salicylic	2s. 4d.—2s. 6d. per lb. Market dull.
Acid, Tannic	3s. 3d. per lb. for B.P. quality.
Acid, Tartaric	1s. 1½d. per lb. less 5%. Fair demand.
Amidol	9s. per lb. d/d.
Acetanilide	3s. per lb. No inquiry.
Amidopyrin	14s. per lb. Demand negligible.
Ammon. Benzoate	3s. 9d. per lb. Much cheaper.
Ammon. Carbonate B.P.	£35 per ton.
Atropine Sulphate	12s. 6d. per oz. for English make. Market neglected.
Barbitone	17s. per lb.
Benzonaphthol	5s. 6d. per lb. Supplies scarce. Some dealers quote more.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Per lb.
Potassium	9½d.—11d. } Foreign market somewhat easier.
Sodium	9½d.—11d. }
Ammonium	11d.—1s. }
Calcium Lactate	2s. 9d. per lb. for best English make. Market firmer in view of shrinkage of imports.
Chloral Hydrate	4s. per lb. Weak.
Chloroform	2s. per lb. for cwt. lots.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Guaiacol Carbonate	13s. per lb. for small stocks available. Slightly weaker.
Hexamine	3s. 9d.—4s. per lb. for foreign makes.
Homatropine Hydrobromide	30s. per oz.
Iron. Ammon. Citrate, B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£72 10s. per ton, less 2½%.
Heavy Commercial	£27 per ton, less 2½%.
Heavy Pure	1s. 6d.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst.	56s. per lb.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Prices reduced.
Red oxide	4s. 9d.—4s. 10d. per lb.
Corrosive sublimate	3s.—3s. 1d. „
White precip.	4s. 1d.—4s. 2d. „
Calomel	3s. 5d.—3s. 6d. „
Methyl Acetanilide	20s. per lb.
Methyl Salicylate	2s. 11d. per lb. for carboys. Slightly firmer.
Methyl Sulphonal	21s. per lb.
Methylene-di-tannin	7s. 6d. per lb. In good demand.
Paraformaldehyde	3s. 6d. per lb., without much inquiry.
Paraldehyde	1s. 7d. per lb.
Phenacetin	7s. 3d. per lb. Orders falling off.
Phenazone	8s. per lb.
Phenolphthalein	8s. per lb. Price shaded for quantity. Ample supplies.
Potass. Bitartrate—99/100% (Cream of Tartar)	88s.—90s. per cwt., less 2½%. Demand improving.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Ferricyanide	3s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. lb., 1-cwt. kegs included.
Potass. Permanganate	9d. per lb. for B.P. crystal English make. In good demand.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	6s. 3d. per lb.
Salol	3s. 9d.—4s. per lb. Slightly firmer.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	3s. 3d. per lb.
Sod. Citrate, B.P.C., 1923	1s. 9d.— per lb., according to quantit.
Sod. Hyposulphite—Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	87s. 6d. per cwt. Market quiet.
Sod. Salicylate	Powder 2s. 10d.—2s. 11d. per lb., Crystal at 2s. 11d.—3s. per lb.
Sod. Sulphide—Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	18s. 6d. per lb.
Tartar Emetic	1s. 4d. per lb.
Thymol	13s. 6d.—13s. 9d. per lb. for good white crystal from ajowan seed.

PERFUMERY CHEMICALS

Acetophenone ..	.. 12s. 6d. per lb.	
Aubepine	.. 13s. 6d. ,,	
Amyl Acetate ..	.. 3s. ,,	
Amyl Butyrate ..	.. 7s. 3d. ,,	
Amyl Salicylate ..	.. 3s. 6d. ,,	
Anethol (M.P. 21/22° C.)	3s. 9d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	2s. 3d. ,,	
Benzyl Alcohol free from Chlorine ..	.. 3s. 3d. ,,	
Benzaldehyde free from Chlorine ..	.. 3s. 3d. ,,	
Benzyl Benzoate ..	.. 3s. 9d. ,,	
Cinnamic Aldehyde Natural ..	.. 18s. 6d. ,,	Cheaper.
Coumarin ..	.. 21s. ,,	
Citronellol ..	.. 19s. ,,	
Citral	.. 10s. ,,	
Ethyl Cinnamate ..	.. 10s. ,,	
Ethyl Phthalate ..	.. 3s. 9d. ,,	
Eugenol	.. 11s. ,,	
Geraniol (Palmarosa)	.. 37s. 6d. ,,	
Geraniol	.. 10s.—17s. 6d. per lb.	
Heliotropine ..	.. 8s. 6d. per lb.	
Iso Eugenol	.. 15s. 9d. ,,	
Linalol ex Bois de Rose ..	20s. ,,	
Linalyl Acetate ..	.. 20s. ,,	
Methyl Anthranilate	.. 8s. 6d. ,,	
Methyl Benzoate ..	.. 6s. ,,	
Musk Ambrette ..	.. 52s. 6d. ,,	
Musk Xylol	.. 19s. ,,	
Nerolin	.. 4s. ,,	
Phenyl Ethyl Acetate	.. 10s. ,,	
Phenyl Ethyl Alcohol	.. 16s. ,,	
Rhodinol	.. 65s. ,,	
Safrol	.. 1s. 10d. ,,	
Terpineol	.. 2s. 6d. ,,	
Vanillin	.. 26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A. ..	.. 14s. 6d. per lb.	
Anise Oil	.. 1s. 11d. ,,	
Bergamot Oil ..	.. 13s. 9d. ,,	
Bourbon Geranium Oil	.. 32s. 6d. ,,	
Camphor Oil ..	.. 75s. per cwt.	
Cananga Oil, Java	.. 9s. 4½d. per lb.	
Cinnamon Oil, Leaf	.. 5½d. per oz.	
Cassia Oil, 80/85%	.. 10s. per lb.	
Citronella Oil— Java 85/90% ..	.. 4s. 7½d. ,,	
Ceylon	.. 3s. 9d. ,,	Cheaper
Clove Oil	.. 9s. 3d. ,,	
Eucalyptus Oil 70/75%	.. 2s. 4½d. per lb.	
Lavender Oil— French 38/40% Esters	24s. 6d. per lb.	
Lemon Oil ..	.. 3s. ,,	
Lemongrass Oil ..	.. 2½d. per oz.	
Orange Oil, Sweet	.. 12s. 6d. per lb.	
Otto of Rose Oil— Bulgarian ..	.. 34s. per oz.	
Anatolian	.. 26s. per oz.	
Palma Rosa Oil ..	.. 20s. per lb.	Cheaper.
Peppermint Oil— English ..	.. 70s. per lb.	
Wayne County ..	.. 16s. 6d. per lb.	
Japanese	.. 13s. 9d. per lb.	Advanced.
Pettigrain Oil ..	.. 9s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents those of applications, and in the case of Complete Specifications accepted those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition within two months of the date given; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C. 2, 15 days after the date given.

I.—GENERAL; PLANT; MACHINERY.

Applications

Backhouse and Samuelson. Apparatus for mixing pulverulent and granular materials. 1129. Jan. 15.

De Laval Chadburn Co., and Johnstone. 1868. *See* XIX.

Duckham and others. 1413. *See* II.

Gray. Dehydration process. 1497. Jan. 18.

Hurst. Separators for liquids. 1727. Jan. 22.

Lamb. Catalysts, and process of producing same. 1777. Jan. 22.

Mortimer. Pressure apparatus for filtering etc. liquids. 971. Jan. 14.

Pehrson and Pehrson. Rotary furnaces. 1748. Jan. 22.

Plauson's (Parent Co.), Ltd. (Plauson). Production of finely-divided materials. 1741. Jan. 22.

Complete Specifications Accepted

24,743 (1922). Toogood, and Dempster and Sons. Regenerator furnaces. (209,458.) Jan. 23.

27,288 (1922). Fothergill. Evaporators. (209,475.) Jan. 23.

28,977 (1922). Seaman, and Brinjes and Goodwin, Ltd. Grinding, crushing, mixing, and like mills. (209,857.) Jan. 30.

31,373 (1922). Meister, Lucius, u. Brüning. Apparatus for absorbing gases or vapours by means of charcoal. (191,005.) Jan. 30.

33,380 (1922). Holmes. Pulverising machines. (209,577.) Jan. 23.

2231 (1923). Candy. Filters. (209,947.) Jan. 30.

2932 (1923). Rialland. Separating mixed liquids of different volatility. (193,030.) Jan. 23.

4843 (1923). Akt. de Norske Saltverker. Treatment of solutions for the precipitation of solid substances therefrom. (195,597.) Jan. 23.

18,473 (1923). Westenholz and Nyrop. Centrifugal machine for producing emulsions, colloidal solutions, etc. (210,023.) Jan. 30.

21,092 (1923). Gelder. Grinding and pulverising machine. (210,027.) Jan. 30.

II.—FUEL; GAS; DESTRUCTIVE DISTILLATION; MINERAL OILS; LIGHTING

Applications

Collin u. Co. Gas-reversing devices for regenerative coke ovens. 1193. Jan. 15. (Ger., 8.2.23.)

Coninck. Combustion of solid fuel. 1308. Jan. 16. (Fr., 26.1.23.)

Davidson and Lindsay. Process of oil refining. 1870. Jan. 23.

Dicker (Wallace). Production of carbon and carboniferous products. 2089. Jan. 25.

Donald. Drying peats etc. 1140 and 1891. Jan. 15 and 23.

Duckham, Rider, Watts, and Thermal Industrial and Chemical Research Co. Heat-treatment of materials for distilling, drying, or carbonising them. 1413. Jan. 17.

Fuchs. Fractional condensation of mineral oils etc. 1099. Jan. 14. (Austria, 13.1.23.)

Kaisler. Fuel for internal-combustion engines. 1172. Jan. 15.

Leggett. Apparatus for washing gas etc. 2142. Jan. 26.

Malone. 1422. *See* XXIII.

Quick. Refining lubricating etc. oils. 1267. Jan. 16.

Stinnes-Riebeck Montan u. Oelwerke. 1794. *See* III.

COMPLETE SPECIFICATIONS ACCEPTED

24,340 (1922). Alexander. Motor spirit for use in internal-combustion engines. (209,453.) Jan. 23.

25,731 (1922). Sutcliffe. Briquetting or agglomerating fuel etc. (209,794.) Jan. 30.

29,241 (1922). White. Low-temperature carbonisation. (192,040.) Jan. 30.

30,919 (1922). Wood. Gas - producers. (189,767.) Jan. 30.

2755 (1923.) Baskerville. Producer for gasifying bituminous and other fuels. (209,955.) Jan. 30.

4261 (1923). Trent Process Corp. Production of coked, semi-coked, or fused fuel. (193,061.) Jan. 23.

III.—TAR AND TAR PRODUCTS

APPLICATION

Stinnes-Riebeck Montan- u. Oelwerke A.-G. Separation of benzol or benzine from mixture containing dilute alcohol. 1794. Jan. 22. (Ger., 22.1.23.)

IV.—COLOURING MATTERS AND DYES

APPLICATIONS

Farbenfabr. vorm. F. Bayer u. Co. 1306. *See* XIII.

Farbw. vorm. Meister, Lucius, u. Brüning. Manufacture of azo dyestuffs. 1505. Jan. 18. (Ger., 18.1.23.)

Hooley, Thomas, and Scottish Dyes, Ltd. Manufacture of hydroxyanthraquinone derivatives. 2148. Jan. 26.

COMPLETE SPECIFICATIONS ACCEPTED

31,406 (1922). Holliday and Co., and Stokes. Azo colouring matter of the pyrazolone series. (209,547.) Jan. 23.

31,413 and 31,427 (1923). Holliday and Co., and Clayton. Yellow colouring matters of the pyrazolone series. (209,885 and 209,887.) Jan. 30.

740 (1923). Pigments Ges., and Detsinyi. Production of a dye for hair. (209,937.) Jan. 30.

12,469 (1923.) Soc. Chem. Ind. Basle. Manufacture of dyestuffs of indigo tint. (210,006.) Jan. 30.

24,609 (1923). Thomas, and Scottish Dyes, Ltd. Chlorination of hydroxyanthraquinones. (209,694.) Jan. 23.

30,645 (1923). Meister, Lucius, u. Brüning. Chlorination of benzene. (208,155.) Jan. 30.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER

APPLICATIONS

British Burmah Petroleum Co., and Dickie. Manufacture of artificial waterproof board. 1280. Jan. 16.

Chem. Fabr. Griesheim-Elektron, and Wiss. Obtaining fibre from plants. 1566. Jan. 19.

Cook and Co., and Stott. Treatment of fibrous materials. 1432. Jan. 18.

Downs. Extraction of oil or grease from textile fabrics. 1900. Jan. 24.

Harbens, Ltd., Leon, and Sharrat. Manufacture of artificial silk threads etc. 2082. Jan. 25.

COMPLETE SPECIFICATION ACCEPTED

22,065 (1923). Marx. Manufacture of paper, pulp, board, etc. (209,693.) Jan. 23.

VI.—BLEACHING; DYEING: PRINTING; FINISHING

APPLICATIONS

Boardman, Hunt, and Hunt an[illegible]rop. Apparatus for treating wool etc. with dye etc. [illegible] Jan. 19.

Boardman, and Hunt a[illegible]rop. Apparatus for dyeing and scouring yarn etc. [illegible] Jan. 19.

Lithgow. Dyeing-jigs etc. 1230. Jan. 16.

Schumacher. Dyeing cops. 2084. Jan. 25. (Ger., 2.2.23.)

COMPLETE SPECIFICATIONS ACCEPTED

18,522 (1922) and 3597 (1923). British Alizarine Co., Harley, Dawson, and Nichol. Discharging vat dyestuffs. (209,188.) Jan. 23.

28,691 (1922) and 16,458 (1923). Johnson (Badische Anilin u. Soda Fabr.). Treatment of cellulose esters for dyeing. (209,849.) Jan. 30.

32,911 (1922). Morton Sundour Fabrics, Ltd., and Thomas. Dyeing animal fibres. (209,569.) Jan. 23.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS

APPLICATIONS

Farbenfabr. vorm. F. Bayer u. Co. Manufacture of nitric acid. 1305. Jan. 16. (Ger., 26.2.23.)

Farbw. vorm. Meister, Lucius, u. Brüning. Manufacture of bismuth compounds. 1709. Jan. 22. (Ger., 22.1.23.)

Haco Co. Bismuth compounds. 1294. Jan. 16. (Switz., 20.1.23.)

Harper and Williams. Production of ammonia. 1991. Jan. 24.

Imray (Meister, Lucius, u. Brüning). Manufacture of arsenic and antimony compounds. 1314. Jan. 16.

Kobelt. 1855. *See* XIX.

Mond (Metal and Thermit Corp.). Titanium oxide. 1851. Jan. 23.

Seth. 1189. *See* X.

Soc. Nat. d'Industrie Chimique en Belgique. Obtaining alkali sulphides. 1874. Jan. 23. (Fr., 23.1.23.)

Wefelscheid. Production of lead oxide. 1276. Jan. 16.

COMPLETE SPECIFICATIONS ACCEPTED

19,154 and 19,155 (1922). Weizmann and Blumenfeld. Titanium compounds. (209,480 and 209,441.) Jan. 30 and 23.

32,134 (1922). Nicholson. Neutralising ammonium sulphate. (209,561.) Jan. 23.

6596 (1923). Henkel et Cie., and Weber. Treatment of ammonium chloride lyes in iron vessels. (196,585.) Jan. 23.

14,929 (1923). Urfer. Manufacture of pulverised catalysts for the synthesis of ammonia. (199,025.) Jan. 30.

32,209 (1923). Weizmann and Blumenfeld. Titanium compounds. (210,033.) Jan. 30.

VIII.—GLASS; CERAMICS

APPLICATIONS

Comp. Générale de Basalte. Manufacture of basalt products. 1405. Jan. 17. (Fr., 23.2.23.)

Mond (Metal and Thermit Corp.). Refractory materials. 1850. Jan. 23.

Semple. Heat-insulating and fire-resisting materials. 1608. Jan. 21.

IX.—BUILDING MATERIALS

APPLICATIONS

Ioco Rubber and Waterproofing Co., James, and Nuttall. Manufacture of laminated materials for decorative etc. purposes. 1859. Jan. 23.

Mackay. Bituminous emulsions. 1885. Jan. 23.

Pearce, and Pearce and Co. Manufacture of a road compound. 2016. Jan. 25.

Petelot. Manufacture of cement. 1793. Jan. 22. (Fr., 31.1.23.)

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY

APPLICATIONS

Brearley, Johnson, and Ridge. Method of chromium plating. 1823. Jan. 23.

Conti. Alloys. 2067. Jan. 25. (Fr., 14.2.23.)

Lanz. Manufacture of grey cast iron. 1781. Jan. 22.

Montgomery. Recovery of zinc from galvaniser's flux. 1895. Jan. 23.

Seth. Obtaining vanadium compounds, or vanadium from pig iron. 1189. Jan. 15. (Sweden, 9.2.23.)

Soc. Electroquimica de Flix. Producing an electric arc for melting and projecting metals. 1407. Jan. 17. (Spain, 24.1.23.)

Talbot, and Talbot-Stead Tube Co. Steel alloys. 1974. Jan. 24.

Weissenstein. Manufacture of bearing metals. 1513. Jan. 18. (Austria, 23.1.23.)

Complete Specifications Accepted

27,934 (1922). Smidth & Co. Agglomeration of ore (187,601.) Jan. 30.

28,584 (1922). Soc. Anon. J. Cockerill. Tunnel furnaces for metallurgical uses. (195,590.) Jan. 23.

34,970 (1922). Constant and Bruzac. Production of steel and iron. (191,032.) Jan. 23.

4398 (1923). Aluminum Co. of America. Aluminium alloys. (195,048.) Jan. 30.

5141 (1923). Padmore, Padmore, and Padmore. Metallic alloys. (209,975.) Jan. 30.

14,578 (1923). Ashcroft. Treatment of lead-zinc sulphide ores, mattes, etc. (210,011.) Jan. 30.

15,667 (1923). Electro Metallurgical Co. Zirconium steel. (202,279.) Jan. 30.

19,052 (1923). Bailey. Case-hardening wrought iron or steel. (209,687.) Jan. 23.

XI.—ELECTRO-CHEMISTRY

Applications

Brearley and others. 1823. *See* X.

Hanson and Moe. Electric battery compound. 1024. Jan. 14.

Manhattan Electrical Supply Co. Dry cells. 1698. Jan. 21. (U.S., 30.7.23.)

Monnot. Electric storage batteries. 1293. Jan. 16.

Soc. Electroquimica de Flix. 1407. *See* X.

Wills. Electric accumulators etc. 1125. Jan. 15.

Complete Specification Accepted

7114 (1923). Schauly and Gernigon. Electric furnaces. (209,988.) Jan. 30.

XII.—FATS; OILS; WAXES

Application

Kumst. Apparatus for chemically combining water with oil, fat, etc. 1228. Jan. 16.

XIII.—PAINTS; PIGMENTS; VARNISHES; RESINS

Applications

Dicker (Aars). Production of white lead. 1790-1. Jan. 22.

Farbenfabr. vorm. F. Bayer u. Co. Manufacture of lakes. 1306. Jan. 16. (Ger., 22.5.23.)

Ioco Rubber Co. and others. 1859. *See* IX.

Wefelscheid. 1276. *See* VII.

Complete Specifications Accepted

28,023 (1922). Schmidt. Waterproof coating compositions. (189,104.) Jan. 30.

28,243 (1922). Torrance. Mills for reducing paints, colours, and pigments. (209,829.) Jan. 30.

3110 (1923). Kur and Wilkinson. Manufacture of silicious ultramarine colours. (209,961.) Jan. 30.

30,805 (1923). Alexander (Stokes). Synthetic resins. (209,697.) Jan. 23.

XIV.—INDIA-RUBBER; GUTTA-PERCHA

Complete Specifications Accepted

19,481-2 (1922). Barney (Miller Rubber Co.). Manufacture of vulcanised rubber articles. (209,528 and 209,773.) Jan. 30.

XV.—LEATHER; BONE; HORN; GLUE

Applications

Carmichael and Ockleston. Tanning. 2159. Jan. 26.

Hutchings, Ltd., and Morrison. Tanning, and manufacture of tanning materials. 2158. Jan. 26.

Complete Specifications Accepted

27,992 (1922). Russell and Broomfield. Treatment of leather and leather waste. (209,811.) Jan. 30.

15,379 (1923). Forselles. Production of leather. (209,674.) Jan. 23.

XVIII.—FERMENTATION INDUSTRIES

Applications

Ricard, Allenet, et Cie. 1783, 1795-7, 1857. *See* XX.

Urbain and others. 1824-5. *See* XX.

Complete Specifications Accepted

12,869 (1923). Pollak. Preparations for cultivating yeast. (197,935.) Jan. 30.

26,014 (1923). Klein. Manufacture of alcohol and yeast. (205,813.) Jan. 30.

XIX.—FOODS; WATER PURIFICATION; SANITATION

Applications

Bacon, Milner, and Munroe. Sterilising and preserving foods. 1458. Jan. 18.

Buckley, and Chem. Eng. and Wilton's Patent Furnace Co. Dealing with waste liquors. 2074. Jan. 25.

Channer. Production of foods from milk. 1634. Jan. 21.

Declercq. Water-purifying apparatus. 1920-1. Jan. 24. (Fr., 10.3.22.)

De Laval Chadburn Co., and Johnstone. Separating foreign matter from liquid. 1868. Jan. 23.

Graham. Flour and foodstuffs made therefrom. 1630. Jan. 21.

Kerr and O'Connell. Pasteurising cream, milk, etc. 1084. Jan. 14.

Kobelt. Production of base-exchanging substances. 1855. Jan. 23.

Rushen (Siemens-Schuckertwerke). Treatment of green fodder. 1861. Jan. 23.

Thésée. Sterilising medium. 1988. Jan. 24.

Complete Specifications Accepted

19,185 (1922). Maclachlan Reduction Process Co. Treatment of sewage sludge. (196,239.) Jan. 23.

7111 (1923). Molassine Co., Davis, and Whalley. Foods for animals. (209,987.) Jan. 30.

XX.—ORGANIC PRODUCTS; MEDICINAL SUBSTANCES; ESSENTIAL OILS

Applications

Albert. Production of organic compounds of mercury. 1039, 1043. Jan. 14. (Ger., 12.1.23.)

Bader, and British Celanese, Ltd. Manufacture of aliphatic compounds. 1944. Jan. 24.

Ellis (Soc. Chim. Usines du Rhône). Preparation of stable concentrated solutions of *p*-oxy-*m*-acylaminophenylarsenilic acids. 1764. Jan. 22.

Farbw. vorm. Meister, Lucius, u. Brüning. 1799. *See* VII.

Imray (Meister, Lucius, u. Brüning). 1314. *See* VII.

Mulford Co. Recovery of bacterial anti-bodies. 1873. Jan. 23. (U.S., 1.2.23.)

Ricard, Allenet, et Cie. Manufacture of butyl alcohol. 1783. Jan. 22. (Fr., 7.7.23.)

Ricard, Allenet, et Cie. Dehydration of mixtures of alcohol and bodies not miscible with water. 1795. Jan. 22. (Fr., 3.2.23.)

Ricard, Allenet, et Cie. *Manufacture of absolute alcohol. 1796, 1797, 1857. Jan. 22 and 23. (Fr., 15.2.23 and 16.4.23; Belg., 7.6.23.)*

Ricard, Allenet, et Cie. Dehydration of organic liquids. 1798. Jan. 22. (Fr., 9.5.23.)

University of Toronto. Preparation of anti-diabetic extracts. 1038. Jan. 14. (U.S., 12.1.23.)

Urbain and Urbain. Manufacture of high-percentage alcohol. 1824. Jan. 23.

Urbain, Verley, and Verley. Process for dehydrating alcohol. 1825. Jan. 23. (Fr., 23.1.23.)

COMPLETE SPECIFICATION ACCEPTED

26,014 (1923). Klein. *See* XVIII.

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES

APPLICATIONS

Bates. Photographic processes. 2122. Jan. 26.

Levy and Mason. X-ray fluorescent screens. 2086. Jan. 25.

XXIII.—ANALYSIS

APPLICATION

Malone. Gas-analysis apparatus. 1422. Jan. 18.

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W.1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number.

Argentina: Iron and steel (134); *Australia:* Hardware (118); *Austria:* Abrasives, grindstones, emery paper, carborundum (124); *Canada:* Steel (119); *Chile:* Photographic supplies (135); *Dominican Republic:* Pottery (8389/U.B./M.C./2); *Egypt:* Soap and palm oil (the Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, London, S.W.1, M.U.H. 1924/27/8); *Germany:* Tin ingots and sheets, copper ingots (126); *Fiume:* Steel (125); *Italy:* Asbestos yarn (21787/F.U./M.C./2); *New Zealand:* Enamelled and aluminium ware (122); *Rumania:* Pharmaceutical products, chemicals (129); *Switzerland:* Steel (130).

French Company News

The Société Anonyme de Commentry Fourchambault et Decazeville is installing in connexion with its coke ovens at Decazeville a factory for the manufacture of synthetic ammonia, the necessary hydrogen being obtained from coke-oven gas. The Claude process will be utilised, tubes being used of a special metal made by the Imphy Steel Works. The plant will have a daily capacity of 5 tons, a figure which could be doubled eventually. It is intended to convert the ammonia produced into ammonium sulphate. The factory will probably begin work in the summer of 1924.

The Hagondange Works of the Union des Consommateurs de Produits Métallurgiques has recently lit its fifth blast furnace.

The Société Chimique des Usines du Rhone, which has been manufacturing cellulose acetate silk with the aid of the Comptoir des Textiles Artificiels, *has now perfected its process for colouring and dyeing these artificial silks.*

The Italian Artificial Silk Industry

It is announced that the Società Viscosa, of Turin, has decided to increase its capital from 350 to 600 million lire, to enable it to enlarge its factories. By the enlargements contemplated, the company, which is the largest manufacturer of artificial silk in Italy, will raise its output from 14,000 to 20,000 kg. per day. The increase is being financed by a consortium of Italian banks, and a share is being taken by a group of French artificial-silk manufacturers.

PUBLICATIONS RECEIVED

CHEMICAL SYNONYMS AND TRADE NAMES, *A dictionary and commercial handbook. By* W. GARDNER. *Pp.* iii+271. *London: Crosby Lockwood and Son*, 1924. *Price* 25*s*.

DYESTUFFS. *Vol. XXIV., No.* 12. *Pp.* 246/264. *U.S.A.: National Aniline and Chemical Co., Inc., with Index*, 1923.

PUBLICATIONS OF DEPARTMENT OF OVERSEAS TRADE. *H.M. Stationery Office*, 1924. *Price* 1*s*. 6*d*. *net*:—

REPORT ON THE TRADE AND COMMERCE OF EAST AFRICA. *By* COL. W. H. FRANKLIN. *Pp.* 47.

REPORT ON THE ECONOMIC, FINANCIAL AND COMMERCIAL CONDITIONS IN THE DOMINICAN REPUBLIC. *By* D. WILSON. REPORT ON THE REPUBLIC OF HAYTI. *By* J. E. M. CARVELL. *Pp.* 56.

CHEMISCHE GRUNDBEGRIFFE. By A. BENRATH. *Translated by* J. BITHELL, M.A. *Pp.* 81. *London: G. G. Harrap and Co.*, 1924. *Price* 1*s*. 6*d*.

ANNUAL REPORT OF THE DIRECTOR OF THE BUREAU OF STANDARDS TO THE SECRETARY OF COMMERCE FOR FISCAL YEAR ENDED JUNE 30, 1923. *Pp.* 330. *Washington: Government Printing Office.*

FATS: NATURAL AND SYNTHETIC. *By* W. W. MYDDLETON, D.Sc., *and* T. H. BARRY. *Pp.* xi+182. *London: E. Benn, Ltd.*, 1924. *Price* 25*s*.

MONOGRAPH ON CORROSION TESTS AND MATERIALS OF CONSTRUCTION FOR CHEMICAL ENGINEERING APPARATUS. *By* W. S. CALCOTT, J. C. WHETZEL, *and* H. F. WHITTAKER. *Pp.* vi+182. *New York: D. Van Nostrand Co.*, 1923. *Price* $3.00.

VANADIUM ORES. *By* MEMBERS OF THE SCIENTIFIC AND TECHNICAL STAFF OF THE IMPERIAL INSTITUTE. *Pp.* iv+72. *London: J. Murray*, 1924. *Price* 5*s*.

PUBLICATIONS OF THE IMPERIAL MINERAL RESOURCES BUREAU. *The Mineral Industry of the British Empire and Foreign Countries. Statistics*, 1919–21. *H.M. Stationery Office*, 1924:—

BARIUM MINERALS. *Pp.* iv+17. *Price* 1*s*. 3*d*.

GYPSUM. *Pp.* iv+24. *Price* 1*s*. 6*d*.

TUNGSTEN. *Pp.* iv+15. *Price* 1*s*.

RED DISCOLOURATION (SO-CALLED "PINK" OR "PINK EYE") ON DRIED SALTED FISH. *By* P. C. CLOAKE, M.D. *Department of Scientific and Industrial Research. Food Investigation Board. Special Report No.* 18. *Pp.* 20. *H.M. Stationery Office*, 1923. *Price* 1*s*.

JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY

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EDITORIAL

THE interesting contribution we have received from Professor G. T. Morgan requires some special mention. He is well acquainted not only with the theory and chemistry of dyes, but also with the progress which has been made in the production of them in this country. He has exact knowledge on many of those points where we and the general public must rely on popular rumour or that long experience which doth attain to something like prophetic strain. If we carry our recollections back a few years and consider our dyestuffs industry, taking a broad look and ignoring the details, we have sufficient to enable us to understand the present situation and its meaning. Before the war two or three important firms and a few smaller ones made dyestuffs; they had sufficient capital, sufficient chemistry and sufficient organisation to supply a small range of dyes to a few consumers. This was in some ways a considerable achievement, having regard to the complexity of the manufacture and to the excellence and power of the organisations manufacturing dyestuffs in Germany. The war came and we saw "a noble and puissant Nation rousing herself like a strong man after sleep and shaking her invincible locks." A great effort was made by the manufacturers of intermediates and of dyestuffs in this country. In spite of every difficulty an immense step forward was taken, and though we may now be critical of some of the decisions and policies, we cannot fail to pay a just tribute to the zeal, patriotism, energy and courage, which the manufacturers showed in this crisis. They built up an important and flourishing industry; nevertheless not an industry which in its present state can successfully compete on equal terms with the German industry, which, in science and in business, in organisation and in capital, is one of the most remarkable developments of modern times.

* * *

The largest, and in some ways therefore the most vulnerable, of the British manufacturers has recently sought some measure of safety. It is wise to agree with thine adversary while he is in the way with you, and the British Dyestuffs Corporation has apparently acted on this sage axiom. The German manufacturers have been equally willing and were they and the Dyestuffs Corporation the only people concerned it would be easy to do what has perhaps already been done and enter into contracts which will secure a profitable and useful future to both parties. The actual position here is complicated by the existence of some other manufacturers and some merchants not so powerful and well organised as to be able to put up a fight against the Dyestuffs Corporation and the German firms, but yet too important to ignore. It is not impossible, though it is difficult, to frame modifications which will enable them to continue their existence, but they would live rather on sufferance and we as a nation are not easily persuaded to enjoy a precarious prosperity so long as our foreign competitors think fit. Moreover, as we have many times pointed out in these columns, a dyestuff industry is essential to our fine chemical industry and a flourishing fine chemical industry is essential to our national prosperity. If it is admitted that these statements are true and if we also admit that our British dyestuff industry is not yet so firmly established and so well organised that it can stand up against our German competitors then it seems to us that the position is fairly plain. The alleged agreement with the German dye manufacturers would be, so far as the Dyestuffs Corporation is concerned, a solution of the problem, but it is not, either from its point of view, or from the national point of view, the ideal solution. It is a great change of mind, a great decline in spirit, for that puissant Nation recently "shaking her invincible locks."

Sometimes we wonder how the great men of past days would have viewed such a situation. There have been sensible and cautious statesmen and men of business who have been content with a line of small resistance; there have been others, much contriving, and much enduring, who, when important interests or national pride have been involved, have been "strong in will to strive, to seek, to find, and not to yield." There have been such men in our chemical industry; men endowed with that determination, which ultimately prevails over every difficulty.

* * *

The importance attached to the possession of trade secrets has, one must suppose, some good justification, since every large manufacturing concern and every one-man show believe that the nature and quality of their products owe much to "something" that their competitors do not possess. There is, without doubt, a "something" in the hands of an experienced manufacturer that is extremely difficult for the novice to acquire, but whether it is just knack, born of much practice, the special skill of an operator, a secret ingredient, or a real novel process

is not easy for an *outsider* to determine. One thing is very sure—a scientific *insider* puts no faith in trade secrets, though he may make much of them for a variety of reasons which redound to his local credit.

Many large manufacturing firms in the past, though it is to be hoped the practice is dying out, used to put a penalty clause in the contracts of their employees who were likely to become wise in the processes of the factory, and to demand a guarantee deposit, running into hundreds of pounds, as a security against the persons with newly-acquired knowledge passing over to competitors. Such a practice is altogether loathsome, and at once puts a price upon the individual's head, whilst it kills the natural inborn tendency of a decent man to play the game. Some of the old contracts are quaint to consider to-day, for quite often the penalty clause prohibited a man, dismissed from the concern or leaving of his own accord, from joining another firm making the same type of article, and, occasionally, handling the same raw materials. This was merely silly, and would have been recognised as such even by the "Hass," if the man found himself unable to support himself owing to a restriction of this nature.

The lot of a chemist in any manufacturing firm is seldom a happy one, and many of the more ignorant directors look upon him primarily as a luxury, sometimes as an unpleasant necessity, more often as a "nosey-parker," and invariably as an unreliable member of the firm from whom trade secrets should be kept. Herein lies the folly of the ignorant, for the chemist will be quick to find the hidden secret, and to realise more often than not that it was not worth the seeking.

Is there such a thing as a trade secret that can exist in the possession of one firm alone for any length of time? Is there any trade secret that cannot be learnt from without by sufficient application? Does the possession of a trade secret, or supposed secret, bring out the good in competition or increase the pride in the production of a good article?

Human nature is peculiarly astute, but it loves a secret both in the finding and in the telling. A secret will cause some men with the craving for knowledge many sleepless nights till it has been found, and will probably cost the lazier man, who prefers to buy it, a pretty penny when it is duly imparted. But the secret will be bound to circulate sooner or later, and each manufacturer, as he acquires it, will keep it jealously from his competitors, under the impression that he is, at the worst, one of a select few. It is certainly to be doubted whether any secret can withstand for ever a thoroughly scientific attack based on the number of permutations and combinations to be squeezed out of a variety of ingredients and processes.

Mass production does, almost invariably, kill trade secrets, and the spirit of "live and let live" will, let us hope, reduce the inflation of the importance too often attached through ignorance to the secret that is no secret. But if the possession of even an imagined secret gives added pride to the manufacturer in maintaining the quality of his product—"Let the play proceed."

THE MANUFACTURE OF POTASH AND OTHER SALTS FROM LEUCITE.*

By PROF. J. W. HINCHLEY, A.R.S.M., Wh.Sc., M.I.Chem.E., F.I.C.

It is a disquieting fact that the whole of the world's supply of potash is still obtained from practically one district (95 per cent. comes from Stassfurt, Germany, and 5 per cent. from Alsace). This is a matter of concern, not only to the British Government, but to the United States, Italian and other governments, and in these countries diligent outlook is kept with a view to obtaining equally cheap supplies from other sources.

The most hopeful source for supplies would appear to be the igneous rocks, which contain, on an average, 3 per cent., while some contain as much as 10 per cent. of potash. It is obvious that these igneous rocks may present some chemical difficulty in attack, as compared with the soluble salts of Stassfurt (sylvine, carnallite, etc.). In the case of these soluble salts of Stassfurt, a complicated and somewhat costly process of crystallisation has to be carried out to obtain pure products, but for agricultural purposes a crude product is usually satisfactory. If, however, pure minerals may be obtained from igneous rocks which are readily treated by chemical methods, it may be possible by these means to compete with the soluble salts of Stassfurt.

Of those minerals which occur in igneous rocks leucite is the most attractive. It is a comparatively rare mineral, except along the line of the Italian volcanoes.

It has some historical interest from the fact that Klaproth discovered potash in 1796, through examining it. The millstones of Rome have been made from leucitic lava for over 2000 years.

The use of leucite as a raw material for the manufacture of potash salts would bring another country into the potash market, and certainly relieve the world's situation with regard to potash, and possibly lead to the utilisation of similar or other minerals occurring in igneous rocks in other countries. Leucite ($K_2O,Al_2O_3,4SiO_2$) in a state of purity contains 21·5 per cent. of K_2O, 23·5 per cent. of Al_2O_3, and 55 per cent. of SiO_2. As a rule the natural mineral contains less potash, on account of the presence of magnesium and sodium, but this replacement of potash and other elements varies among the different volcanoes, and in some places, practically pure leucite occurs in extraordinarily large quantities.

Orthoclase is another mineral occurring in igneous rocks, which offers possibilities for the extraction of potash. It occurs in smaller proportion than leucite in the lavas of the Italian volcanoes, and, unfortunately, is usually associated with albite (soda felspar), so that whilst pure orthoclase contains 16·9 per cent. K_2O, 18·4 per cent. Al_2O_3, 64·7 per cent. SiO_2, that occurring in the Italian lavas contains only 7·1 per cent. of potash.

*Paper read at the joint meeting of the London Section, and the Chemical Engineering Group on Feb. 4, Dr. B. Dyer presiding.

In a few of the Italian lavas the amount of orthoclase exceeds that of the leucite; in a great majority it is much less, but in a large number of leucitic lavas, orthoclase is entirely absent.

Mr. Henry S. Washington has made a large number of analyses of the Italian leucitic lavas, and states that the average potash content is 8·72 per cent., whilst the average for all lavas, leucitic and non-leucitic, is 8·31 per cent. of potash. A region of igneous rocks so high in potash is unknown in any other part of the world.

The row of volcanoes extending 186 miles from Orvieto to Naples, contains seven craters, of which Vesuvius alone is active, the others being Bolsena, Vica, Bracciano, Alban Hills, Hernican Volcano, and Rocca Monfina. From a careful examination of the rocks during the war by Baron Blanc, it was found that the leucitic rocks of Rocca Monfina contain the

Fontanaradina, Rocca Monfina, Italy. Section of Leucitic Lava × 12

Fig. 1

purest leucite, the leucite being practically free from magnesium and sodium. The leucites of other volcanic regions contain in many cases considerable quantities of these elements.

The author has examined the leucitic rock obtained in the Rocca Monfina district, at places about half-a-mile apart, and has found that the composition of the leucite is practically the same.

The Rocca Monfina volcano lies about thirty miles to the north of Naples. Its igneous rocks cover an area of about 80 square miles, and are computed by Mr. Henry Washington to contain 1008 million metric tons of K_2O. There are some flows of non-leucitic lavas—basalts, andesite, and trachyte—but the leucitic lavas are the most abundant. The average content of potash in the latter is about 10·5 per cent.—the highest figure for K_2O in the whole of the Italian lavas. Occasionally on the surface the leucite is somewhat kaolinised, but this is the exception rather than the rule. At the centre of the volcano is a small cone, Monte Santa Croce, of non-leucitic andesite. It would appear that this volcanic district could supply the world with potash at the present rate of consumption for a thousand years.

The leucitic lavas which are being worked at the present time at Fontanaradina are about twelve miles from the little port of Scauri. The rock, after removing a very shallow layer of soil, is at once capable of being quarried, and by a simple telpherage system can be carried straight down over the intervening country to the wharf at Scauri by gravity. Fontanaradina lies about 370 metres above the intervening country, lying towards Scauri.

A photograph of a section of the rock is shown in Fig. 1; × 12. The regular trapezoidal form of the crystals is clearly shown. Examined under polarised light the crystals are found to be under stress; when heated to 500° C., however, this stress disappears and the simple crystalline form is revealed. Inclusions of gangue are very common in the leucites of many of the lavas, but this is not common in those of Rocca Monfina.

A view of one of the workings is shown in Fig. 2, from which the simplicity of the mining will be seen.

It will be obvious that unless the leucite can be separated from the gangue, the proposition of the manufacture of potash salts at a reasonable cost may be practically impossible. It has been found, however, that the small content of iron in the gangue is sufficient to permit of perfect electro-magnetic separation of the two materials.

The leucite occurs in the rock in crystals, varying from 3 in. in diameter to microscopic dimensions, but after crushing the rock and sifting to obtain uniform granular material, a very simple machine, which has been devised by Baron Blanc, brings about at a very rapid rate, the complete separation of the leucite crystals from the gangue.

The mill in which the crushing, sifting and electro-magnetic separation takes place, is shown in Figs. 3 and 4. The rock is crushed in jaw-breakers and rolls, sifted to separate into granular material and fine powder and then treated in "belt" electro-magnetic separators.

For chemical treatment it is desirable, for reasons which will appear later, to use material whose grains are about one-sixteenth of an inch in diameter.

The fine powder produced during the process of crushing may be used as a potash manure.

Dr. Voelcker has carried out a series of experiments during the last three years, on the value of powdered leucite as a manure, and has found as a general conclusion, from his experiments, that the value of leucite is practically identical with that of soluble manures of the same potash content. His pot experiments may be cited :—

TABLE VI

Treatment	Weight of corn g.	Weight of straw g.	Percentage of untreated Corn	Percentage of untreated Straw
1. Untreated	8·19	16·70 ..	100	100
2. Leucite—5 cwt. per acre	11·23	19·99 ..	137	119
3. Sulphate of potash containing potash equal to 5 cwt. per acre of leucite	11·00	18·55 ..	134	111

The chemical properties of leucite are extremely interesting, and there is little doubt that as it becomes better known it will be used for many purposes and in many processes in which it is at present unknown. The potash present is readily replaceable by many other elements. It is related to the zeolites, but contains no water. Its application to water softening and similar purposes is obvious.

The behaviour of natural silicates with acids varies enormously. In some cases the attack is nil, and in many cases in which attack takes place gelatinous silica is formed, and the separation of the liquids from the solids becomes extremely difficult, and may make the cost of treatment excessive and impossible. On treating powdered leucite with acids, solution takes place with evolution of heat and gelatinous silica is formed in sufficient quantity to make the process difficult on a commercial scale. If, however, granular leucite is treated with acids the amount of gelatinous silica formed is small, but still sufficient to seriously interfere with economic manufacture. Baron Blanc, however, found that if the acid liquid be continually circulated through the granular leucite a solution was obtained in which no gelatinous silica occurred. The gelatinous silica which must be formed through the presence of small quantities of powdered leucite is removed from the solution by the filtering or adsorbing action of the granular material. At the end of the process of solution in acid the crystals of leucite appear as little skeleton crystals of silica.

One of the Quarries

FIG. 2

The granular material obtained by the electro-magnetic separation of the crushed rock contains :—

K_2O	.. .. ..	18–20 per cent.
Al_2O_3	.. .. ..	22–24 ,,
SiO_2	.. .. ..	53 ,,

On examination of the crystals of leucite separated, there will be found inclusions of gangue, so that many of the grains consist partly of leucite and partly of gangue. On this account the separated material usually contains from 2 or 3 per cent. of gangue.

On treatment of the separated material with acid, a certain amount of iron enters into the solution, but the amount of iron is not sufficient to interfere with the chemical processes, or to affect seriously the purity of the chemical substances produced by very simple processes.

MANUFACTURE OF ALUM

Perhaps the simplest industrial process is that of the manufacture of alum and silicate of soda from this material. Potash and alumina are present in the correct proportions for forming alum by the action of sulphuric acid on the material according to the equation :—

$$K_2O,Al_2O_3, 4SiO_2+4H_2SO_4+20H_2O= K_2SO_4, Al_2(SO_4)_3, 24H_2O+4SiO_2$$

A plant treating 4 tons of leucite per day by this process is in operation at Pierre Benite, near Lyons, France. It yields 6 tons of alum per day.

Works seen from the Road

FIG. 3

Granular leucite is treated with circulating dilute sulphuric acid which is continually enriched as combination takes place. The heat of solution of the acid in the water and that due to the formation of alum raises the temperature of the liquor and the action becomes vigorous. By the circulation of the liquor through the granular mass, any colloidal silica produced at the beginning is absorbed by the silica formed, and a solution is obtained which is free from silica but contains a little iron.

It is well known that iron is a serious impurity in alum, and therefore it is essential that this iron should be completely removed from the final product. The gangue is almost unattacked by acid even when hot, so long as it has not been reduced to powder. In actual practice saturated mother liquors are used for the solution of leucite, and when the process is complete the temperature has been raised to about 95° C. On cooling, alum corresponding to the amount of leucite attacked, crystallises out, and is separated and washed in a centrifuge, by which a very pure alum is obtained. During this crystallising process the liquor should be agitated so that the crystals are produced in micro-crystalline form; as a result the whole of the iron remains in the mother liquor, and the crystals are obtained in the form known as fine crystals. About 20 per cent. of the alum present in the solution is crystallised out on each operation.

The mother liquors are used for a further treatment of the mineral, but as a rule the iron present is removed by simple chemical treatment, either in neutral solution by precipitation with a small amount of ammonia, so that a small precipitate of aluminium hydrate with ferric hydrate is formed; or, in acid solution, by adding a small amount of milk of lime or baryta to serve the same purpose. Agitation should be continued during this precipitation. On account of the large amount of water removed as water of crystallisation, the mother liquors, after being freed from iron, are diluted and again acidified and used for the treatment of a new batch.

The residual silica after washing with water, is removed from the dissolving apparatus, and on drying becomes reduced to an impalpable powder, and by a simple air separation gives a very pure product. This silica is remarkable in that it may serve at once for the formation of important silicon

compounds. As obtained in a dry state it usually contains about 18 per cent. of water, corresponding to $4SiO_2,3H_2O$. On drying in a vacuum desiccator at the ordinary temperature this is reduced to $4SiO_2,H_2O$; on being exposed to moist air, it again takes up water. Its properties correspond therefore with those of ordinary precipitated silica.

Manufacture of Silicate of Soda, etc.

On adding this silica to solutions of caustic soda or potash, even when very diluted, solutions of corresponding silicates are almost immediately obtained. The reaction takes place according to the equation :—

$$2NaOH + nSiO_2 = Na_2O,\ nSiO_2 + H_2O$$

Such silicates of soda and potash, when the air-separated silica has been employed, are extremely pure and may be obtained of practically any composition. Commercial silicates may be made by using the wet residue from the manufacture of alum. The gangue is not attacked by caustic soda or caustic potash, and is separated from the silicate solutions formed by settling.

The importance of this process of making silicates will appear when one compares it with the usual method of manufacture. It avoids the fusion of silica with the solid alkali and the subsequent treatment in an autoclave of the solid silicate obtained. The composition of commercial silicate of soda is (40° Bé) :—

SiO_2	.. .. ..	26·1 per cent.
NaOH	.. .. ..	9·8 ,,
Water	.. .. ..	54·1 ,,

The residual silica from Rocca Monfina leucite usually contains 5 per cent. of gangue and 40 per cent. of water. It is therefore a simple matter to calculate the amount of caustic soda solution of given composition to add in order that commercial silicate of soda (40° Bé) may be obtained.

The reaction is spontaneous and rapid; the caustic soda solution is placed in an ordinary vessel provided with an agitator, and the silica residue is gradually added. The reaction is exothermic, so that there is a rise in temperature. The operation may be accelerated in the beginning by warming the caustic soda solution. In practice, the silica is usually added slightly in excess, and while the liquor is hot it is rapidly pumped through a filter press, from which the silicate of soda of 40°Bé, issues, pure, colourless and transparent. The proportions used in practice amount to 474 kg. of silica and 549 kg. of soda of 29° Bé to obtain one ton of 40° Bé silicate of soda. The cost of production by this process in France with sulphuric acid at 22 centimes per kg. is 31 centimes per kg. for alum and 18 centimes per kg. for sodium silicate, or in round figures, with acid at £3 per ton, the cost of production of alum is £4 4s. per ton and of sodium silicate £2 19s. per ton.

The production of alum and silica of soda at Pierre Benite, corresponds to an 80 per cent. yield.

Hydrochloric Acid Treatment of Leucite

The treatment of leucite with hydrochloric acid presents greater chemical-engineering difficulties than the treatment with sulphuric acid, on account of the volatility of hydrochloric acid, and also of its greater corrosive action. The material is treated in a similar manner, as in the former case, but the plant must be completely closed, with a vent connected to a suitable scrubbing tower for the removal of hydrochloric acid fumes. This scrubbing tower may be packed with leucite with advantage, the water which trickles down it being used in due course to dilute the mother liquor obtained in the operation. Mother liquor in suitable quantity, (usually from 2 to 2½ cubic metres of liquor per ton of leucite treated), is continually circulated through a bed of granular leucite, and gradually acidified, as solution takes place. The circulation of the liquor is brought about by a centrifugal or other pump, and the liquor meets at one point in the plant hydrochloric acid gas, so that as attack takes place further acid is provided. For a reason which will be realised presently, strong acid solutions may reduce the rate of solution. In the course of 2 to 4 hours the whole of the potash and alumina has gone into solution and the temperature has risen to a little above 90° C. The amount of heat generated by the process is so great that the plant must be arranged to dissipate a proportion of it or the temperature may rise too high.

Since the solubility in the cold of aluminium chloride is much greater than that of potassium chloride (400% Al_2Cl_6 32% KCl); and since the solubility of potassium chloride is nearly twice as great at 90° C. as at 15° C., if suitable quantities are chosen, the whole of the potassium chloride dissolved in the reaction may be crystallised out, by cooling the resultant liquor obtained. In practice the amount of solution used is such that it is saturated with potassium chloride at a temperature not higher than 70° C. After discharge from the dissolver, the liquor is passed into a cooling apparatus, in which the potassium chloride crystallises out. Evaporating coolers are very convenient for this purpose, since the crystals form on the surface of the liquor, and the operation need only take a very few hours. About one third of the potassium chloride present in the liquor is crystallised out in cooling.

The magma of potassium chloride crystals and concentrated solution of aluminium chloride are run into a centrifuge, in the basket of which the potassium chloride is retained, and is washed with a small quantity of water, or potassium chloride solution, by which white crystals of 98/99% purity are obtained.

The aluminium chloride solution is now treated in a closed vessel with hydrochloric acid gas, when crystals of hydrated aluminium chloride are precipitated; the rise of temperature which takes place during this operation through absorption of hydrochloric acid is useful as it prevents any risk of further crystallisation of potassium chloride. At this point, water may be added to the liquor with advantage, to restore to the liquid some of that removed by the

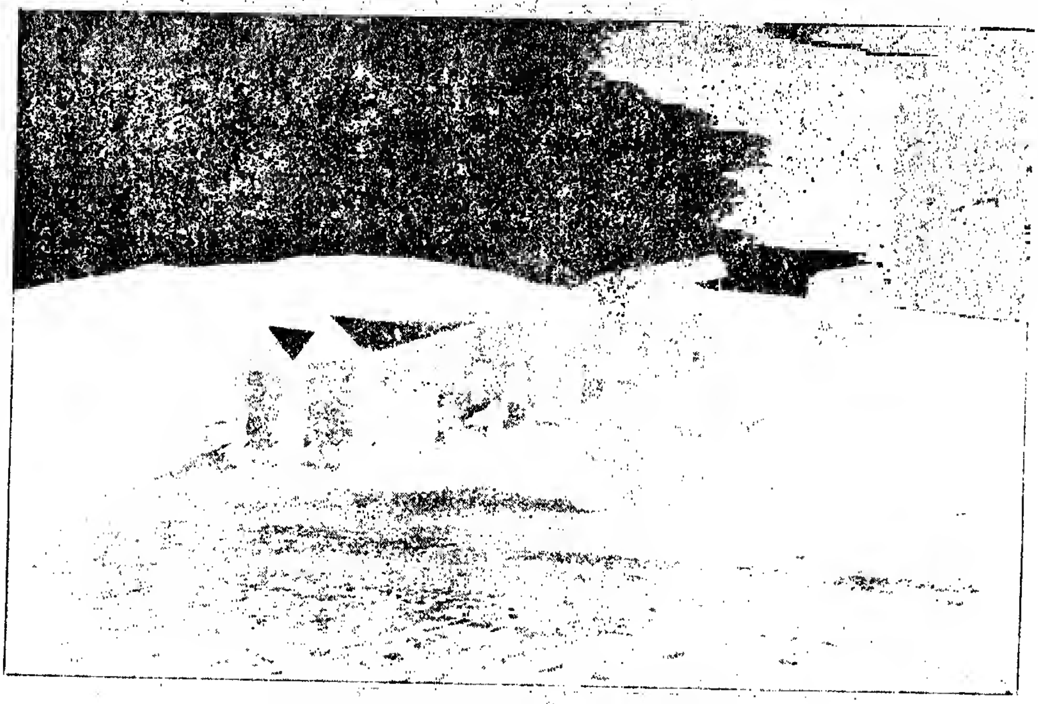
crystallisation of the aluminium chloride. The concentrated solution of hydrochloric acid and mother liquor thus obtained is transferred to the dissolver, whilst the precipitated hydrated aluminium chloride is transferred to a porous brick filter, washed with water, and drained.

By this method of operation, practically the whole of the potassium and aluminium present in the leucite is obtained in the form of potassium chloride and hydrated aluminium chloride. The process is one which needs careful attention to detail; it is obvious that the liquor at the end of the dissolving stage will be acid, and that there may be risk of precipitation of aluminium chloride on this account,

It will therefore be realised that this constitutes a simple cycle of operations, by which the same mother liquors are returned to the cycle continually, and any impurities may be concentrated in these mother liquors.

Ferric chloride accumulates this way, and tends to discolour the salts obtained, although simple washing easily removes it.

The author examined the results of a series of ten operations carried out on a small scale, and it appeared that the colour of the solution due to ferric chloride was practically the same in each case, a point being reached in the second or third operation by which the amount of iron eliminated with the



Works, with Rocca Monfina in the distance
Fig. 4

but practical experience has shown that some time is required after the end of the attack on the leucite, before the passage of the hydrochloric acid gas can give that degree of concentration which is necessary for the precipitation of hydrated aluminium chloride. The mother liquor rejected from the last operation will obviously be nearly saturated with potassium chloride, and it is obvious that if it is used for the attack on a fresh supply of leucite, the whole of the potassium in the mineral treated may be crystallised out by cooling the liquid. It is found that the volume of liquor needed for each operation is such as will contain about three times the amount of potassium chloride corresponding to that in the charge of mineral.

chlorides of potassium and aluminium, is equal to that entering the solution with each new attack. This state of impurity of the solution gives no cause for trouble. Although the iron may be readily removed in practice, it is found that there is no necessity for this, provided that the crystallisation of the two salts takes place while the liquid is in a state of agitation. The crystals which will form under these conditions are very pure and free from ferric chloride, except as wetted by the solution, and a small amount of washing water readily removes this.

The aluminium chloride obtained, may be further treated, so that hydrated oxide of aluminium is produced and hydrochloric acid driven off. This

process depends on the fact that hydrated chloride of aluminium when heated to about 280° C. decomposes according to the reaction:—

$$2AlCl_3,6H_2O = Al_2O_3,3H_2O + 6HCl + 6H_2O.$$

This reaction is carried out on a practical scale in a tubular furnace. The inclined rotary tube may be made of aluminium or of iron, since neither are attacked by hydrochloric acid at this temperature, even in the presence of water vapour. The hydrochloric acid thus produced serves for attacking a fresh charge of leucite, but it must be observed that it is associated with an equal amount of water; on the other hand also, for the purpose of ensuring that the aluminium hydrate is free from acid, an additional amount of steam may be introduced at the discharge end of the rotary tube. The alumina usually produced contains less water than the equation indicates—the amount corresponds to $Al_2O_3,1\frac{1}{2}H_2O$. The hydrochloric acid thus driven off, on being admitted to the dissolving plant, will play its part in the attack of the leucite, while the water vapour will pass off to the scrubbing tower connected with the plant.

Quantities of Materials

It is now worth while considering the relative quantities of materials required for carrying out this process:—618·3 kg. of hydrochloric acid gas is required to attack one ton of leucite (19 per cent. K_2O, 22 per cent. Al_2O_3), of which 471·1 kg. will form aluminium chloride, and 147·2 kg. will form potassium chloride. The 471·1 kg. fixed by the aluminium would, of course, be liberated if that aluminium chloride were transformed into aluminium hydrate. Should potassium sulphate be required, the displacement of chlorine from the potassium chloride by well-known methods, would mean that 197·6 kg. of sulphuric acid would be required per ton of leucite treated; the amount of liquor required is about 2500 kg. per ton of leucite. The reaction which takes place is the following:—

$$K_2O,Al_2O_3,4SiO_2 + 8HCl = 2KCl + 2AlCl_3 + 4SiO_2 + 4H_2O.$$

A small amount of water is thus produced by the reaction, but in a well-closed plant, the loss of water by evaporation during the process of solution, is sufficiently great to necessitate the addition of water. The water produced by the reaction is found to be associated with the silica, apparently in a loose state of combination.

Each molecule of aluminium chloride precipitated is associated with six molecules of water, as water of crystallisation ($AlCl_3,6H_2O$), so that in the treatment of one ton of leucite, 466 kilos. of water will be taken up in this way. The quantity of water required for washing the silica, is about 200 kilos. per ton of leucite treated, and is again used for washing the chloride of potassium and chloride of aluminium obtained.

Heat Equations

In the attack of leucite, we have three exothermic reactions which serve to bring and keep the liquid at the temperature of ebullition when one works with considerable charges of material. The reactions are as follows:—

(a) $K_2O + 2HCl = 2KCl + H_2O + 102{\cdot}3$ cals.
(b) $Al_2O_3 + 6HCl = 2AlCl_3 + 3H_2O + 67{\cdot}2$ cals.
(c) $HCl(gas) + nH_2O = 17{\cdot}3$ cals.

For one ton of leucite, it would appear, therefore, that by reaction (a) 227,253 calories are produced, and by reaction (b) 118,746 calories. With regard to the reaction (c), the total heat produced may be taken to be about 293,000 calories, for each ton of leucite treated. It will thus appear that 600,000 calories are generated by the attack of hydrochloric acid gas on one ton of leucite—a quantity of heat more than is required to bring and keep the liquid at the boiling point. It is therefore necessary to provide means in the plant of dissipating heat, and to conduct the reaction so that a temperature of over 90° C. is not obtained.

The decomposition of hydrated aluminium chloride in the tubular furnace is an endothermic one.

(d) $2AlCl_3,6H_2O + 211{\cdot}4\text{cals.} = Al_2O_3,3H_2O + 6HCl + 6H_2O$

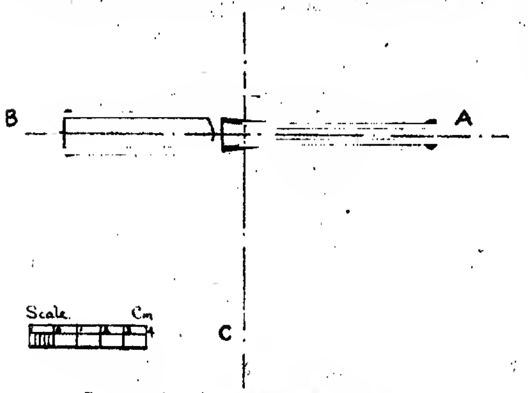
It will therefore be necessary to provide 2070 calories for each kilogramme of aluminium hydrate ($Al_2O_3,3H_2O$) obtained, which is equivalent to approximately 696,000 calories for each ton of leucite treated, assuming a production of 336 kg. of aluminium hydrate corresponding to 220 kg. of Al_2O_3. In addition, there is, however, the evaporation of the water associated with the HCl, which will absorb 10·8 calories per gramme molecule, so that about 149,000 additional calories are required for the vaporisation of the 233 kg. of water corresponding to the ton of leucite treated; thus a total of approximately 836,000 calories is required for the whole operation of converting the hydrated aluminium chloride obtained from the treatment of one ton of leucite into aluminium hydrate.

Taking factory operations, handling, say, 36 tons of leucite per day, about 5 tons of hydrochloric acid would be required, to which must be added any loss of hydrochloric acid which may be due to faulty chemical engineering. The cost of fuel for the treatment of this amount of material would be approximately 3s. per ton of leucite treated, and the products obtained would amount to $10\frac{1}{2}$ tons of potassium chloride, 8 tons of alumina, and 9 tons of silica. This estimate supposes a 93 per cent. yield.

I regret that I am unable to give views of the actual plant used to these processes, whilst the photographs in my possession of the small scale experimental plant in which the technical details were elaborated are too complicated to be of any value. The first factory experiments were performed in an ordinary stoneware tower, fitted with a plunger pump for the circulation of the liquid. The hydrochloric acid used was obtained by burning chlorine in hydrogen gas, produced from the electrolytic soda plant of the "Pomilio" factory at Naples. The commercial possibilities of this process depend mainly on the cost of the hydrochloric acid and the chemical engineering. In a factory where chlorine is a considerable by-product a careful consideration of costs will show the excellent commercial possibilities of this method of treatment of leucite.

The chemical-engineering problem of designing plant for the manufacture of alum and silicate c

soda presents no difficulty, since the ordinary materials of construction used in handling such products can be adopted, and apart from the provision of a circulating pump the plant may be designed in very many forms without serious effect on its efficiency. In the case, however, of hydrochloric acid treatment, on account of the volatility of the gas and the limited number of constructional materials available, the problem is far more difficult. If stoneware is used, the rise in temperature which occurs during the process may bring about stresses and failure through the serious cost in renewals and repairs. The removal of the silica obtained increases the difficulty of the problem if the usual methods are employed. Since the dissolving operation does not involve a temperature higher than that of boiling water, materials containing rubber may be used, and recently a new material containing a small amount of rubber has been produced, which seems to have all the qualities required for the construction of apparatus for this purpose. There is little doubt that soft rubber suitably prepared and supported by wood framing may also be used with success. In the plants erected on the Continent, stoneware, ebonite and soft rubber are used, but it would appear that



Silica Ejector. Sectional Elevation

FIG. 5

soft rubber or a composition of rubber might be used entirely, provided that the problem of dissipation of heat is properly attended to. Silica, cerotherm and similar materials might be used for those parts of the apparatus where heat dissipation occurs, and by the use of rubber connections stresses could be avoided.

The removal of the silica formed can be readily accomplished by means of ejectors. This method avoids doors, joints and stresses, and at the same time the operation is more rapidly and more efficiently conducted. Compressed air or steam may be used as the motive fluid, but as a rule steam should be preferred. The material of which they should be made must be hard and acid-resisting. For general purposes there is nothing better than a silica ejector, the body being protected by a rubber casing. Fig. 5 is a drawing of a useful type. Soft rubber tubing is carried from leg C, to the vessel to be emptied, steam is admitted by a flexible hose by leg A, and a rubber hose for delivery is connected to leg B. The granular mass associated with washing water in the dissolver is blown by the ejector on to a porous brick filter bed or draining bin, from which it may be taken for drying, air separation, etc.

These processes are due to Baron Blanc. Several other processes have been worked out, but have not been extensively used. The process of Dr. Hæge for making a phospho-potassic fertiliser has been worked to some extent. An acid process using nitric acid, an electric furnace process for the production of potassium carbonate and alumina, and a method of producing caustic potash call for some remark. The two last are due to Felix Jourdain. For producing caustic potash, powdered leucite and slaked lime with water are placed in an autoclave and treated for 3 hours at a pressure of 200 lb. per sq. in. The volume of the mass increases three times, and after two operations a solution containing 12 per cent. KOH is obtained. In a typical run with a 5-litre autoclave, 500 g. of powdered leucite, 400 g. of hydrated lime and 3 litres of water produced 51·6 g. of KOH, a yield of 95 per cent. Chemical engineering difficulties of handling the material, separating and concentrating the solution, are present, but the process is attractive. The residue in the autoclave is an excellent cement.

Discussion

Dr. J. A. Voelcker said that, as Professor Hinchley had very rightly observed, the need for potash in the agricultural world is undoubted. At the time of the war we had found ourselves dependent upon Germany for potash, and a potash famine was staring us in the face. We managed to get through that time, but it was not long before we felt that we must look elsewhere for supplies. Just then this new material, leucite, came along, and agricultural chemists turned to it very hopefully as another source of potash. When it was first brought to this country he was disposed to treat it, as he had treated several other sources of potash that had been proposed, such as the granites, felspars, and other insoluble materials of that kind, with some doubt; but leucite showed itself to be soluble to a large extent in hydrochloric acid, and even to give up a fair amount of its potash with such a weak acid as citric acid. Experiments that he himself had carried out with it had given most favourable results and there really was no reason why, being so readily comparatively soluble, it should not become an ordinary source of potash. In fact, it differed very little in effect from sulphate of potash containing an equivalent amount of potash. He believed that he was correct in saying that the reason we did not know of the existence of potash near Rome was due to the Germans, who not only knew something about these leucite deposits, and kept it up their sleeves, but had succeeded in persuading the Italians that these deposits were no good. Happily, this new source had now been opened, and he was disposed to believe that it was a very hopeful source of potash supply. Though he was not given to being over sanguine, he had

no hesitation in saying that he was very hopeful indeed of this source of potash if only it could be produced at a reasonable price; subject to that, he regarded the leucite deposits as likely to be a very valuable contribution to our sources of potash supply.

Dr. W. R. Ormandy said that the importance of these new deposits, of course, could not be denied, but the question was how far we as a nation were going to benefit from them. He did not feel, at the moment, that the leucite deposits of Italy would be of much benefit to us unless we had some hand in their control, and that was essential if we were to spend large capital sums in connexion with this new material. It had been pointed out that the first and simplest method of treating this leucite was to convert it into alum; but the world's market for alum was a comparatively small one, and this aspect might be ruled out as being of any very serious importance. Prof. Hinchley said the alum was approximately 99 per cent. pure, but commercial alum to-day might contain only 0·01 or 0·02 per cent. of iron, and for many fine chemical industries the permissible content of iron in alum was of the order of 0·001 or 0·002 per cent., so that more specific information was required before it could be said that the leucite product was of commercial quality. The value of this product could not be based on treatment with sulphuric acid, since the market for alum is so infinitesimally small in comparison with the potash requirements of the world. Therefore, the production of alum as the first process might be ruled out as being a serious outlet for a supply of potash which was said to run into thousands of millions of tons. Consequently, we were dependent upon the hydrochloric acid method, and here, as Professor Hinchley had said, the problem of handling hydrochloric acid in hot solution needed solving. Hitherto, on the Continent, they had used stoneware plant, which was immensely expensive, sensitive to changes of temperature, and easily damaged. Professor Hinchley had found a rubber for chemical plants dealing with hydrochloric acid at 100° C., which, under these conditions, would last for a long time; Professor Hinchley had been much more fortunate than he himself had been, or hoped to be. The problem of finding a material to deal with hydrochloric acid had, he believed, been solved in Switzerland. He had just visited a plant there which had been in use experimentally for two years, and in which hydrochloric acid, both as gas and liquid, was being boiled at 100° C. in vessels 9 ft. in diameter and 20 ft. high, made monolithic, and there was not the slightest evidence of any action. The manufacture of this material depended upon a concrete using pitch instead of Portland cement as a binder. Ordinary gas works pitch was a fluid, but it was possible to make hard pitch from it by mixing 7 per cent. of molten pitch with fine silica, then adding coarser silica, and then adding ¼-in. silica. This substance could be cast into various forms, but they lost their shape and deformed at a temperature of about 30° C. It has now proved possible, however, to make pitches which have the peculiar property that at a temperature of 100°, if mixed with siliceous material and cast into a bar, they will not change their shape unless sufficient pressure is applied to make them break suddenly. By means of such pitches a pitch concrete had been made which can be poured and cast into pipes having a thickness of wall of 9 mm. and a length of 6 ft., or it can be made into vessels 10 ft. in diameter and 20 ft. high, which will stand hydrochloric gas or fluid up to 100°. The cost of plant made with this material is about 20 per cent. of that of stoneware plant to carry out the same work, and therefore it appeared that the problem of finding a material for dealing with hydrochloric acid at high temperatures was capable of solution. How far could the development of the Italian leucite deposits be of value to this country? They were valuable in that they are an alternative supply, which is not controlled by Germany or by France, but he still failed to see how it was going to pay English industry to spend large capital sums for the commercial development of a material the control of which, like the control of potash, was as much out of our hands as the Alsace-Lorraine and Stassfurt product was. It was eminently desirable that we should have a supply, and an essential method of dealing with the difficulty might be to form an international company in Germany, in which we should have a share, so that we did not spend our capital to develop this product only to find later that an area 40 miles away was being developed and the leucite sold at a lower price to our competitors.

Mr. Howard Spence said that Baron Blanc had rendered enormous service to chemical industry by the processes that he had developed. The actual use of leucite had been known and practised 15, 20 or 25 years ago, one process being operated for quite a considerable time. Others, too, had experimented with it on a large scale, but they failed because they were unable to produce leucite at anything like a commercial price. Apparently these early workers were operating on some material which was not of the character of that being worked by Baron Blanc, *i.e.*, leucites which had largely decomposed under atmospheric conditions, and which, with a certain measure of difficulty, allowed the separation of the leucite crystals from the gangue by hand labour without any mechanical operation at all. Baron Blanc had developed a most interesting and ingenious process, apparently by going to the true source of the raw material, where it occurred in unlimited quantity, and being able to separate it under controlled conditions at a very low cost. The other processes worked out by Baron Blanc were also extremely interesting, and their development would be watched with great interest by the chemical industry.

Dr. R. Lessing said it so happened that leucite constituted the subject-matter of what he believed was his first consulting job twenty years ago. At that time some interest was taken in the exploitation of leucite, which came very largely from further north, nearer Rome, and the Italians at the time tried to induce English industrialists to take a hand in the matter. The process then being tried was an

alkaline one, and alumina was to be recovered from the solution by treatment with carbonic acid. The process came to nothing because the chemical and engineering difficulties were under-estimated, and nobody like Baron Blanc was found to carry on the work. A process which was worked out in America, although not, he believed, on a very large scale, consisted in treatment with ammonium chloride. It was a high temperature process, and the ammonia could be recovered.

Dr. R. Seligman said he had come to hear something about the production of alumina from these ores. Did Prof. Hinchley say that the decomposition of the aluminium chloride was carried on at about 350°?

Prof. Hinchley said that it began at about 280°, but the actual temperature of the tube in the furnace was about 300° to 350°. At that temperature they got a white product free from aluminium chloride, but it contained traces of acid in the first treatment.

Dr. Seligman said he would next like to ask as to the purity of the product. Prof. Hinchley had said the alum was nearly pure, which did not go far enough.

Prof. Hinchley said it could be absolutely pure; with only 0·001 per cent. of iron, and free from silica.

Dr. Seligman then asked as to the physical and other properties of the alumina, which, he said, were as important as the purity. The alumina used for the production of aluminium to-day was very largely made by the so-called Baeyer process, in which sodium aluminate is decomposed with the production of hydrate. The calcination of the hydrate was one of the most serious problems of the manufacturer, because not only were there considerable losses when the calcination was carried out, but it was very difficult to render the alumina produced non-hygroscopic. If it took up water, as it very easily did, the losses when it was subsequently put into the aluminium reduction furnace were very serious. It had always been his hope that by some such means as those described by the author, it would become possible to obtain alumina which is much more readily rendered non-hygroscopic. He was very anxious to know whether that was so, because in calcining by the Baeyer process it was necessary, either to work at a very high temperature, which was costly, or to use catalysts to get the change from the hygroscopic to the non-hygroscopic state. Alumina so treated caused difficulties in the reduction furnace. The change did not occur anywhere near 800° C. There was no difficulty in getting rid of the water, but it was the subsequent change which was of interest.

Prof. Hinchley said it occurred in this case between 600° and 800°, and the material was always non-hygroscopic. It was one of the questions that was being pursued, but the various processes had not yet been fully worked out for the commercial purposes to which the materials were being applied. The alumina was obtained in the ordinary way with 1½ molecules of water, but at 600° it seemed to be absolutely free from water, and there seemed to be a change.

Mr. Norman Swinden said he had been engaged for three years on investigating materials to withstand hydrochloric acids. He had found a rubber base to satisfy all the requirements of a plant to carry out all the operations mentioned that evening up to 110°. He had not found ebonite and pure rubbers satisfactory. He wanted a material which would resist the action of hydrochloric acid up to 110° C., which would neither contract nor expand on heating and which would not cost more than 1s. 6d. per lb., and which also could be taken to the far regions of the earth and be used by natives under skilled European control. At the moment a large plant, made entirely of rubber, including the boiler, was being put up in London for the treatment of hydrochloric acid and saturated brine. What was in mind was a material like sand which could be cemented together by the smallest possible quantity of rubber. The sample pot which he exhibited was lined with a leaded rubber compound, and all the processes were being carried out with that material. If this material was heated to 95° or 100°, it underwent surface change, was hardened and became more or less impervious. The rubber people said it was not vulcanisation but it was good enough for the purpose for which it was required. Furthermore, it had the advantage that alterations could easily be made, because one only had to cut a hole with a knife and weld a piece of rubber in. The material was delivered in the rough state and the rest was done by unskilled labour. Cocks, valves, tees, etc., were made in this way. The material would transmit 200 calories per sq. mm., per hour, and it formed a basis for the designing of plant for the dissipation of heat. Another great advantage of this material was that if softened it became doughy and could be used without any trouble for lining peculiar shaped vessels used in chemical engineering and covering agitators, paddles, etc. It was easy to cover such things with this material or line them without any trouble.

Prof. J. W. Hinchley, replying to the discussion, said that the successful commercial treatment of Italian leucite might bring about the treatment of other materials which we might have in this country although at present there might be no suspicion of their existence. He did not believe that the mineral riches of the British Isles were thoroughly exhausted. It might still be possible to find a source of potash in this country of which the development of leucite in Italy might be the first stage. The purity of the products depended entirely on the men in charge of the operations. It was possible to get very pure products and also extremely impure products. On the other hand, the purest materials demanded by the trade can be readily obtained, and he had been informed by Mincing Lane merchants that the products which had been put forward, *e.g.*, alum, were purer than the ordinary products usually sent there. He should not think of using a silicate of soda cement for hydrochloric acid plant but he was surprised to find it was successfully used when special precautions were taken. The Rocca Monfina deposits of leucite were in the hands of one firm and an analysis of the leucite from seven other volcanic areas showed that these materials had nothing like the purity of the Rocca Monfina. Alumina can be

produced to a degree of purity, with greater ease and at a lower cost by this process than by any other. The cost of precipitation and filtration alone represented a saving of half. Prof. Hinchley said he was pleased that Mr. Norman Swinden had spoken because although in the course of his paper he had mentioned the pot made of material with a rubber base, he did not like to say that Mr. Swinden had handed it to him several months ago in order to test it. He had, however, had it under test with hydrochloric acid, although he had not had the acid boiling, but the material had stood up well to the temperatures that had been used; the test was not completed yet. Mr. Swinden considered the material satisfactory and from the scale upon which he was using it, and from his (Prof. Hinchley's) own experiments, he believed Mr. Swinden was correct. A heat transmission rate of 200 calories per sq. m. per hour at first sight appeared low, but that rate was perfectly satisfactory for nearly all chemical plant. The size of the plant, of course, was affected by the rate of the heat transmission, but it was always possible to use other materials in conjunction with this one when a greater rate was required. Research on this aspect was still going on.

THE BRITISH AND GERMAN DYESTUFFS INDUSTRIES

By Prof. GILBERT T. MORGAN, O.B.E., D.Sc., F.R.S.

The Editorial of *Chemistry and Industry* for February 1 refers to negotiations which have recently taken place between the British Dyestuffs Corporation (B.D.C.) and the German chemical combination known as the Interessen Gemeinschaft (I.G.) and the subject has been widely ventilated in the daily press during the last three weeks, although so far no authorised version of the alleged agreement has been made public. Nevertheless, current rumours have already given rise to an extraordinary divergence of opinion as to the outcome of this new development. On one hand it is stated that the first overtures came from the magnates of the I.G., who had become genuinely alarmed at the rapid success of the British dye industry. Meetings began in 1921 and conferences have been held since in several continental capitals with the result that the Directors of the B.D.C. having made clear their position of independence in respect of supplies of German dyes, have returned from Berlin bringing "peace with honour" together with an agreement which will increase the efficiency of the dyemaking industry in this country.

Less optimistic views are, howe[illegible] by other interested parties. One section [illegible]ye users is becoming alarmed at the prospe[illegible] an Anglo-German monopoly controlling the supplies of essential colouring matters. The dyemakers outside the state-aided merger, who are also among the critics of the proposed arrangement, have not yet published any official opinion but it is obvious that their interests are gravely involved.

Whatever may be the fate of the agreement it is interesting in view of the *rapprochement* between the leading British and German colour firms to read again reports of speeches made in 1915 and since in connexion with the establishment and the subsequent developments of British Dyestuffs Ltd. and its present successor. One of the Government directors of the B.D.C., who is stated to have been present at the Berlin conference, was formerly Sir Albert Stanley, who in 1918, as President of the Board of Trade, referred to "the dye industry for this country free for all time from any association with Germany."

Certain terms of the agreement were disclosed by the *Manchester Guardian* on January 25, and although repudiated by the B.D.C. as "unauthorised and premature," they were subsequently confirmed by Dr. Duisberg of the I.G.

They may be summarised as follows:—

(1) A monopoly of the British market for the B.D.C. with a percentage share of foreign and Colonial markets; (2) the B.D.C. shall be able to draw on the I.G. for *personnel* and for information as to manufacturing and technical processes; (3) the I.G. to receive half the profits of the B.D.C.; (4) the B.D.C. to offer such dyes as it imports at world prices; (5) reparation deliveries of dyes to cease.

It is probably the second clause which will arouse the most acute feelings in the minds of chemical readers. The policy implied is by no means new; several of our pre-war colour makers had recourse to a *personnel* drawn from foreign sources. "A German chemist with a process" was the favoured recipe, but the dye shortage of 1914 was the sequel to this easy-going dependence on alien aid.

Before the reintroduction of German chemists changes completely the essentially national character of our dye-making undertakings it seems desirable to direct public attention again to the meritorious advances in the manufacture of dyes and intermediates which have been accomplished in our dye factories during the past five years (*v.* The New Dyestuffs Industry of Great Britain, *Chemistry and Industry*, September 14, 1923).

These remarkable achievements were a revelation to those members of the Dyestuffs Development Committee of the Board of Trade who recently visited some twelve of the representative colour works of Great Britain. Two lines of improvement were apparent: the range and purity of dyes and intermediates were being increased, while the cost of production was being diminished rapidly as the result of further experience in the manufacture of these highly complicated chemical materials on a large scale.

In view of this striking demonstration of manufacturing aptitude on the part of British chemists the following extract from an article on "A Dye Combine," published by the *Manchester Guardian* on January 25, must be regarded as misleading and very unfair to our colour chemists:—

"Under its [the Dyestuffs Act] shelter we have tried with conspicuous ill success to foster an industry which shows no signs of being able to stand on its own legs when the protection is withdrawn." It is only right to add that in reply to a spirited protest a partial qualification of this assertion was made a

few days later as regards "the efforts of the independent dye makers." The truth of the matter is that no distinction can be drawn between the chemists employed by "independent dye makers" and those on the staff of the B.D.C. Both sections of British chemists have made good in such a way as to astonish their best informed critics, the chemically trained chiefs of the I.G. This success of the British chemist furnishes at the same time a reason for the German overtures and the only possible justification for the accommodating attitude taken up by the Board of the B.D.C. But although in certain contingencies, working arrangements with foreign manufacturers may be desirable, as for instance the one by which the Clayton Aniline Co., although under Swiss inspiration, continues to employ English chemists and operatives and to extend its plant for the manufacture of dyes and intermediates in this country; yet it is very doubtful whether, on the lines of the proposed agreement, the non-technical directorate of the B.D.C. will be able to maintain a position of independence in association with such past masters of colour chemistry as the chemical directors of the I.G.

If this foreboding is justified the outlook for the British synthetic colour industry is deplorable. For it should never be forgotten that the vital importance of this branch of applied chemistry lies not in its financial value but in its educational aspect. It is the only chemical trade which can offer on an extensive scale a training in industrial synthetic chemistry, the ramifications of which spread throughout the high grade industries subserving the needs of modern civilisation.

The great factories of the I.G. are industrial universities within which German chemists continue their vocational studies, thereby diverting their technical knowledge into profitable channels. Before the war her indigenous industry in coal tar products had endowed Germany with the chemical hegemony of the civilised world. It remains to be seen whether the proposed agreement will retain for British colour chemistry "a place in the sun."

The announcements in the press of this compact were accompanied in many instances by a flash of grim though probably unconscious humour. The German combine was repeatedly described as the Inter-Essen Gemeinschaft, a timely reminder that German dye making is not entirely dissociated from the war-time activities of Messrs. Krupp.

PULVERISED "COALITE"

In considering the question of the use of pulverised fuel and the complete solution, as represented by the "Lopulco" patents, of the various problems, such as the wear and tear on the brickwork, the cost of drying and pulverising, the slagging of the ash, and the depreciation of the plant, it is interesting to note that pulverised "Coalite" can be burnt by the Lopulco system with equally remarkable results, namely 85–89 per cent. boiler plant efficiency, in addition to being superior to mechanical stoking in many other directions. If the fuel is pulverised so that 90 per cent. will pass through a 100-mesh screen (100 holes to the linear inch) and 65 per cent. through a 200-mesh screen, the contact with the air for combustion is so intimate that only 20 per cent. excess over the theoretical amount is required, and almost any carbonaceous fuel can be burnt at the highest efficiency, irrespective of the ash and the volatile matter. Thus, in the Ford plant at Dearborn, Detroit, blast furnace gas, pulverised coal, coke-oven gas, pulverised coke, and oil are used with equal facility, although the normal fuel is 70 per cent. blast furnace gas and 30 per cent. pulverised coal.

"Coalite," which contains 8 per cent. of volatile matter, would of course be a particularly easy fuel to burn in a pulverised condition at the highest efficiency, especially because the modern hollow air-cooled brickwork combined with a very large furnace volume allows the most intense heat and the maximum radiant efficiency to be maintained continuously for months without difficulty. It will be remembered that "Coalite" is particularly efficient in this respect, and for ordinary solid fuels in the open household fire, the radiant efficiency is approximately per cent. "Coalite," 35; coke, 30; semi-bituminous coal, 30. The great development in pulverised fuel-burning seems to be in fact only another argument for the wholesale low-temperature carbonisation of our coal, and the rapid extension of the "Coalite" process is coming at a very opportune time.

MIDLAND JUNIOR GAS ASSOCIATION

At the meeting on February 9, Mr. W. A. Twine, A.I.C., M.I.M.E. (supt. of Chemical Plant, Birmingham Gas Dept.), gave an address on "Chemical Engineering in Gas Works Practice."

In the course of the address he said he was confident that in the future only those who were prepared to make a study of chemical engineering alongside their other training would be qualified as first-class gas engineers. This fact had been overlooked by those who had been framing the syllabus for training the gas engineer. Many patents connected with the chemistry and physics of gas manufacture were unsuccessful in practice largely because the scientist was not an engineer, or the engineer was not a scientist. The friendliest feeling existed between the chemical and gas industries though from time to time the relations became strained. This was largely owing to the short-sighted policy of the chemical manufacturers that gas undertakings were driven more and more into chemical manufacture owing to the high prices they were charged on occasion for chemicals they required, or the low price offered for gas residuals. The speaker then discussed various improvements in gas-works practice, such as the use of waste heat from the retort house to distill the gas liquor, the removal of sulphuretted hydrogen by improved methods, and means of reducing losses of ammonia.

SOCIETY OF CHEMICAL INDUSTRY

MEETING OF COUNCIL

The monthly meeting of Council was held on February 8, 1924, Mr. E. V. Evans, and (subsequently) Sir Wm. J. Pope, F.R.S., in the chair. The President was unfortunately absent on account of illness.

The Council at its previous meeting decided to award the Messel Medal for 1924 to the Rt. Hon. Viscount Leverhulme, and the following cable had been received from him in reply :—

"Profound thanks distinguished honour Society Chemical Industry conferred and accept relying members will generously accept unworthy but sincerest efforts prove myself entitled their confidence.—Leverhulme."

Intimation was made of the death on January 24 of Mr. A. C. Flint, assistant secretary of the Chemical Engineering Group, and of the Institution of Chemical Engineers. It was agreed to send a letter of sympathy to his widow.

It was decided to give a donation of £100 to the Library Fund of the Chemical Society for the year 1924.

The financial arrangements that had been made for carrying on the work of the Bureau of Chemical Abstracts were reported to the Council and were approved.

Reports of various committees of the Council were submitted; and twenty-one new members were elected: Home 15, Overseas 6.

Dr. Geoffrey Martin and Dr. David Prentice were nominated as delegates from the Society to the International Cement Congress which is to be held, under the auspices of the Institution of Structural Engineers, at the International Building Exhibition, Olympia, London, on April 22 and 23.

A preliminary announcement as to conditions and privileges of membership of the World Power Conference was laid on the table.

It was reported that Mr. W. J. Leonard, a member of the Society, had by a codicil, dated August 19, 1921, to his will, directed his trustees to pay to the Society the sum of £5000 as soon as a definite scheme for the provision either by the Society or in conjunction with other chemical societies of a building and accommodation to form a Centra Institute and Club for Chemists has been decided upon and is being carried into effect, the decision of the trustees as to whether such scheme has been decided on and is being carried into effect or not to be final and binding upon the Society. In the meantime, the income from the Trust Fund will be paid yearly to the treasurer of the Society for the general purposes of the Society for a period of seven years from the time of the testator's death or until before the expiration of such period a definite scheme has been decided upon. But if at the expiration of such period of seven years no definite scheme as aforesaid is being carried into effect then the Trust Fund shall fall into and form part of the testator's residuary estate. It was resolved: (1) To express the thanks of the Council to Mr. Leonard's trustees, and (2) to open a fund, to be called the Leonard Bequest Fund, into which all moneys shall be paid, including the income from the Trust Fund. It was further decided that at next meeting of Council a scheme for carrying out the objects of the fund should be submitted for discussion.

The next meeting will be held on Friday, March 14, 1924, at 2.30 p.m.

FORTHCOMING EVENTS

Feb. 15. SOCIETY OF CHEMICAL INDUSTRY, *South Wales Section*, in the Technical College, Swansea, at 7.15. "The Increased Application of Physical Metallurgy for purposes of Control." By H. J. Williams, F.I.C., and L. Tavernor, A.R.S.M., D.I.C.

Feb. 16. SOCIETY OF CHEMICAL INDUSTRY AND INSTITUTE OF CHEMISTRY, *Bristol and South-Western Counties Sections*. Annual Dinner, to be held at the Royal Hotel, College Green, Bristol, at 7 p.m.

Feb. 18. INSTITUTION OF ELECTRICAL ENGINEERS, Savoy Place, W.C. 2, at 7 p.m. "Electrical Development in France." Discussion to be opened by E. M. Malek.

Feb. 18. INSTITUTION OF CHEMICAL ENGINEERS, The Engineers' Club, Coventry Street, W., at 8 p.m. "The Transport, Storage and Distribution of Hydrochloric Acid, with an Account of a Complete Modern Installation," by D. M. Newitt, B.Sc.

Feb. 19. HULL CHEMICAL AND ENGINEERING SOCIETY, Hull Photographic Society's Rooms, Grey Street, Park Street, Hull, at 7.45 p.m. "The Manufacture and Testing of Portland Cement," by Miss D. J. Butterfield.

Feb. 20. SOCIETY OF CHEMICAL INDUSTRY, *Nottingham Section*, University College, Nottingham, at 7.30 p.m. "A Note on the Estimation of Poisonous Metals in Gelatin for the U.S.A. Food Laws," by S. R. Trotman, M.A.. "The Weathering of Cotton and Wool, with Special Reference to the Action of Bacteria," by R. W. Sutton, B.Sc.

Feb. 20. SOCIETY OF GLASS TECHNOLOGY, Sheffield. "Recent Advances in Pyrometry with Practical Demonstrations."

Feb. 20. ROYAL SOCIETY OF ARTS, W.C. 2, at 8 p.m. "New Uses for Rubber," by P. P. Burgess.

Feb. 21. THE CHEMICAL SOCIETY, Burlington House, Piccadilly, W. 1, at 8 p.m. (1) "The Rotatory Dispersive Power of Organic Compounds. Part XI. Octyl Alcohol and Octyl Oxalate." By T. M. Lowry and E. M. Richards. (2) "Investigations on the Dependence of Rotatory Power on Chemical Constitution. Part XXII. Simple and Complex Rotatory Dispersion." By H. Hunter. (3) "The Rotatory Dispersive Power of Organic Compounds. Part XII. Borneol, Camphor, and Camphorquinone. Asymmetric Atoms and Asymmetric Molecules." By T. M. Lowry and J. O. Cutter. (4) "The Rotatory Dispersive Power of Organic Compounds. Part XIII. Halogen-derivatives of Camphor. Optical Superposition in the Camphor Series." By T. M. Lowry and J. O. Cutter.

BIRMINGHAM AND MIDLAND SECTION

Dr. E. B. Maxted presided over the meeting held on February 5, when Mr. E. J. Lush, of the Technical Research Works, London, read a paper on "Some Studies in the Kinetics of Oil Hydrogenation." Briefly describing a continuous process of hydrogenation, he showed by means of graphs that temperature played an important part in the formation of *iso*-oleic acid, but that the pressure of the hydrogen was without apparent effect on composition. The continuous process was, therefore, deemed suitable for measurements on the rate of hydrogenation with change of pressure. Charts were shown giving the experimental results for the effect of pressure on the rate of hydrogenation of cottonseed, palm kernel, coconut and groundnut oil. Except for coconut oil, the rate of hydrogenation was found to be approximately proportional to the square root of the pressure. This was further confirmed by maintaining a constant degree of hydrogenation (as measured by the iodine value of the oil) by a simultaneous change of rate of flow of oil and pressure, so that the two effects balance one another. A suggestion as to the cause of the difference in the effect of pressure in this and other processes was put forward for discussion.

MONTREAL SECTION

During the 1923-24 session most successful gatherings have been held since the inaugural meeting on October last. The Executive Committee of the Section had decided to secure greater publicity, and the co-operation of the Press in bringing the importance of chemical industrial problems before the public. With this point in view, the chairman of the Programme Committee, Dr. A. R. MacLean, has been eminently successful in securing prominent speakers upon subjects that are of interest to the members of the section as well as to the public. Mr. W. B. Woodland, who has charge of publicity matters, very happily co-operated with Dr. MacLean, so that the season's programme has been attractive in every respect. Good reports of the meetings have been published in the local papers. *La Press* is also giving good reports through the activity of the French Section, of which Prof. P. P. LeCointe is chairman.

The winter's programme to date has been:—*October* 29, 1923.—"Serums," by Mr. F. A. Bert. *November* 19, 1923.—"Chemistry as a National Asset," by Dr. C. T. Herty, of New York. *December* 17, 1923.—"Nitrogen Cycle," by Dr. G. H. Baril; "Food and Drug Control in Canada," by Mr. Aime Valin, Dominion Analyst. *January* 21, 1924.—"Forest Fire Prevention." A symposium at which Mr. Ellwood Wilson, Manager of Forestry Division of the Laurentide Co., and Mr. Robson Black, Manager of the Canadian Forest Association, were the chief speakers. The speeches and discussion were broadcasted from the Chemistry Building of the McGill University.

At the February meeting Mr. G. E. Saunders will speak on "Insecticides and Fungicides."

CHEMICAL SOCIETY

The President, Prof. W. P. Wynne, who occupied the Chair at an ordinary meeting held on Thursday, February 7, 1924, reminded Fellows that on February 28, at the Institution of Mechanical Engineers, Storey's Gate, S.W. 1, Prof. J. Joly would deliver the Hugo Müller Lecture, the subject being "The distribution of the radioactive elements in the rocks."

He further announced that the Bureau of Chemical Abstracts, in carrying out their policy of co-ordinating the production in this country of abstracts of papers in both pure and applied chemistry, had appointed Mr. T. F. Burton to be Chief Editor; abstracts in the various sections would also come under the review of Assistant Editors, as follows:—Dr. H. M. Dawson (General and Physical), Mr. A. A. Eldridge (Inorganic and Analytical), Mr. W. E. Garner (General and Physical), Mr. H. J. Page (Biochemistry), Dr. E. H. Rodd (Organic-aromatic), Mr. A. Shonk (Applied), Dr. E. E. Turner (Organic-heterocyclic), and Dr. H. Wren (Organic-aliphatic). Mr. Greenaway's unique experience would fortunately still be at the disposal of the Bureau.

The following paper was read by Mr. W. F. K. W. Jones:—

The activity of hydrogen ion in aqueous solutions of hydrofluoric acid. W. F. K. W. Jones and L. J. Hudleston.

THE e.m.f. of cells of the type H_2 | HF | KCl (sat) HgCl | Hg have been measured with concentrations of the acid ranging from 0·030 to 1·55 N. From these measurements, assuming that the potential at the liquid junction has been annulled by the saturated potassium chloride solution, the activity of the hydrogen ion of the acid has been calculated at these concentrations, and the results have been compared with the concentrations of the hydrion calculated by Davies and Hudleston from experiments on conductivity and transference number. The two sets of values agree within the limits of experimental error up to 0·4N solution, after which the activity is found to be materially higher than the concentration. The question as to whether the discrepancy is genuine, or due to a potential difference at the liquid junction is left open.

Mr. Jones agreed with Dr. Irvine Masson's suggestion that it might be possible for mercury to find its way to the electrode by diffusion through the platinum contact.

Dr. N. V. Sidgwick then dealt with the substance of two papers:—

The solubility of the aminophenols. N. V. Sidgwick and R. K. Callow.

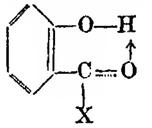
THE solubility-curves of the isomeric aminophenols in water, and in benzene, were determined, and their volatilities were compared. Only the *meta*- compound forms two layers with these solvents; with water, the two-liquid system is metastable, and lies 60° below the solid-liquid curve. The critical solution temperatures are: in water, *ortho*- (54°), *meta*- (1·9°), *para*- (25°); in benzene, *ortho*- (28°),

meta- (122·3°), *para-* (37°). Values in brackets are calculated from the slope of the solid–liquid curve. The volatilities are in the order $o > m > p$.

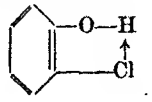
The aminophenols are abnormal, but their abnormality is not of the usual type; the *meta* compound is more soluble in water, and less soluble in benzene than would be expected.

Abnormal benzene derivatives. N. V. Sidgwick and R. K. Callow.

This paper summarises and discusses the results of a series of investigations on this subject (*T.*, 1915, **107**, 1202; 1920, **117**, 389, 396; 1921, **119**, 979, 1001, 1013; 1922, **121**, 1844, 1853, 2256, 2263, 2586; 1923, **123**, 2813, 2819; and the preceding paper). Abnormality (large differences between the isomerides in vapour pressure, and in solubility in the liquid state) requires: (1) that there should be two active substituents (such as Cl, NO_2, OH, etc.) on the nucleus; (2) that one of these should be: (*a*) OH; (*b*) NH_2 or substituted NH_2; or (*c*) CO_2H. The nature of the abnormality is different in cases (*a*), (*b*) and (*c*). With (*a*) the phenols, the *ortho*-compound is always more volatile, more soluble in benzene, and less soluble in water, than the *meta-* and *para-*, which resemble one another closely; that is, the *ortho* is far less polar (probably less associated). Comparison of the properties of normal and abnormal groups shows that the abnormality is mainly in the *ortho*-series. On combining these results with the cryoscopic work of Auwers (*Z. physikal. Chem.*, **18**, 595, **30**, 300, **42**, 513), it appears that the introduction of an active group into a phenol (1) in the *ortho*-position, makes it highly non-polar (2) in the *meta-* and *para-* makes it rather more polar, while (3) if it is introduced into the solvent, then in this solvent, the *para*-compounds appear to be less associated. All these facts can be explained by supposing that an active group is one which can co-ordinate with the hydroxyl hydrogen. (1) In the *ortho-* position it will form a stable ring of the types I (with NO_2, CHO, CO_2H, CO_2R, etc.), and II (with Cl, OCH_3, OH, etc.):



I



II

(2) In the *meta-* or *para-* positions it cannot do this, but will join to the hydroxyl of another molecule (though to a less extent) increasing the association or polarity of the phenol. (3) In the solvent it will co-ordinate with a *m-* or *p*-substituted solute, thus diminishing its association. This explains the non-polarity of the *ortho-* series, and the absence of compounds of *o*-nitrophenol with amines, as well as the fact that in an *o-p*-di-substituted phenol the influence of the *ortho-* substituent predominates. The behaviour of the acids and amines shows many differences from that of the phenols, and from one another which we cannot explain. The acids cannot form stable 5- and 6-ring compounds; the amines, though the formula admits of this, do not seem to co-ordinate in this way unless they are negatively substituted (chloro- and nitro-anilines).

Professor T. S. Moore referred to similar formulæ which had been put forward by Hantzsch, *e.g.*, in the case of ethyl sodioacetoacetate. Mr. W. E. Garner asked whether the differences in solubility extended to dinitro-compounds. Mr. H. Hunter enquired whether, in the case of the sodium salt of *o*-nitrophenol, where a colour change was observed, co-ordination ought not to occur even more strongly. With reference to the neutral character of the methyl group, Dr. J. Kenyon cited the reduction of one or other of the nitro-groups of 2:4-dinitrotoluene by different reducing agents, and asked whether the facts harmonised with the postulation of the *ortho*-compound being less polar. The President asked if the distance between the nitro- and the *p*-hydroxyl group was greater than the distance between two molecules.

Dr. Sidgwick, in reply, said that although Hantzsch had suggested similar ring formation, their view was that this should occur only in the *ortho*-series, whereas the chromoisomerism occurs also in the *meta-* and *para*-series. Internal salts, mentioned by Dr. P. May, could not be regarded as ring compounds, but as positive and negative ions forming part of the same molecule. According to the author's results, a dinitrobenzene (having no hydrogen atom in a side chain) should be normal. In the co-ordinated ring the hydrogen [or metal] is joined by non-polar links; if it is replaced by a metal, this may be ionised, destroying the ring and changing the colour. The difference in boiling point of 20° between *o-* and *p*-nitrotoluene suggested that there may be some co-ordination of the nitro-group to the hydrogen of the methyl group, which is known to be very mobile; this might explain the influence of the methyl group on the reducibility of the nitro-group. Dr. Sidgwick was unaware of any *X*-ray measurements of these substances, but it was assumed that the nitro-group of one molecule could get as near to the hydroxyl group of another as the OH- is to the NO_2- in o-nitrophenol.

Professor J. C. Philip discussed:—

The conductivity and ionisation of solutions of potassium iodide in nitromethane. By J. C. Philip and H. B. Oakley.

Much yet remains to be done in the investigation of the electrical properties of non-aqueous solutions. The present work is a study, for a given solute in a given solvent, of the bearing of the three factors—(*a*) temperature; (*b*) viscosity; (*c*) concentration—on conductivity and ionisation. The solutions examined were those of potassium iodide in nitromethane at dilutions up to V=10,000 and over the temperature range 0–85°. In work on the conductivity of non-aqueous solutions much uncertainty arises in connexion with the evaluation of Λ_∞ and large discrepancies exist between the figures reached by different investigators. One method of extrapolation much used hitherto is based on the cube root formula $\Lambda_\infty - \Lambda = a\sqrt[3]{c}$ (compare Philip and Courtman, *T.*, 1910, **97**, 1261), but the measure-

ments recorded in the present paper indicate that the linear relationship between the equivalent conductivity and the cube root of the concentration ceases to be valid at the highest dilutions. An attempt has accordingly been made to arrive at the value of Λ_∞ for the various temperatures by Washburn's method (*J. Amer. Chem. Soc.*, 1918, **40**, 122), which, as is well known, assumes the validity of the mass action law at extreme dilutions. From the values of Λ_∞ obtained in this way the values of α, the degree of ionisation, have been worked out for the concentrations employed at each of the experimental temperatures. It is found that α decreases markedly with rise of temperature. At the dilution $V=200$, for example, α diminishes from 0·82 at 0° to 0·76 at 85°. Measurements of the viscosity η of nitromethane were carried out at the same temperatures as those at which conductivity determinations were made, and it was found that the value of Λ_∞ increased with rising temperature in almost exact proportion to the fluidity. The value of the product $\Lambda_\infty \times \eta$ is 0·76 at 0° and 0·73 at 85°.

Mr. W. F. K. W. Jones said that in recent work on methyl alcohol, carried out under General Hartley's direction, the square root formula was found to hold; the cube root formula did not hold, and Washburn's formula gave different results.

Professor Philip said that the cube root formula was clearly useless for practical purposes; it was desirable to investigate the matter at higher dilutions. The correction for the conductivity of the solvent at the highest dilution employed was about 3·5 per cent.

Professor Philip also gave an account of work on :—

The solubility of anilinesulphonic acids. By J. C. Philip and R. S. Colborne.

THE aniline- or bromoanilinesulphonic acids are characterised by extreme readiness to separate from their aqueous solutions in unstable forms, which in some instances are sufficiently persistent to permit the determination of their solubility at a series of temperatures. The stability relationships of the various forms have been studied on these lines for aniline-*o*- and -*m*-sulphonic acids and *p*-bromoaniline- *o*- and -*m*-sulphonic acids, whilst a few observations have been made on the behaviour of the corresponding *p*-chloroanilinesulphonic acids. Perhaps the most interesting case under investigation is that of *p*-bromoaniline-*m*-sulphonic acid. When this compound separates from aqueous solution, either on cooling a solution saturated at a higher temperature, or by the addition of mineral acid to a solution of its sodium salt, it yields a felted mass of crystals of a labile monohydrate. When the separation is complete, the containing vessel can be inverted without loss of liquid. On standing, the more stable and therefore less soluble anhydrous acid gradually forms at a number of nuclear points, and the felted mass is ultimately replaced by a small quantity of compact crystals at the bottom of the vessel. The changes observed resemble those described by Chattaway for the production and transformation of the labile hexahydrate of calcium tartrate. This same acid in the anhydrous form is obtainable in two enantiotropic modifications—monoclinic and rhombic—although it is only above 100° that the rhombic variety is the stable one. For the whole range of temperature—up to 85°—over which determinations were made the rhombic form was found to be the more soluble.

Prof. C. S. Gibson mentioned that he had observed similar behaviour in the case of an organic substance in carbon tetrachloride solution.

Mr. R. S. Colborne said that the meta-derivative, as was observed by Dr. Sidgwick in other cases, most readily formed supersaturated solutions. It was possible that the extreme instability of the hydrates of the anilinesulphonic acids is connected with their amphoteric character, the hydrated forms being the "acid" type whilst the anhydrous acids possess an internal salt structure.

Dr. T. A. Henry described experiments on :—

Mercuration of nitrohydroxybenzaldehydes. By T. A. Henry and T. M. Sharp.

THE mercury derivative of *m*-hydroxybenzaldehyde previously described (*T.* 1922, **121**, 1056) is now shown to be 2-acetoxymercuri-3-hydroxybenzaldehyde

$$CH_3.CO.O.Hg.C_6H_3(OH).CHO.$$

The three nitrobenzaldehydes do not mercurate even on boiling in solution with mercuric acetate for three weeks. Under similar conditions 3-nitro-4-hydroxybenzaldehyde mercurates in position 5, as is shown by the conversion of the resulting mercury compound into 5-iodo-3-nitro-4-hydroxybenzaldehyde by the action of iodine. 6-Nitro-, 4-nitro-, and 2-nitro-3-hydroxybenzaldehydes all yield both mono- and di- mercurated compounds, which can be separated by fractional crystallisation from appropriate fatty acids, the only media in which they are conveniently soluble. They react with iodine in potassium iodide, forming iodo-compounds in which iodine has replaced mercury residues in the normal fashion. Bromine, on the contrary, shows abnormal behaviour with them. Thus whilst 2:4-dihydroxydimercuri-6-nitro-3-hydroxybenzaldehyde yields the expected 2:4-dibromo-6-nitro-3-hydroxybenzaldehyde, the latter is also formed in yields of over 80% by the action of bromine on the dimercurated derivatives of the 4-nitro- and 2-nitro-3-hydroxybenzaldehydes. Of the possible explanations of these latter results: (1) that the starting materials were impure; (2) that the original compounds are not correctly represented by the formulæ assigned to them; or (3) that a re-arrangement of groups within the molecule takes place, involving the migration of a nitro-group from an *ortho-* to a *para-* position with respect to the hydroxyl group, the third is shown to be the only one tenable. Results of bactericidal trials with the mercury compounds are summarised.

Mr. T. M. Sharp gave some additional details regarding the evidence on which the conclusion that migration occurs was based.

ROYAL MICROSCOPICAL SOCIETY

Sir Robert A. Hadfield, Bart., F.R.S., presided at a meeting of the Industrial Applications Section on January 23, and, in the course of his address, gave the Society a cordial invitation to visit the laboratory at his works in Sheffield. It was largely through the efforts of the microscopist, he said, that they had been able to fathom, at any rate to some better extent than previously, the mysteries of the many combinations or compounds formed in alloys of iron with other elements. He believed this country would continue to hold its own in this branch of science, provided the same energy was displayed as during and since the war. He hoped that the Society would extend its influence in the various districts where the study of metallurgy was so necessary. One point which had very much interested him with regard to the microstructure of steel was a fuller and more careful study of the effects produced on the physical properties of various kinds of steel by what might be termed "cold treatments" in contradistinction with "heat treatments," but which did not bring chemical action into play. A comparatively new competitor was coming into the field which in one sense might be thought to supplant the work of the microscopist and the metallographer. He referred to X-ray analysis of metals. But there was still ample room in these branches of research for further and supplementary work. It was impossible to prophesy the extent to which X-rays would be used in the future, but a great advance in research was inevitable.

Captain J. W. Bampfylde, A.R.S.M., F.R.P.S., read a communication on "Some Failures in Steel as Revealed by the Microscope and Recorded by Photography." The main lines of research employed in the investigation of failures in steel were chemical analysis, physical tests, macroscopical and microscopical examinations. The object of the communication was to show that the last two named were most important factors in such examinations, and that much evidence might be brought to light by using the microscope, the attainment of which might otherwise be almost impossible. On account of the fact that macroscopical and microscopical work were so closely interwoven, a few of the methods employed in the former were briefly described. Three cases of failure in railway material were dealt with and the manner in which their causes were investigated by the above methods were described. In conclusion, a new form of metallurgical objective in which oblique light from all sides was employed was discussed. This was made possible oven with high-power objectives such as the 2 mm. oil-immersion. Photomicrographs taken with these objectives were shown.

Mr. H. B. Milner, M.A., A.M.I.P.T., read a paper on "The Use of the Microscope in the Petroleum Industry." The wonderful strides made in the evolution of the petroleum industry had provided one of the most fascinating romances of modern commerce, particularly if the position to-day was compared with that of, say, fifteen years ago. To a large extent this rapid progress had been the result of development in the technique of production and refining, and in both branches microscopy had played an important part. Production implied, apart from drilling and engineering operations on an oilfield, all the geological work essential to the exploration and location of oil-bearing territory and had come to be more and more dependent on the precise methods of micropalaeontology and micropetrology, especially the latter. Similarly the microscopical investigation of impregnated (bitumenised) rocks was of great practical importance. On the refining side the microscope was being employed in a number of specialised operations including those concerned with decolorisation of oil and the use of certain filters such as fuller's earth, "floridin," charcoal and bauxite, whilst a study of oil-films and oil-blending was greatly facilitated by the microscope. Lubricants and greases, including graphite lubrication, presented a variety of practical problems of both manufacture and use, *e.g.*, in connexion with fibre and other "loaded" greases; these were more readily solved by means of the microscope than in any other way, as was the case with problems arising from the production of other impregnated textile materials used for roofing, insulation and sheathing purposes. Asphaltic rubber and asphaltic cement were two further commodities whose manufacture and use gave rise to difficulties often met satisfactorily by microscopical enquiry.

THE SIR JOHN CASS TECHNICAL INSTITUTE

The Annual Distribution of Prizes at the Sir John Cass Technical Institute was held on January 30, 1924, when the prizes and certificates were distributed by Sir W. H. Bragg, K.B.E., F.R.S., Director of the Royal Institution.

The Chairman of the Governing Body, the Rev. J. F. Marr, M.A., in giving a summary of the work of the Institute, stated that an outstanding characteristic of the past session had been the earnestness of the students and the regularity of their attendance. The work done had undoubtedly been of great value to the students, and through them to the industries with which they were associated. Altogether, 41 students had been successful at the examinations of London University, five having obtained the degree of M.Sc. by research carried out at the Institute. Twenty-two students had been engaged in research work during the session and 17 original investigations had been published, bringing the total number of papers issued from the Institute to 137.

Following the distribution of the awards, Sir William Bragg delivered an address on "Research Work and Its Applications." The address was devoted particularly to the nature and objects of research. Emphasis was laid on the new era of research work marked by munificent gifts such as those of Sir Alfred Yarrow to the Royal Society, of the Rockefeller Trustees to University College, and by the stimulus given by the Department of Scientific and Industrial Research. Research work, it was pointed out, brought out self-reliance, the faculty of

selection and judgment of evidence, and developed a sound study of previous investigations. The valuable faculty of selection was one of the most important lessons to be learnt in connexion with research. A good research student was likened to a fire which, on a match being put to it burned without being touched again. The research worker should never try to convince others of the value of his work, but leave them to discover this themselves. Those who devoted their time to research were always hoping to add something to human knowledge and to human interest. It was our duty and our gain always to explore and the spirit of research therefore was something which we should try to foster and incorporate in the nation's life. Concluding, Sir William Bragg said that research was not a religion, but the act of one. It implied a certain faith in the beauty and the purpose of the Universe; that whatever there is in the world was really meant for us to see if only we can see it.

BIRMINGHAM UNIVERSITY CHEMICAL SOCIETY

"The Chemistry of the Photographic Plate" was the subject of the Presidential Address delivered by Prof. G. T. Morgan, F.R.S., on January 21. There was a large attendance of graduates, research workers and science students. In an historical introduction to the photochemistry of silver salts, Prof. Morgan referred to the early experiments made by Fabricius (1556), Scheele (1777), and by Wedgwood and Davy on the action of light on the silver halides (1800–1802). The production of a permanent picture was achieved by J. N. Nièpce (1813), who noticed that light rendered insoluble the bitumen of Judea, whereas the unexposed portion was removed by organic solvents. Daguerre (1835) introduced the method which still bears his name, Daguerrotype. This now obsolete process, which was practised for nearly twenty years, resembled the modern processes in being dependent on the formation of a latent image, which, in this case, was developed by mercury. The discoveries by Talbot and Herschel (1839) led to the improved Calotype or Talbotype process (1841), a procedure which involved the use of sensitisers and developers. Herschel's contributions were of fundamental importance, and included the employment of hyposulphite (thiosulphate) for fixing, and the discovery of the blue print and platinotype processes. The wet-plate collodion process discovered by Scott Archer (1851) had a considerable vogue until superseded by the dry plate or emulsion process introduced by Maddox (1871) and improved by Wratten (1876). The action of light on the silver halides was discussed with special reference to current hypotheses concerning the nature of the latent image. A practical demonstration was given of the chemical changes involved in the use of sensitisers and developers. Reference was made to the chemical constitution of organic developers and of the synthetic dyes employed in the production of panchromatic plates. The chemical processes involved in fixing, intensifying, printing and toning were also explained by means of specially-devised experiments carried out by Mr. C. P. Proctor. The more modern applications of the platinotype and carbon printing processes were reviewed, and the address concluded with a brief reference to colour photography.

SOCIETY OF PUBLIC ANALYSTS

The Annual General Meeting was held at the Chemical Society's Rooms, Burlington House, on February 6, when the president, Mr. P. A. Ellis Richards, delivered his annual address. The following were elected as Officers and Council for the ensuing year:—*President:* G. Rudd Thompson. *Past-Presidents* (Serving on the Council): Leonard Archbutt, A. Chaston Chapman, Bernard Dyer, Otto Hehner, P. A. Ellis Richards, Alfred Smetham, E. W. Voelcker, and J. Augustus Voelcker. *Vice-Presidents:* S. F. Burford, F. H. Carr, and A. More. *Hon. Treasurer:* Edward Hinks. *Hon. Secretary:* E. Richards Bolton. *Assist. Hon. Sec.:* R. G. Pelly. *Other Members of Council:* F. W. F. Arnaud. H. Ballantyne, E. T. Brewis, R. T. Colgate, R. L. Collett, J. C. Drummond, S. Elliott, E. M. Hawkins, H. F. E. Hulton, A. E. Parkes, A. R. Tankard, and J. F. Tocher.

Mr. C. Ainsworth Mitchell, M.A., then read a paper on "Osmium Tetroxide as a Reagent for the Estimation of Tannins and their Derivatives." Osmium tetroxide (the osmic acid of the microscopists) can be used as a sensitive reagent for tannins and their derivatives, being capable of detecting, *e.g.*, 1 part of gallic acid in 3,000,000. The coloration ranges from red-violet in dilute solutions to violet-black in concentrated solutions. Unlike the author's ferrous tartrate reagent, osmium tetroxide gives similar colorations with both the pyrogallol and catechol tannins. For quantitative work the ordinary 1 per cent. microscopic stain is diluted with 10 parts of water and a solution of 0·1 g. of pure pyrogallol, catechol, or gallic acid is used as the standard. The colorations produced by catechol and pyrogallol are relatively proportional to their molecular weights and the same relationship applies to the colorations given by protocatechuic acid and catechol, but gallic acid gives a relatively more intense coloration than pyrogallol. The method affords a convenient means of estimating the pyrogallol and catechol tannins together, in terms of catechol, pyrogallol, or gallic acid, and it has been applied to the analysis of various products such as extracts of wood, commercial saw-dust intended for curing fish, coffee, and hops.

Apparatus for fat extraction and solvent recovery was demonstrated by Mr. S. A. de Lacy, A.I.C. The apparatus consists of an extraction vessel with a three-holed stopper, one hole for the special key device, one for the attached condenser, and one for the tube to lead away the vapours of distilled solvent. The material to be extracted is suspended in a container supported in the extraction vessel, and the key device can be operated from the outside to close either the opening to the condenser or to the side tube, in turn. This device is essentially a thick circular rod attached to an oval platform with a drip point projecting from the lower surface.

ACADÉMIE DES SCIENCES

On January 21, Prof. Le Chatelier presented a paper by Monsieur Le Beau on the distillation of coal. Previously Monsieur Le Beau had shown that when distilling anthracite a large quantity of hydrogen was given off. The present work related to gas coals containing from 30 to 35 per cent. of volatile matter. By carefully fractionating the distillate he has found that hydrogen and the higher homologues of methane are of more importance as constituents of gas than was thought. Thus, the higher homologues of methane may be present to the extent of 10 per cent. These differences were ascribed to the fact that formerly all the compounds of the saturated series were generally estimated as methane, which was thus given too much importance.

Monsieur C. H. Lallemand presented a note by Monsieur Bochet who attempted to show that the theoretical argument which led Van der Waals to enunciate the law of "The Corresponding States of Fluid," lacked a sound basis. Bochet claims that by comparing the properties of water and of carbonic acid differences are found which are incompatible with the truth of the law.

During the meeting on January 28, Monsieur Béhal communicated the results of a study by Monsieur Freundler, on "The Iodine Content of Algæ," a study not merely of theoretical interest, but which may lead to an increase in the production of iodine. When estimating the iodine in *Laminaria* by various methods, Monsieur Freundler found that the element was present in greater amount when the algæ had been kept in the dark, or immersed in a saline solution. By combining these two factors the yield of iodine was almost doubled. Monsieur Gentil gave some new information on the magnetic anomalies observed by Prof. Lazarev in the Koursh region of Russia.

SOCIÉTÉ DE CHIMIE INDUSTRIELLE

On January 30, the Metallurgical and Mineral Industry Group heard, under the chairmanship of Mr. Gall, a paper by Mr. Boutigny on "Aluminothermy." After discussing the important part played by electric energy in the heavy chemical industry, Mr. Gall showed how the electrolytic soda process had become the necessary ally of the ammonia process in order to compete with the Leblanc process, which consumed so much coal. He then discussed aluminothermy and pointed out how great a heat arose from the combustion of aluminium, owing to its great affinity for oxygen. Under certain thermo-electric conditions aluminium would reduce metallic oxides to form alumina, freeing the metal and liberating a great amount of heat in yields sufficient for industrial purposes. The state of division of the mixture of met[illegible] oxide and aluminium powder was an imp[illegible]tor, which might increase or moderate the [illegible] of the reaction. In practice the state of divis[illegible] was designed to enable the operation to be carried out with safety. The most important reaction was that of iron oxide $F_2O_3+Al_2=Fe_2+Al_2O_3+182$ calories, a reaction which found numerous applications in welding. Other reactions of less industrial importance were not without interest and found application in metallurgy when metals free from carbon were necessary. In this field aluminothermy competed with the electric furnace, and the special steels containing chromium, nickel and titanium were the proof. An interesting field of research lay open for aluminothermy, a field first discovered by Moissan and realised by Goldschmidt.

THE BRITISH SCHOOL OF MALTING AND BREWING

The annual dinner of this School was held on February 9, at the Midland Hotel, Birmingham. The company included about forty. Professor Arthur R. Ling occupied the chair.

The usual loyal toasts having been duly honoured, Mr. Walter Scott proposed the chairman and the Brewing School. In the course of a humorous speech he said that his toast could be divided into two parts, the animate and the inanimate. He referred to the falling off in the numbers attending the dinner and suggested that the company should consider what steps could be taken to revive its interest. Professor Ling said that it was to be regretted that neither Mr. Butler, Mr. Field (the External Examiner) or any other member of the board of management was present. He was pleased to say that the School was progressing favourably and that a comparatively large amount of research work was being turned out. During the past session there had been published from the department ten papers. They had to thank Mr. H. E. Field for presenting the School with a potentiometer, whereby the concentration of hydrogen ions could be measured. This was one of the factors which would probably be found of great utility in the future in deciding the stability of beer.

Mr. F. J. Paton, one of the honorary secretaries, in proposing the past students, said that he welcomed the past students to the dinner as it was essential that the Brewing School as a whole should be able to meet together. All its students had a common tradition and this constituted a strong tie between the past and present students. Mr. W. E. Showell replied.

The toast of the present students was given by Mr. F. A. Smith and replied to by Mr. W. S. Shaw in the absence of one of the honorary secretaries, Mr. S. N. Yeomans.

The Chairman then proposed a vote of thanks to the honorary secretaries for organising the dinner.

After the dinner the company became an informal committee, and the question was discussed as to what steps should be taken to induce a larger number of past students to attend the dinner. Among other things the point was raised as to whether it would be preferable to hold the dinner in London instead of in Birmingham and ultimately it was decided, at any rate for the next year, to continue to hold the dinner in Birmingham. A large committee, representative of past students in various districts, was then formed, Mr. S. Raine being appointed secretary.

CORRESPONDENCE

ADVANCE PROOFS OF PAPERS

SIR,—The provision of advance proofs of Prof. Hinchley's paper on Monday last rendered an excellent address even more valuable and gave opportunities for a useful discussion, which would otherwise have been lacking, and I am sure that practically all the members of our Society will agree with me that the provision of advance proofs of papers is much to be desired.

I quite realise that this is impossible in all cases, but I suggest the following idea for the favourable consideration of the Council. Whenever the author of a paper to be read before any section of the Society considers his communication of sufficient importance, he should submit the manuscript to his local committee in sufficient time to allow their acceptance of it, and also of its acceptance by the Publication Committee and the Editor. If accepted for publication it could be set up at once and a sufficient number of galley proofs provided at comparatively little extra cost, and these should be available on request by any member desiring them.

I would further suggest that the discussion of papers should not be confined to the occasion on which it is read, but continued by both oral and written contributions at subsequent meetings of the Section. This would, I am sure, lead to a much better discussion, and would bring to our notice many points otherwise omitted. To complete the scheme it would, of course, be necessary that the discussion, if bearing on the subject, should be published in full. In your interesting paragraph in the last issue you rightly say that the reading of papers to one another can be overdone. It both can and is, but good discussions or debates on useful and interesting subjects can only be productive of good, both to the debaters and listeners.

I trust, Sir, that some way may be found to ventilate this idea, and, if possible, to adopt it with such modifications as the Council, in its wisdom, may consider advisable.—I am, Sir, etc.,

W. H. COLEMAN

Chemical Industry Club,
2, Whitehall Court, S.W. 1
February 5, 1924

PERSONAL AND OTHER NOTES

Prof. J. Joly will deliver the Hugo Müller lecture of the Chemical Society on February 28, at 8 p.m., in the Hall of the Institution of Mechanical Engineers, Storey's Gate, S.W. 1.

The jubilee of the Physical Society of London is, states *Nature*, to be celebrated from March 20 to 22, March 21 being the fiftieth anniversary of the meeting of the Society.

Prof. G. H. Hardy has been elected president of the National Union of Scientific Workers for the year 1924, and Dr. J. W. Evans has been elected president of the Research Council.

Amongst Mr. Baldwin's resignation honours mention may be made of the baronetcies conferred on Sir O. Beit, for services rendered to the Imperial College of Science and Technology, and on Mr. W. H. Barber, a generous benefactor to the University of Birmingham.

At a meeting of the Faraday Society to be held in the Rooms of the Chemical Society on February 18, at 8 p.m., Principal A. P. Laurie will put forward some suggestions for a magnetic theory of valency based on the model of an atom which he has recently devised. The lecture will be illustrated by lantern slides.

Monsieur R. P. Duchemin, who was recently appointed an officer of the Legion of Honour, has been elected president of the Union des Industries Chimiques. Other officers of the Union are MM. Michel, Roche, Lheure, and Bezançon, vice-presidents; M. Langois, treasurer; M. Saunier, assistant treasurer; MM. Agashe, Guieu, Le Play, Thesmar, secretaries; MM. Poulenc, Huillard, Etienne, Binoche, Bisset and Herr, members of council.

* * *

From Paris the deaths are announced of Monsieur G. Dumont, a past president of the Société des Ingenieurs Civils, and Monsieur Lavaurs, formerly managing director of the Cie. des Mines de Courrières.

Prof. George Quincke, described as the nestor of German physicists, and professor of physics at Heidelberg until 1907, has died at the age of ninety. Other deaths from Germany include the names of Prof. E. Dieckhoff, director of the Qualitative and Pharmaceutical Division of the Chemical Institute of Karlsruhr; Th. Melzbach, director of the paper factory of that name; and Dr. L. Schroeder, director of the Accumulatorenfabrik A.-G.

Dr. Julius Szilagyi, professor at the Budapest Technical Hochschule, who died recently at the age of sixty-four, had done valuable work on the scientific control of the alcohol industry.

SOUTH AFRICA

Discovery of Platinum in the Waterberg District

The recent discovery of platinum in lode form in the Waterberg District of the Transvaal has aroused a good deal of interest on account of the unique nature of the find, and the great economic possibilities of it to the Union.

To date, 99 per cent. of the world's output of the platinum metals has been recovered from alluvial placers, the principal deposits being in the Central Urals in Russia, where the pre-eminent matrix of the platinum is dunite, an ultrabasic rock consisting essentially of olivine and chromite. The minor deposits of platinum metals in the other parts of the world are almost wholly in rocks of a basic or ultrabasic type, or in placers derived from the weathering of such rocks. It is interesting to note that there appears to be a distinct relationship between platinum and nickel or chromite, and that in the smelting of the nickel-copper ores of Sudbury the matte in 1916 (80,000 tons) contained 50,000 oz. of platinum and palladium. One of the smelting companies states

however, that the recovery of platinum metals was only 8 per cent. of the total contained in the matte. In Southern Africa the occurrence of platinum metals (apart from the osmiridium in the Rand banket) has been noted in a dyke of norite in the Gwelo District of Rhodesia and in the Somabula (Rhodesia) diamond-bearing gravels. In the Cape Province, platinum is known to exist in the copper-nickel ores of the Insizwa Range. In the Transvaal, chromite ores in Rustenburg and Lydenburg contain traces of platinum, and its presence has also been known in the norites of the Northern Transvaal.

Platinum in vein material of an acid type has been recorded at a few isolated places only, but except for one occurrence in Nevada, these finds were of very small extent, and only of academic interest. It is evident that the recent discovery in the Transvaal of platinum in a quartz lode in acid country rock extending over a considerable distance is quite unique. The lode is in the Waterberg District, about 100 to 110 miles north of Pretoria, and consists of a brecciated quartz filling with angular inclusions of felsite. Up to the present no particular type of lode matter has been found to carry platinoid values. The lode itself varies in width from one to 30 feet. Active prospecting in two areas showed platinum in the outcrop. At "Doornhoek" the lode was found to be 30 feet wide, but the values so far have been very low. At "Rietfontein," however, where the lode can be traced continuously for 3000 yards, the outcrop has been trenched and partly stripped for a distance of about 400 yards along the strike, the average content of platinum metals being 23·3 dwts. over 54 in. in width. The platinum in the ore is generally very fine, though nuggety pieces are seen. —(*J. Chem. Met. and Min. Soc. S. Africa, Sept.*, 1923.)

GENERAL

The Mass-Spectrum of Indium

In a letter to *Nature* of February 9, Dr. F. W. Aston states that he has examined the mass rays of indium (at No. 49, At. Wt. 114·8), using an anode containing the fluoride, and found that the mass-spectrum of the element showed only one line at 115. This, measured against I^{127} and Cs^{133} showed no deviation from the whole-number rule. Its intensity was insufficient to rule out the possibility of a small percentage of a second isotope, but, in the absence of evidence on this point, Dr. Aston considers that indium is best regarded as a simple element of mass number 115, as predicted by Russell. This, states Dr. Aston, was "the only success worth recording," owing partly to the capricious behaviour of the apparatus for producing accelerated cathode rays, and partly to the unfavourable properties of the elements remaining to be analysed.

Metallurgy in Luxemburg

The production of iron and steel in Luxemburg has risen from 1,685,700 tons, and 1,394,103 t., respectively, in 1922, to 1,406,666 t. and 1,197,739 t., in 1923. By far the larger proportion is produced by the Thomas process, Martin steel and electric steel being still limited in quantity.

REVIEW

INDUSTRIAL ALCOHOL. *By* J. G. MCINTOSH. *Second edition, revised and enlarged. By* H. B. STOCKS, F.I.C. *Pp.* xii+400. *London: Scott, Greenwood and Son,* 1923. *Price* 12*s.* 6*d. net.*

The first edition of this book appeared in 1907, and the present volume is practically the same book, with the addition of three short chapters dealing with alternative sources of alcohol which have been opened up in recent years, together with various other additions, but few corrections. The reviser would have been well advised to rewrite entirely the older portions of the book. However accurately it may have represented Continental distillery practice of thirty or forty years ago, it is now so out of date as to be of little more than historical interest. In the sections dealing with the fermentation of beets, grain, molasses, wine, etc., and the distillation and rectification of alcohol, many passages bear evidence of literal translation from standard French works of the latter part of last century, and the frequent occurrence of such terms as "phlegm," "retrogradation," "leaven," to say nothing of "sodic ethylate," "oenanthic vapours," etc., emphasises the archaic character of the work. Few of the alcohol lighting and heating appliances figured in Chapter XIV are now to be found outside museums, and the statistics relating to the production of alcohol are, with few exceptions, carried no further than 1912. The language of the author is often obscure, and in places quaint. We read "There are three principal classes of substances in phlegm . . . All other kinds are bastard lots"; and on page 60 we learn the function of the "unique mother vat" in continuous fermentation.

Apart from the shortcomings of the older portion of the book, the reviser's additions are not free from serious omissions. No reference is made to Ricardo's important work on the use of alcohol in the internal-combustion engine, nor is mention made of the Power Methylated Spirits Regulations of 1921, under which alcohol is now being denatured and used for motor transport in this country. The synthesis of alcohol from acetylene, which attained considerable importance during the war, and which is being further developed on the Continent, is given less than 20 lines, with no indication of the nature of the chemical reactions involved. The "amylo" process, one of the most important developments of recent years, is referred to in only 7 lines. The theory of fermentation is confined to a short statement of Harden and Young's hexose-phosphate equation of 1910, but perhaps a fuller treatment of this subject is hardly to be expected in a work on industrial alcohol.

With all its faults the book is undoubtedly valuable, as giving a detailed account of the development of French distillery practice. The controversies which arose between Barbet and Guillaume as to methods of distillation and rectification are fully discussed, and the practical man cannot fail to find useful information in a book which deals exhaustively with the pioneer work of the older French distillers.

G. W. MONIER-WILLIAMS

REPORTS

REPORT ON THE ECONOMIC AND COMMERCIAL CONDITIONS IN THE DOMINION OF NEW ZEALAND, DATED JULY, 1923. *By* N. ELMSLEY, *Trade Commissioner, New Zealand. Department of Overseas Trade. Pp.* 60. *H.M. Stationery Office,* 1923. *Price* 2*s.*

The year now under review was one of recovery from the post-war depression. The trade returns in the last few years give little idea of the actual state of the country, but 1922 showed a more favourable trade balance than the previous year, while imports increased steadily consequent on the reduction of stocks accumulated in 1920.

During 1922-23 the wool industry recovered from the previous two bad seasons. In 1922, 914,094 bales, valued at £11,883,463, was exported. Most of this export took place before the rise in prices, so the figures do not indicate rightly the great improvement which took place during the year over the position in 1921, when 452,231 bales, valued at £5,221,479, was exported. Dairy produce is an important item of export. In 1922, 1,120,200 cwt. of butter and 1,161,196 cwt. of cheese were exported, valued at £9,041,554 and £4,686,850 respectively.

Imports in 1922 were valued at £35,012,561, and exports at £42,726,249. Pastoral industries are responsible for an overwhelming majority of the exports. Of the imports the United Kingdom supplied 52·25 per cent. in 1922, against 48·5 per cent. in 1921. The Dominion is now importing on the same scale as in 1914, and the United Kingdom is supplying about the same proportion as then, though there are still some articles which could be imported more largely from Britain; the increase customs preference accorded to British goods since the end of 1921 has no doubt helped greatly to bring about the recent increase in the proportion of these in the total imports. The items of import in 1922 included manufactured goods of animal origin, £41,641; oils, fats and waxes, £2,324,333; paints and varnishes, £370,552; stones and industrial minerals, £716,726; unmanufactured metals and ores, £331,577; manufactured metals, £4,249,178; machinery, £2,769,325; leather and substitutes, £475,385; earthenware, china and glass, £716,182; drugs and chemicals, £1,098,024; manures, £248,572.

REPORT ON THE ECONOMIC AND COMMERCIAL SITUATION OF AUSTRALIA, DATED JUNE, 1923. *By* S. W. B. MCGREGOR, *Senior Trade Commissioner of Australia. Department of Overseas Trade. Pp.* 83. *H.M. Stationery Office,* 1923. *Price* 2*s.* 6*d.*

The year under review was again one of great prosperity (*cf. Chem. and Ind.*, 1923, 107), and Australia seems to have suffered less than any other country from the war. The position of wool continues good, but wheat prices are down, and the reduction in the value of wheat exports led to an adverse trade balance. Cotton-growing is assuming some importance. The following quantities of metals were exported during 1922: silver, 11,746,295 oz. fine; lead, 130,187 t.; zinc, 159,414 t.; copper, 11,850 t.; tin, 2657 t.; pig iron, 83,533 t.; whilst £3,507,119 was realised from the sale of gold in 1922. Prospecting for oil has been continued, but at present the only useful sources of oil are shale beds, which are worked to some extent.

In the financial year 1922-23 imports amounted to £131,808,673 and exports to £117,913,083, giving an unfavourable balance as mentioned above. In 1921-22 the corresponding figures were £103,066,436 and £127,846,535. Of the imports in the latter period the United Kingdom supplied 51 per cent. and the United States 18 per cent. Some particulars are given of imports in 1923, with reference to home resources. The existing cement works in Australia are more than capable of supplying the demand but 44,969 t. was imported. About 90 per cent. of the cinematograph films imported, which were valued at £289,244, came from the United States. The figures for chemicals, drugs, etc., are for 1921-22, when the value of such imports was £3,553,377. Items of interest were tartaric acid, £29,354, and cream of tartar, mainly derived from the United Kingdom. Synthetic dyes were valued at £162,498, proprietary medicines, etc., at £513,000, perfumery and toilet preparations at £278,000. Imports of explosives in 1922-23 were valued at £202,758; some explosives are made in Australia.

Of the exports from Australia in 1921-22 the United Kingdom took 45·2 per cent., and other British countries 17·1 per cent.; both figures are somewhat less than in the previous year but more than before the war.

Although protected by heavy tariffs Australian manufacturing industries are making little headway. The reasons are the small home market and high costs of production and distribution which render export impossible.

Some account is given of the development for production of electric power of brown coal deposits in Victoria; 10 acres of brown coal have been exposed, and the main power-house is nearly completed. Hydro-electric development is going on in Tasmania and 63,000 h.p. is now available.

REPORT OF THE FOOD INVESTIGATION BOARD. *Department of Scientific and Industrial Research. Pp.* 60. *H. M. Stationery Office,* 1923. *Price* 1*s.* 6*d.*

The outstanding event of the year recorded in the report of the Food Investigation Board is the equipment of the Low-Temperature Research Station at Cambridge, at which work has already begun. It is interesting to note that the station intends to aim at an accuracy in its work comparable even with that of the National Physical Laboratory. Already the station has been used for the determination of the effect of cold on insulin and an account is given in the report of a promising development of the theory of the freezing of tissues. Work has also been carried out under the Board on the storage of apples, the preservation of fish, the chemical changes in meat during cold storage, and the chemistry of the ripening of fruit.

During investigation of "gas storage" the Fruit and Vegetables Committee found that the carbon dioxide used leaked at an unexpectedly high rate through the walls of the store, and experiments are in course at the National Physical Laboratory on coating materials to prevent this loss. The work on carbohydrate and nitrogenous autolysis of cold-stored meat is far enough advanced to show that, even at cold-storage temperatures, the glycogen content diminishes, the change being complete and comparatively rapid at high temperatures. Miss D. M. Moyle has worked out a method for estimating small quantities of succinic acid in muscle and Miss D. L. Foster has investigated methods for estimating glycogen. The production of brown methæmoglobin in frozen meat has been studied and the attempt is being made to correlate the chemical changes taking place in meat extract with the various phases in the growth of a single species of bacterium, viz., *Staphylococcus aureus*. Work done under the Engineering Committee includes research on the "time-lag" of thermometers, the absorption of moisture by insulating materials, the thermal and corrosive properties of ethyl chloride, and hygrometry. The investigation (under the Oils and Fats Committee) of the products of the hydrolysis of fats has been continued under the supervision of Principal J. C. Irvine, using a fat consisting essentially of tristearin, and various methyl ethers of glycerol have been prepared for reference, particularly trimethylglycerol, β-dimethylglycerol and $\alpha\gamma$-dimethyl glycerol. At Manchester, oleic acid and the synthesis of the higher unsaturated acids have been investigated. The formation of fat by yeasts is still being studied at the Lister Institute, interesting results having been obtained. Much time has been devoted, under the Canned Foods Committee, to the improvement of methods, *e.g.*, for distinguishing between primary, secondary and tertiary amines, and for estimating inorganic phosphate in the presence of organic matter.

COMPANY NEWS

SOUTH METROPOLITAN GAS CO.

The revenue account for the year 1923 shows a credit balance of £530,699, against £741,903 for 1922, and the balance brought forward was £234,986. Debenture interest and other fixed charges being met, the dividend of 5 per cent. has been paid on the preference stock, and the dividend for the year on the ordinary stock is 5¾ per cent. (against 5¼ per cent.). An allocation of £16,500 is to be made to the reserve fund (against nil), and the balance to be carried forward is to be increased by £1[illegible] to £254,510. The capital liability of the undertaking has been reduced during the year by the redemption of £147,420 five per cent. preference stock, issued in 1917. The balance of this stock will be redeemed in December next. The directors report an increase in the number of gas consumers, and in appliances used by them. The total receipts for the year amounted to £4,542,497 (against £4,891,620).

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

The market shows signs of confidence and business seems to be settling down on a satisfactory scale in spite of the depressed state of the textile trade and unsettled labour conditions. There are no changes of price to be noted in any of the standard lines but in articles which are imported from the Continent values are continuing to rise. Formic acid is in better supply, the home-produced material being now available.

Acetic Acid, 40% tech.	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages included.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5½d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports. Business good.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid. In fair request.
Sod. Bisulphite Powder 60/62%	£19—£20 10s. per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb. Very quiet.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included

RUBBER CHEMICALS

The demand for rubber chemicals remains somewhat slow.

Antimony sulphide	Expected to advance in sympathy with the crude metal.
Golden	5½d.—1s. 3d. per lb., according to quality.

Antimony Sulphide, [illegible]—
Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow 1s. 11d. per lb.
Cadmium Sulphide .. 4s. per lb.
Carbon Bisulphide .. £24—£26 10s. per ton according to quantity.
Carbon Black .. .. Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.
Carbon Tetrachloride .. £55 per ton, drums free.
Chromium Oxide .. 1s. 3d. per lb.
Indiarubber Substitutes,
White and Dark .. 4d.—6½d. per lb. Fair demand
Lamp Black .. .. 40s. per cwt., barrels free.
Lead Hyposulphite .. 7½d. per lb.
Lithopone .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. £15 10s. per ton f.o.r. London.
Sulphur .. .. £10—£12 per ton, according to quality.
Thiocarbanilide .. .. 2s. 9d. per lb.
Vermilion, pale or deep .. 3s. 4d.—3s. 6d. per lb.
Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade and there appears a more healthy prospect in the charcoal market.

Acetate of Lime—
Brown .. .. .. £14 10s. per ton d/d. Demand active.
Grey .. .. .. £22 per ton.
Liquor .. .. .. 9d. per gall. 32° Tw.
Charcoal .. .. .. £7 5s.—£9 per ton, according to grade and locality. Market quiet.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. „ „ 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 7d. per gall. Unrefined.
Wood Naphtha—
Miscible .. .. 5s. 6d. per gall. 60% O.P. Dull market.
Solvent .. .. 5s. 6d. per gall. 40% O.P. Dull market.
Wood Tar .. .. £5—£6 per ton according to grade. Demand not very brisk. Ample supplies.
Brown Sugar of Lead .. £42 per ton. Demand more active.

TAR PRODUCTS

Acid Carbolic—
Crystals .. .. 8½d. per lb. Some business passing at lower prices.
Crude 60's .. .. 1s. 10d.—2s. per gall. Little business passing, but more inquiry.
Acid Cresylic, 97/99 .. 2s.—2s. 3d. per gall. Steady business.
Pale 95% .. .. 1s. 10d.—2s. 2d. per gall. Good demand.
Dark .. .. .. 1s. 11d. per gall. Steady business.
Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—
Strained .. .. 9d.—10d. per gall. Very quiet.
Unstrained .. .. 8½d.—9d. per gall.
Benzole—
Crude 65's .. .. 10½d.—1s. per gall. ex works in tank wagons.
Standard Motor .. .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure .. .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% .. .. 1s. 4½d.—1s. 7d. per gall.
Pure .. .. 1s. 8d.—1s. 10d. per gall.
Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 11½d. per gall. Few inquiries.
Middle Oil .. .. }
Heavy .. .. .. } 8½d.—9½d. per gall. according to grade and district. Market very firm. Demand good.
Standard Specification }
Naphtha—
Solvent 90/160 .. 1s. 1d.—1s. 2d. per gall. } fair
Solvent 90/190 .. 1s. 1d.—1s. 3d. per gall. } business.
Naphthalene Crude—
Drained Creosote Salts £7 10s.—£8 per ton. Demand maintained.
Whizzed or hot pressed £10—£14 per ton. Price nominal. No business.
Naphthalene—
Crystals .. .. £18 per ton.
Flaked .. .. .. £18 per ton.
Pitch, medium soft .. 57s. 6d.—60s. per ton. Market weak. Few sellers.
Pyridine—90/140 .. 14s. 6d.—15s. per gallon. Fewer inquiries.
Heavy .. .. 11s.—12s. Steady with fair business.

INTERMEDIATES AND DYES

Business in dyestuffs has improved appreciably with orders being given for larger quantities. Prices are unchanged.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. .. 4s. 6d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 11d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 6d. per lb. Better demand.
Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 8½d. per lb. naked at works.
Aniline Salts .. .. 9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 3d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 29/31° C. .. 5½d.—6d. per lb. Demand quiet.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Market quiet.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Market quiet.
Dichloraniline .. .. 2s. 2d. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethyaniline .. .. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 3s. 3d. per lb. d/d.
Monochlorbenzol .. £63 per ton.
β-Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. .. 1s. 5d. per lb. d/d.
β-Naphthylamine .. .. 4s. per lb. d/d.
m-Nitraniline .. [illegible]

p-Nitraniline ..	.. 2s. 5d. per lb. d/d.
Nitrobenzene ..	.. 5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol	.. 2s. per lb. 100% basis d/d.
Nitronaphthalene	.. 11¾d. per lb. d/d.
p-Nitrophenol ..	.. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	.. 4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	.. 4s. 6d. per lb. d/d.
p-Phenylene Diamine	.. 10s. 6d. per lb. 100% basis d/d.
R. Salt	.. 3s. per lb. 100% basis d/d.
Sodium Naphthionate	.. 2s. 7d. per lb. 100% basis d/d.
o-Toluidine ..	.. 7d.—8d. per lb.
p-Toluidine ..	.. 3s. 10d.—4s. 5d. per lb. d/d.
m-Toluylene Diamine	.. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	.. £52 per ton.
Acid, Acetyl Salicylic	.. 3s. 6d.—3s. 9d. per lb. Steady demand.
Acid, Benzoic ..	.. Commercial acid dearer at 2s. 9d. per lb. B.P. quality remains unobtainable.
Acid, Boric B.P.	.. Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric ..	.. 18s.—20s. per lb.
Acid, Citric ..	.. 1s. 5½d. per lb., less 5% for ton lots. Market firm.
Acid, Gallic ..	.. 3s. per lb. for pure crystal. Steady market.
Acid, Pyrogallic, Cryst.	.. 6s. per lb., for 28 lb. lots.
Acid, Salicylic ..	.. 2s. 4d.—2s. 7d. per lb. For ton lots 2s. 3d. is quoted. Market slightly easier.
Acid, Tannic ..	.. 3s. 3d. per lb. for B.P. quality.
Acid, Tartaric ..	.. 1s. 1½d. per lb. less 5%. Very firm. Considerable inquiry and buying.
Amidol	.. 9s. per lb. d/d.
Acetanilide ..	.. 3s. per lb. Weak.
Amidopyrin ..	.. 14s. per lb. Demand negligible.
Ammon. Benzoate	.. 4s. per lb.
Ammon. Carbonate B.P.	£35 per ton.
Atropine Sulphate	.. 12s. 6d. per oz. for English make. Market neglected.
Barbitone	.. 17s. per lb.
Benzonaphthol ..	.. 5s. 9d.—6s. 3d. per lb. Supplies scarce.
Bismuth Salts ..	.. A steady market. Prices according to quantity :
Bismuth Carbonate	.. 12s. 9d.—14s. 9d. per lb.
„ Citrate ..	.. 11s. 4d.—13s. 4d. „
„ Salicylate	.. 10s. 2d.—12s. 2d. „
„ Subnitrate	.. 10s. 9d.—12s. 9d. „
Borax B.P. ..	.. Crystal £20, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Per lb.
Potassium ..	.. 9d.—10d. } Steady market.
Sodium ..	.. 9½d.—10d. } Steady market.
Ammonium ..	.. 11d.—1s. } Steady market.
Calcium Lactate	.. 2s. 9d. per lb. for best English make. Market firm.
Chloral Hydrate	.. 3s. 9d. per lb. Weak.
Chloroform	.. 2s. per lb. for cwt. lots.
Creosote Carbonate	.. 6s. 6d. per lb. Little demand.
Guaiacol Carbonate	.. 13s. per lb. for small stocks available. More inquiry. available. Slightly weaker.
Hexamine ..	.. 3s. 9d.—4s. per lb. for foreign makes.
Homatropine Hydrobromide	.. 30s. per oz.
Iron. Ammon. Citrate, B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate— Light Commercial	.. £36 per ton net.
Magnesium Oxide— Light Commercial	.. £72 10s. per ton, less 2½%.
Heavy Commercial	.. £26 per ton, less 2½%.
Heavy Pure ..	.. 1s. 6d.—2s. 3d. per lb., according to quantity. Steady market.
Menthol— A.B.R. recryst. B. P.	56s. per lb.
Synthetic ..	.. 26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials ..	.. Prices reduced. Market quiet.
Red oxide ..	.. 4s. 9d.—4s. 10d. per lb.
Corrosive sublimate	.. 3s.—3s. 1d. „
White precip. ..	.. 4s. 1d.—4s. 2d. „
Calomel ..	.. 3s. 5d.—3s. 6d. „
Methyl Acetanilide	.. 20s. per lb.
Methyl Salicylate	.. 2s. 10d.—2s. 11d. per lb. for carboys.
Methyl Sulphonal	.. 22s. per lb.
Methylene di-tannin	.. 7s. 6d. per lb. In good demand.
Paraformaldehyde	.. 3s. 6d. per lb., without much inquiry.
Paraldehyde ..	.. 1s. 8d. per lb.
Phenacetin ..	.. 7s. 3d. per lb. Dull.
Phenazone ..	.. 8s. per lb. Dull.
Penolphthalein ..	.. 8s. per lb.
Potass. Bitartrate— 99/100% (Cream of Tartar) ..	.. 88s.—90s. per cwt., less 2½%. Firm market. Inquiry good.
Potass. Citrate ..	.. 1s. 8d.—2s. per lb.
Potass. Ferricyanide	.. 3s. per lb.
Potass. Iodide ..	.. 16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	.. 7½d. lb., 1-cwt. kegs included.
Potass. Permanganate	.. 9d. per lb. for B.P. crystal English make. In good demand.
Quinine Sulphate	.. 2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	.. 6s. 3d. per lb.
Salol	.. 3s. 9d. per lb.
Silver proteinate	.. 9s. 6d. per lb.
Sod. Benzoate, B.P.	.. 3s. 3d. per lb.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity.
Sod. Hyposulphite— Photographic ..	.. £14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	.. 16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	.. 87s. 6d. per cwt. Market quiet.
Sod. Salicylate ..	.. Powder 2s. 10d.—3s. 1d. per lb., Crystal at 2s. 11d.—3s. 2d. per lb.
Sod. Sulphide— Pure recryst. ..	.. 10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	.. 18s. 6d. per lb.
Tartar Emetic ..	.. 1s. 4d. per lb.

Thymol	13s. 6d.—14s. 6d. per lb. for good white crystal from ajowan seed. Distinctly firmer.	

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine	13s. 6d. "	
Amyl Acetate	3s. "	
Amyl Butyrate	7s. 3d. "	
Amyl Salicylate	3s. 6d. "	
Anethol (M.P. 21/22° C.)	3s. 9d. "	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. "	
Benzyl Alcohol free from Chlorin	3s. 3d. "	
Benzaldehyde free from Chlorine	3s. 3d. "	
Benzyl Benzoate	3s. 9d. "	
Cinnamic Aldehyde Natural	18s. 6d. "	Cheaper.
Coumarin	21s. "	
Citronellol	19s. "	
Citral	10s. "	
Ethyl Cinnamate ..	10s. "	
Ethyl Phthalate	3s. 9d. "	
Eugenol	11s. "	
Geraniol (Palmarosa) ..	37s. 6d. "	
Geraniol	10s.—17s. 6d. per lb.	
Heliotropine	8s. 6d. per lb.	
Iso Eugenol	15s. 9d. "	
Linalol ex Bois de Rose ..	20s. "	
Linalyl Acetate	20s. "	
Methyl Anthranilate ..	8s. 6d. "	
Methyl Benzoate ..	6s. "	
Musk Ambrette	52s. 6d. "	
Musk Xylol	19s. "	
Nerolin	4s. "	
Phenyl Ethyl Acetate ..	10s. "	
Phenyl Ethyl Alcohol ..	16s. "	
Rhodinol	65s. "	
Safrol	1s. 10d. "	
Terpineol	2s. 6d. "	
Vanillin	26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	14s. 6d. per lb.	
Aniseo Oil	1s. 11d. "	
Bergamot Oil	14s. 6d. "	
Bourbon Geranium Oil ..	32s. 6d. "	
Camphor Oil	75s. per cwt.	
Cananga Oil, Java ..	9s. 4½d. per lb.	
Cinnamon Oil, Leaf ..	5½d. per oz.	
Cassia Oil, 80/85% ..	9s. 6d. per lb.	
Citronella Oil— Java 85/90%	4s. 7½d. "	
Ceylon	3s. 6d. "	Cheaper.
Clove Oil	9s. "	
Eucalyptus Oil 70/75% ..	2s. 4½d. per lb.	
Lavender Oil— French 38/40% Esters	24s. 6d. per lb.	
Lemon Oil	3s. "	
Lemongrass Oil ..	2¾d. per oz.	
Orange Oil, Sweet ..	12s. 6d. per lb.	
Otto of Rose Oil— Bulgarian	34s. per oz.	
Anatolian	26s. per oz.	
Palma Rosa Oil	20s. per lb.	Cheaper.
Peppermint Oil— English	70s. per lb.	
Wayne County ..	16s. 6d. per lb.	
Japanese	13s. 9d. per lb.	Advanced.
Pettigrain Oil	9s. 6d. per lb.	

TRADE NOTES

Official Trade Intelligence

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number.

Argentina: Tinplate (167); *Belgium*: Chemical products, ores (147); *Brazil*: Artificial silk (169); *British India*: Silk yarns (139); *Bulgaria*: Small tools, grindstones (12,355/F.E./E.C./2); *Danzig*: Oils (148); *Denmark*: Tinplate, steel, iron (149); *Egypt*: Steel (Inspecting Engineer, Egyptian and Sudan Governments, Queen Anne's Chambers, London, S.W. 1, Ref. E.S.R. 49-3/2); *Esthonia*: Chemicals, rubber, leather (150); *Italy*: Leather (151); *Morocco*: Hardware (160); *Poland*: Leather (8566/F.R./M.C./2); *Rumania*: Petroleum (154); *Spain*: Paper, chemical fertilisers (155); *Sweden*: Paint, chemicals, petrol, oil (157); *United States*: Tiles, cement, coal-tar products (163), tinplate (164), silk (166); *Uruguay*: Tinplate (167); *West Africa*: Iron (162).

Dyestuffs (Import Regulation) Act, 1920

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during January has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 441, of which 377 were from merchants or importers. To these should be added 17 cases outstanding on January 1, making a total for the month of 458. These were dealt with as follows:—Granted, 363 (of which 340 were dealt with within 7 days of receipt); Referred to British makers of similar products, 52 (of which 41 were dealt with within 7 days of receipt); Referred to Reparation Supplies available, 8 (all dealt with within two days of receipt); Outstanding on January 31, 1924, 35 (mostly dealt with at Meeting of the Committee, held February 1).

Of the total of 458 applications received, 389 or 85 per cent., were dealt with within 7 days of receipt.

Foreign Company News

The Franco-Belgium Syndicate for the Advance of Franco-Belgium interests in the Russian Petroleum Industry, in agreement with the Committee Interallée des Sociétés Naphtifères, has decided that it is impossible to continue to collaborate with the Groupement International des Sociétés Naphtifères.

A new company, the Société Anversoise de Soie Artificielle, has been formed at Antwerp (Belgium) to exploit the viscose process.

The Société Girod Cogne has been formed to take over the electrical steel works at Aosta, where special steels are made.

The Société Industrielle de Coke, Charbons et Agglomérés has been established at Paris to produce special foundry coke by distilling Durham coking coal mixed with English anthracite, and to recover by-products.

The Société Progil (Gillet) has taken over the Société des Anciens Etablissements Cognat, which manufactures wood-distillation products at its works at St. Rambert d'Albon.

The Syndicat Français d'Études Pétrolifères constituted under the Government auspices to form a Union Nationale des Pétroles is negotiating with the Turkish Petroleum Co., and with American petroleum experts, who are studying the oil-fields in Mesopotamia. The negotiations are sufficiently far advanced to enable the Board of Directors of the Syndicat to decide to form the company, which should constitute the national petroleum group, and to ask the French Government to renounce the option which it holds on one-quarter of the shares of the Turkish Petroleum Company.

Trade Information

Dyestuffs Catalogues used to be fascinating productions in pre-war days, but have long been either lacking or uncommon. It is a pleasure to note the appearance of a new series of productions, issued by the Clayton Aniline Co., Ltd., of Clayton, Manchester, to illustrate the effects that can be obtained with the various dyestuffs supplied by that company. Each booklet contains an introduction describing the properties of, and methods of using, the particular dyes, and illustrates the effects obtained by a series of samples, showing a wide and pleasing range of shades. Mention may be made of the booklets devoted to "Direct Colours on Cotton Piece," "Acid Colours on Woollen Piece," "Acid Colours on Woollen Felt," "Chrome Colours on Woollen Piece" and "Union Colours," the last-named being applied by the one-bath process. Of special interest is the booklet devoted to direct and sulphur colours showing "Celanese" effects, a discovery which has placed a new weapon in the hands of the textile designer. Attention may be drawn to a pamphlet, also issued by the Clayton Aniline Co., which details the latest recipes for producing a red upon cotton by means of paranitraniline red, a dye whose brilliancy and fastness combined with cheapness make it a serious competitor of alizarine for many classes of work. A further catalogue is devoted to the direct colours of the Society of Chemical Industry in Basle, colours which are obtainable in this country from the Clayton Aniline Co., Ltd.

British Chemical Standards

The Organisers of the British Chemical Standards movement announce the publication of the complete certificates of analyses of the following samples :—

	Carbon Steel "C."	Carbon Steel "P."	Cast Iron "D."
Carbon	0·091%	0·205%	
Sulphur	—	0·073%	
Phosphorus ..	—	0·105%	
Manganese ..	0·50% (approx.)	0·706%	
Phosphorus [illegible]			1·19%

The samples were first issued about eight months ago, but it has not been possible to publish the full details of all the figures until now. Each of the steel standards has been tested by a selection of about a dozen prominent chemists, representing independent analysts (metallurgical), the U.S. Bureau of Standards, and English, French, Italian and United States iron and steel works chemists (both makers and users).

A special feature of steel "P" certificate is that it contains full notes of the methods actually used by the co-operating analysts.

The standard samples may be obtained in 50, 100, and 500 gramme bottles, either direct from Organising Headquarters, 3, Wilson Street, Middlesbrough, or through any of the leading laboratory furnishers at a price just sufficient to cover the cost. The usual certificate, giving the names of the analysts, the types of methods used, and a detailed list of the results will be supplied with each bottle.

The full list of all the standards now available may be obtained on request.

PUBLICATIONS RECEIVED

REPORT ON THE PRESENT STATE OF KNOWLEDGE OF ACCESSORY FOOD FACTORS (VITAMINS). *Compiled by a Committee appointed jointly by the Lister Institute and Medical Research Council, Privy Council and Medical Research Council. Second edition, revised and enlarged. Pp.* 171. *London: H.M. Stationery Office*, 1924. *Price* 4s. 6d.

BULLETIN OF THE IMPERIAL INSTITUTE. *Edited by The Director and prepared by the Scientific and Technical Staff of the Imperial Institute and by other Contributors. Vol. XXI., No.* 3. *Pp. viii.*, 431—567. *London: John Murray*, 1923. *Price* 6d.

REPORT OF THE GODLEE OBSERVATORY FOR THE YEARS 1916—1922. *Manchester: Municipal School of Technology.*

PUBLICATIONS OF THE DEPARTMENT OF THE INTERIOR. *United States Geological Survey. Mineral Resources of the United States*, 1922. *Washington: Government Printing Office*, 1923 *and* 1924:—

CEMENT IN 1922. *By* E. F. BURCHARD *and* B. W. BAGLEY. *Pp.* 227—249. *No. II.*: 26.

SAND AND GRAVEL. *By* L. M. BEACH. *Pp.* 187—194. *No. II.*: 22.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA IN 1922. *By* V. C. HEIKES. *Pp.* 306—339. *No. I.*: 20.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN IDAHO AND WASHINGTON IN 1922. MINES REPORT. *By* C. N. GERRY. *Pp.* 217—256. *No. I.*: 18.

MINERAL WATERS IN 1922. *By* W. D. COLLINS. *Pp.* 207—220. *No. II.*: 24.

REPORT ON THE ECONOMIC AND FINANCIAL CONDITIONS IN BRAZIL, DATED SEPTEMBER, 1923. *Department of the Overseas Trade. By* E. HAMBLOCH. *Pp.* 104. *H.M. Stationery Office*, 1924. *Price* 3s.

The Cambridge University Press will shortly publish for the Cambridge Philosophical Society a translation, in two parts, of Dr. Niels Bohr's papers "On the Application of the Quantum Theory to Atomic Structure." Part I., which will appear immediately, is entitled "The Fundamental Postulates of the Quantum Theory," and will be closely followed by Part II., "The Theory of Series Spectra." Dr. Niels Bohr's new work is closely allied to his previous book, "The Theory of Spectra and Atomic Constitution," also published by the Cambridge University Press, the first impression of which is now almost exhausted.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

CHEMISTRY & INDUSTRY

Official Organ of the Federal Council for Pure and Applied Chemistry

Vol. 43 NEW SERIES LONDON, FEBRUARY 22, 1924 No. 8

EDITORIAL

OUR recent remarks comparing the multiplicity of societies and journals in the chemical, as compared with those in the legal, profession appear to have struck a sympathetic chord in the hearts of many chemists. Unfortunately, chemistry has not yet reached the stage of being a closed profession like the law and medicine, and there is no sharp line of demarcation between the qualified and unqualified practitioner. This fact is probably at the root of a good deal of the deplorable lack of organisation at the present time, and it is difficult to suggest an effective remedy. The closer co-operation now existing between the Chemical Society, the Society of Chemical Industry, and several other bodies is all to the good, but it seems to us that the time has now come for still closer co-operation, particularly on the financial side. At present many chemists spend too large a proportion of their precarious and slender incomes in subscriptions to several societies which maintain certain services in common to which membership of a single society confers the full right of use, for example the excellent library service of the Chemical Society. Surely the time has now come when members of several societies should be able to pay a composition subscription rather less than the total of the subscriptions payable to each individual society? It may be argued that the loss of revenue would be too great, but on the other hand there is the probable large increase of membership. Many of us hesitate to join fresh societies and add to our burdens, and to these of our number a composition subscription might be a strong inducement to join another society whose activities we would like to support if this could be done without too much financial strain. It would be of interest if some such arrangement could be made between the Chemical Society and the Society of Chemical Industry to start with, and if successful it could then be extended to other societies such as the Faraday Society, the Institute of Chemistry, the Society of Public Analysts, etc.

* * *

Although the multiplicity of societies and the many journals to be read are undoubted evils, it is difficult to see how they can be avoided or mitigated in view of the ever increasing specialisation of our science and its applications. One bad effect of this specialisation is seen in the growing use of a hideous jargon of uncouth technical terms. The chemistry of colloids offers possibly the worst examples of this, but no branch of pure or applied chemistry is immune from them. No one can quarrel with the use of special terms when they are necessary for clear and exact understanding, but too often they are coined with a wanton disregard for the difficulties they may cause to workers in other branches of the science. It is not only the scientific writer who sins in this respect. The trade terms used in the different branches of chemical technology are often obscure and sometimes actually misleading to those not intimately acquainted with them. There must be many of our readers who at times are mystified and possibly misled by phrases such as "Marc Oil," "Benzolo, Crude 65's," "Caustic Soda 76/77," "Solvent Naphtha 90/190." Indeed, we recently met with an instance of quite a wrong interpretation of the last named phrase on the part of a person actually engaged in the solvent industry. Perhaps some reader will one day furnish us with a list of these mystifying trade terms, together with their actual meaning. Many of these are of considerable antiquity, and no doubt owe their origin, like many trade terms and many of our more obscure weights and measures, to a desire to keep the knowledge of a particular trade within a charmed circle of the elect. Fortunately in chemical industry we are not called upon to use so bewildering a variety of weights and measures as is usual in some industries, and it is unlikely that the chemist will now be asked to express the results of an analysis in grains per kilderkin.

* * *

The Bureau of Chemical Abstracts is quietly and steadily considering the huge problem which confronts it. The chairman, Professor J. C. Philip, is devoting a good deal of time to the task and he and the other members of the Bureau are already making progress. This small piece of co-operation between two Chemical Societies is destined to become important. We suppose that only those who have taken part in the organisation of joint effort know how slow is the progress that can be made. Among some ten thousand chemists who may be supposed to be affected by the reforms contemplated, a few score are keenly enthusiastic, a proportion is invariably hostile and the great mass is either indifferent or inarticulate. There is no need why chemists should be inarticulate; we

welcome correspondence in our columns and do not hesitate to print any letters likely to interest our readers, whether we agree with the contents or not. We should value highly any contributions from readers who can offer any suggestions for the furtherance of the objects we and they have in view. All our readers will be pleased with the effort made to co-ordinate chemical abstracts. Other forms of chemical publication are receiving consideration, and one of the most notable of these is the book now being prepared in connexion with the British Empire Exhibition at Wembley.

* * *

Chemical science, both pure and applied, will be well represented at Wembley, and will be a striking testimony to the efficiency of British chemistry at the present time. But some more permanent record is required, and the book designed for this purpose will be excellent. It will be called "Chemistry in the XX Century," and is being edited by Dr. E. F. Armstrong, F.R.S., who has found time to organise the preparation of it in addition to his industrial, presidential, and other activities. He himself contributes the Introduction. Sir William Bragg will write on "X-ray Analysis"; and who can do it better? Professor Andrade deals with the "Structure of the Atom"; he has already written on this subject most skilfully. Professor Lapworth has written the chapter on "Valency Theories," a subject with which he is familiar. Sir Henry Miers and Mr. T. V. Barker will deal with "Crystallography," and what they do not know of the subject is immaterial. Dr. Irvine Masson contributes a chapter on "General Physical Chemistry," Professor Baly one on "Spectroscopy," Dr. Hilditch one on "Catalysis," and Dr. Clayton one on "Colloids." Rare Gases, Alloys, Organic Chemistry, Coal-Tar and other Colours, Biochemistry, Explosives and indeed all branches of the science are dealt with by experts whose competence is at once obvious. In a subsequent issue we shall furnish a complete list of these articles and the book is awaited with impatience. It is to be published by our enterprising friends, Messrs. Benn Brothers, Limited. In addition to this book, which is intended for all sorts and conditions of chemists, including those whose knowledge is vague and elusive, there is to be a series of pamphlets intended for a far wider public. These are to make plain to the average man the place occupied by chemistry in the various industries, in our national and daily life, in our homes and in every department of human activity. The organisation of these pamphlets is entrusted to an editor, a poor, harmless drudge, who informs us that his name may with advantage be withheld. By means of this book and these pamphlets it is hoped to make some impression on the public, and it is no small feat to have secured the co-operation of the various authors, busy as they already are with their academic tasks, and their work on the various bureaus, councils and associations. Lack of space has compelled us to omit a long list of contributors to the book of equal eminence to those we have mentioned. This omission will be duly rectified.

THE TRANSPORT, STORAGE AND DISTRIBUTION OF HYDROCHLORIC ACID, WITH AN ACCOUNT OF A COMPLETE MODERN INSTALLATION*

By D. M. NEWITT, A.R.C.S., B.Sc.

The number of industries which now use hydrochloric acid in large quantities has rendered improvements necessary upon the present means of handling and storing it; and since such improvements involve problems of practical importance met with continually in all processes, it is hoped that a survey of the subject will be of general interest.

Amongst industrial chemicals, hydrochloric acid is the most difficult to store in bulk owing to its corrosive action on all materials of which large receptacles can be constructed. The number and nature of the materials used in the manufacture of acid reaction-vessels and acid pumps, together with the lack of any uniform practice in handling the acid afford sufficient evidence of the demand for improved methods.

In considering possible lines of development it is essential to bear in mind the special circumstances arising from the chemical properties of the acid and the very limited choice of material available to withstand its action.

Of those substances inert to hydrochloric acid, nearly all are brittle, and all of them are costly and by reason of their mechanical properties unsuitable for the construction of large sized vessels.

Where the ideal cannot be attained it is necessary to compromise, and, in this case, two alternatives present themselves. Containers of small capacity can be made of an inert material, protected from rough handling by some suitable form of "armouring," or large iron, steel, or wood tanks can be lined with an inert substance.

Both these methods are found in practice, and both are open to criticism on account of the unsatisfactory mechanical properties of the substance which has to resist the action of the acid.

But the former method has objections, in addition, of a more serious nature. The small container is usually made to serve the triple purpose of transporting, storing and distributing the acid.

Its size is therefore limited to such as will provide a one man load, whilst its shape has to be modified to meet the requirements of its manufacture, and results in a vessel occupying a large space in proportion to its capacity.

The glass carboy in this country and its counterpart the earthenware bottle used largely on the Continent, are standard examples of such vessels. The carboy is usually protected by an iron basket packed with straw; together with its packing it weighs nearly forty pounds empty and has a capacity of some twelve gallons.

The economic aspect of handling a commodity used in tons in receptacles holding one hundredweight scarcely calls for comment. Freight charges,

* Read at the meeting of the Institution of Chemical Engineers held on Friday, Feby. 18th.

breakages with consequent loss of acid, and the frequent handling necessary add considerably to the cost of the acid. With so little to recommend it, the wide use of the carboy to-day is one of the anomalies of chemical industry.

Efforts have not been wanting on the part of acid manufacturers to introduce a system of bulk handling of hydrochloric acid, and in some cases they have taken the first step in adopting tank wagon transport; but such a move calls for co-operation on the part of the consumer. The essential concomitant of transport in bulk is storage in bulk. That portion of the acid price which in fact pays for the hire of carboys should be invested in bulk storage; and such an investment may be shown, happily, to be sound.

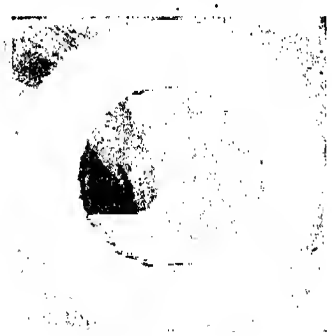


Fig. 1

The introduction of this system involves the provision of a storage tank with distributing mains, pumps and cocks so that the acid may be carried from the tank to the various reaction vessels without any handling.

The Storage Tank

In the selection of material and the design of the storage tank the conditions of its employment differentiating it from an ordinary storage tank must not be overlooked.

Considering a lined iron or steel tank for example, it is essential to have a non-porous lining, made from a material which can derive support by being firmly attached to the metal with as few joints as possible. In this connexion the large coefficient of expansion of iron with rise of temperature is an important factor; for, if, as is usually the case, this coefficient is much greater than the corresponding coefficient for the lining, severe stresses will be set up in the latter with a consequent tendency for the lining to warp away from its support and in extreme cases to crack.

This indeed was the fate of many of the earlier ebonite lined steel tanks, and even with improvements in the quality of the ebonite and the methods of attaching it, such tanks are still somewhat fragile for this reason.

Mention may be made of an attempt to remedy this defect carried out by Messrs. E. I. Du Pont des Nemours and Co.[1] A steel tank was lined with ebonite superimposed upon soft rubber, the rubber being vulcanised to the steel. After several months service the tank was opened up and examined. Several joints in the ebonite lining were found to have given way, but the soft rubber was intact and had completely protected the steel from corrosion.

It will be obvious that the consequences of a break in the lining of a steel or iron tank are serious, for unless discovered early and promptly attended to irreparable damage may be done to the metal plates.

It is therefore best to avoid the use of these metals if possible. The alternative as a material for large tank construction is wood. Certain varieties of wood, such as yellow pine and cypress, withstand the action of hydrochloric acid remarkably well[2], and may be used unprotected in tanks to contain dilute acid. For general use, however, the surface of the wood should be protected from direct contact with the acid, although the demands on the lining are less exiguous than is the case with a metal tank. For instance such a material as asphalt, which is slightly porous and would be inadmissable in the case of iron, forms quite an efficient lining for wood.

Many designs of wood tank for acids have been patented and a number of composition linings recommended.[3] In one case a tank is constructed of two layers of wood with the enclosed space filled with a fused mixture of sand, pyrites and sulphur.

But the material best adapted for the purpose of a lining is an acid-proof quality of soft rubber, and rubber lined tanks, although rarely seen in this country, are largely used in America and have earned a high reputation. It is evident that, given acid-resistant properties, rubber is a material peculiarly suited to the service. Its strength and resistance minimise the danger of damage through accidental rough usage, and when used in conjunction with wood a tear in the lining may be repaired both quickly and without risk of damage to the tank.

The special feature of the installation described below is then the use of a soft grey rubber mixture, as a lining for wood in the case of the storage and reaction tanks, and in the form of hose for the pipe lines.

This rubber has a specific gravity of 0·98 and a breaking stress of 2000 lbs. per sq. inch. A sample, tested by immersion in boiling hydrochloric acid (38 per cent.) for 48 hours, remained unchanged. As far as can be seen it is inert to sulphuric acid up to a strength of 70 per cent., acetic acid to 10 per cent., ferrous chloride to 50 per cent., and to any strength of oxalic acid, phosphoric acid and sodium chloride.

It is not suitable for use in the presence of free halogens.

The effect of heat on the rubber is influenced by the nature of the liquid in contact with it. In some cases a temperature of 130° C. may be safely used and in most cases a temperature in the neighbourhood of 100° C. causes no ill effects. This may be contrasted with the behaviour of ebonite which softens rapidly when heated above 70° C.

As a practical example of the behaviour of this rubber in contact with Hydrochloric Acid, Fig. 1

will be of interest. This illustration is from a photograph of a section of rubber hose that has been used continuously for twenty years for the conveyance of strong acid. An examination of the section shows that the inner surface of the rubber has shrunk slightly and has become somewhat harder for a depth of $\frac{1}{16}''$, but no other change is apparent.

In addition to the advantages of strength and durability accompanying the use of rubber and wood, the cost of an installation built up of these materials is very much less than that of any other combination that can be employed for the purpose.

The plant described here is for the storage of twenty tons of Hydrochloric Acid of Sp. Gr. 1·2, and its distribution to eight acid baths in two groups. Its object is to replace four hundred carboys hitherto used both for the storage and the distribution of the acid.

Since all the baths are on ground level, gravity is made use of for distribution, and to give sufficient head the storage tank is mounted on a wooden foundation four feet high. This provides an average fall of 0·9 inch per foot for the 120 foot main.

The choice of shape for the storage tank lies between rectangular and round with nearly all the advantages in favour of the latter. A round tank in addition to being easier to make and erect, has all its iron supports on the outside and visible, whilst the rubber lining can be applied with only a quarter of the number of seams demanded by a rectangular construction.

Fig. 3 is taken from a photograph of the tank in position. It is ten feet in diameter and ten feet high and slightly tapered from bottom to top. The wood used is 3″ yellow pine, the staves being supported by twelve $\frac{3}{4}''$ W.I. hoops bent to the circle of the

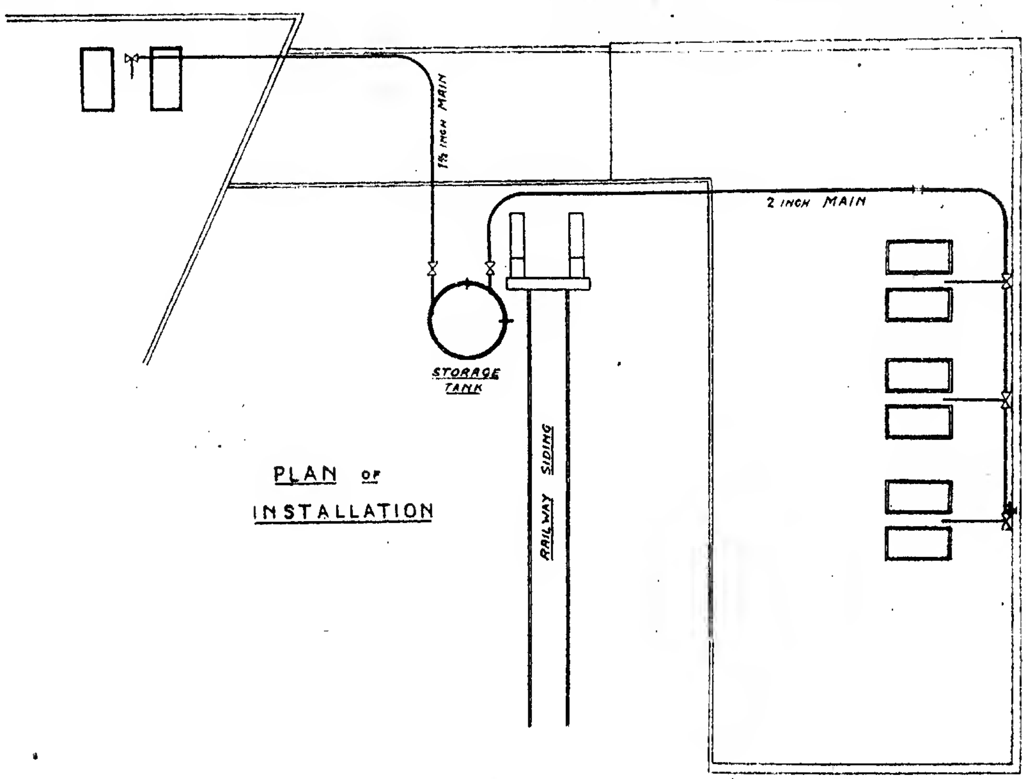


FIG. 2

Fig. 2 shows in plan the situation of the acid baths relative to the goods yard where the acid enters the works.

It will be observed that the storage tank has been placed close to a railway siding to facilitate rapid and direct filling from a tank wagon. Two acid mains are then necessary for distribution; one of length 60 feet to feed two baths, and the other of length 120 feet for the remaining six baths in the long shed.

tank and fastened by adjustable lugs. The lugs (Fig. 4) are so designed as to fit close to the staves, and to prevent the ends of the hoops being forced into the sides.

An octagonal cover to the tank protects its contents from the weather, and stops the escape of fumes.

Both the outside of the tank and the iron hoops and lugs are painted with coal tar pitch.

The lining consists of sheets of acid proof grey rubber mixture, $\frac{3}{32}''$ thick. To obtain perfect

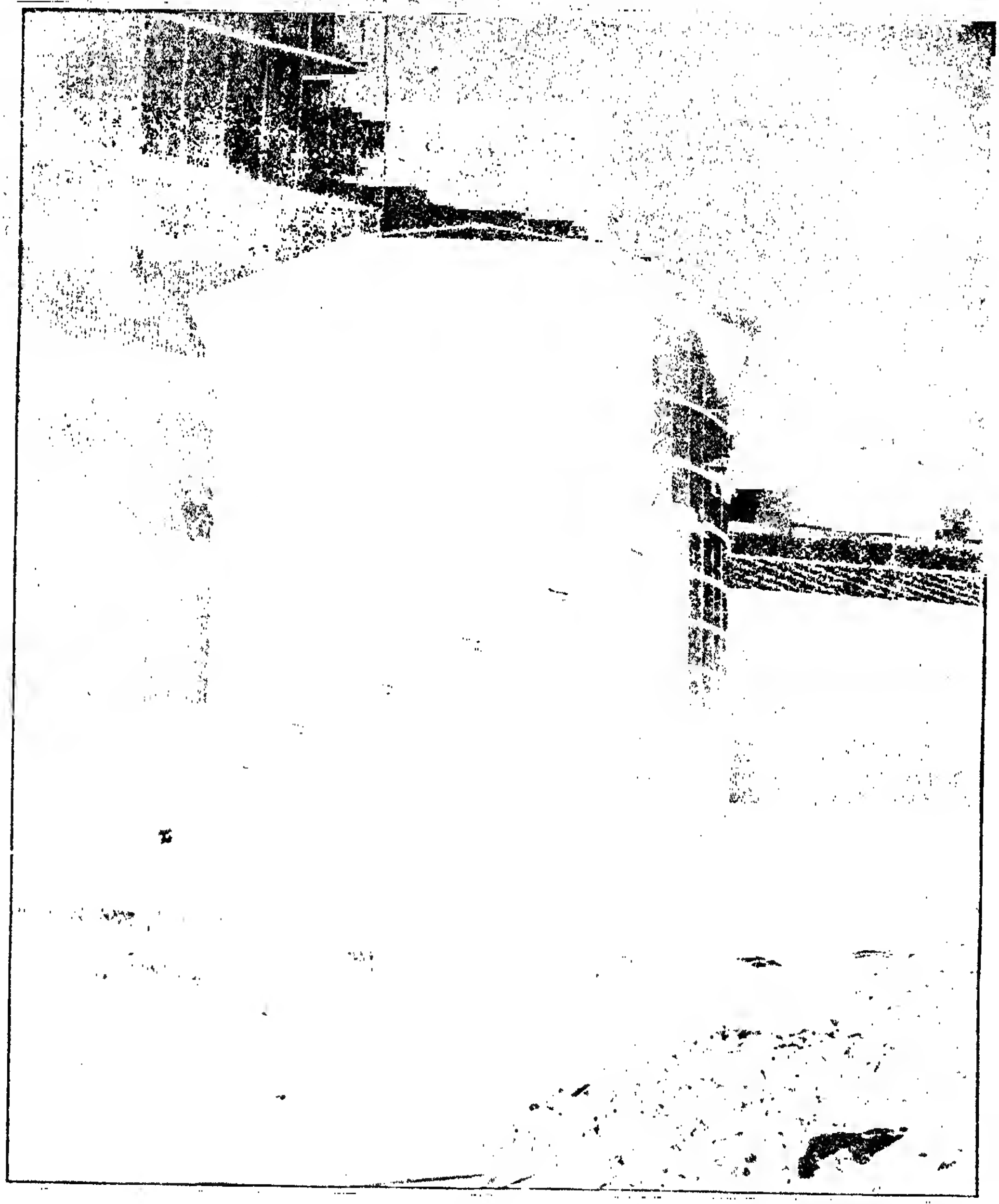


Fig 3

adhesion with the wood the inside of the tank must be free from ridges or other irregularities.

A backing composed of strong rubber impregnated fabric is first applied. The sheets of rubber, after having been vulcanised, are then rolled on to this fabric, and pressure and heat maintained until adhesion is complete. The seams in the lining are covered with broad rubber straps and sharp bends are avoided.

There are no breaks in the lining for exit pipes, distribution being effected by syphons.

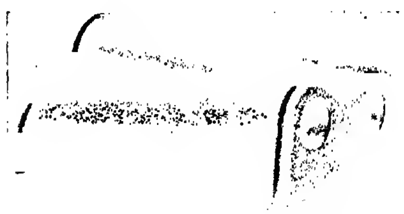
The Distributing System

Second in importance to the storage tank are the acid mains; and here again practice differs as to the choice of material for the pipes.

Ebonite, silica, glass, earthenware boiled in tar, and soft rubber have all been used. As in the case

of tanks, the nature of these materials render it necessary to protect the pipes either by a suitable casing or by running the line as far as possible out of reach of accidental blows, a condition not always practicable. With the exception of the last, they are rigid and brittle, and can only be obtained in short lengths. Ebonite pipes, for instance, are not made in lengths much exceeding ten feet; a main 60 feet long would thus have seven joints, and all joints are potential leak points.

Soft rubber piping, on the other hand, is made in lengths of 65 feet and therefore very few joints are necessary, and the risk of leaks in the mains is minimised. In addition, pipes of this material may be carried round bends and corners which would require special sections in the case of rigid pipes.



MALLEABLE IRON LUG FOR ROUND HOOPS

FIG. 4

The two mains used in the installation described here are made of acid proof hose, and are supported along their whole length in wooden launders to which they are fastened by loose straps at intervals of 15 feet.

The shorter one, 1½″ in diameter, feeds the two isolated baths, and the other, 2″ in diameter, feeds the battery of six baths. The mains are supplied by rubber syphon tubes, the bend of the tubes being carried over the edge of the storage tank on wooden shoulders to avoid strain and deformation.

The positions of the cocks are indicated in Fig. 2. Hard rubber cocks have been found most suitable for this purpose; but in special cases they may be advantageously replaced by bronze pinch cocks, of a design similar to those used in chemical laboratories.

Attention is called to the safety cocks placed as near the storage tank as possible in each main. The mains are in general carried close to the walls of buildings out of harm's way; the reaction vessels are then fed by short lengths of hose branching from the mains.

In each long length of pipe about one foot of overlength has been allowed. The slack is taken up in bays close to the ends of the pipe and provides for remaking a joint without disturbing the main pipe.

RELAY TANKS AND REACTION VESSELS

From the mains the acid is delivered to relay tanks or direct to the reaction vessels. Both must be made of or lined with acid resisting material.

The relay tank may be of similar design to the storage tank. A very convenient form is shown in section in Fig. 5. The purpose of this tank is to permit of the acid from the mains being diluted, heated or otherwise treated before being run into the reaction vessels.

Since all chemical reactions involve energy changes, the reaction vessels have to withstand, in addition to the acid, more or less rapid fluctuations of temperature. It may also be necessary to carry out the reaction under reduced or high pressure.

This introduces new factors into the design of the tanks. The effect of heat on the material used to line the tank must be ascertained. Ebonite and asphalt for example soften and become plastic above a certain temperature, whilst stone and ceramic materials are liable to crack as the result of sudden changes in temperature or pressure.

Moreover the mechanical wear on the lining may be considerable, due to the abrasive action of suspended solids in an agitated liquid, or to the formation of a precipitate or sediment which has to be dug out from the bottom of the tank.

For reaction vessels therefore a much stouter construction is both necessary and desirable.

Without venturing on a comparison of the various types of vessels in use, a comparison rendered difficult by the multiplicity of processes in which hydro-

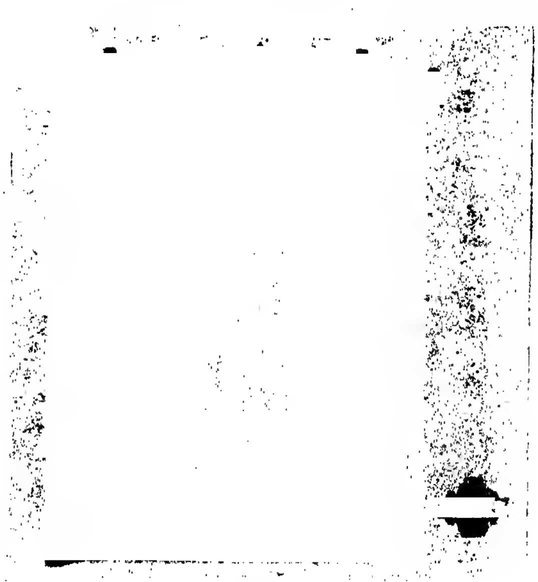


FIG. 5

chloric acid is employed, a brief description will be given of the application of lined wooden vessels to two typical reactions; these will be found to offer guidance in the majority of cases that arise.

In the first type of reaction, a crystalline product was obtained by adding solid in small quantities at a time to a 10 per cent. solution of hydrochloric acid, heated to 65° C. by steam, and kept constantly

agitated both during the addition of the solid and during the subsequent cooling and crystallisation.

A rectangular rubber lined tank was specified. The tank was ten feet long, four feet wide and three feet high and made of 3" cypress. After being in use some months it was observed that whilst the main structure of the tank was adequately protected by the rubber lining, the lining itself showed signs of wear, due to the scouring action of the crystals. It would, of course, be possible to repair or renew the lining from time to time as occasion required; but it was found to be cheaper and better to protect the rubber from mechanical action by a light inner lining of wood. This could be renewed at small cost when worn out. Such a lining need not be tight since its only function is to act as a buffer between the rapidly moving particles and the rubber surface.

Fig. 6 shows, in plan and elevation, the tank fitted with its double lining. The rubber lining is carried well over the edges of the tank to protect the vertical rods from acid and the outside of the tank is given a coat of pitch.

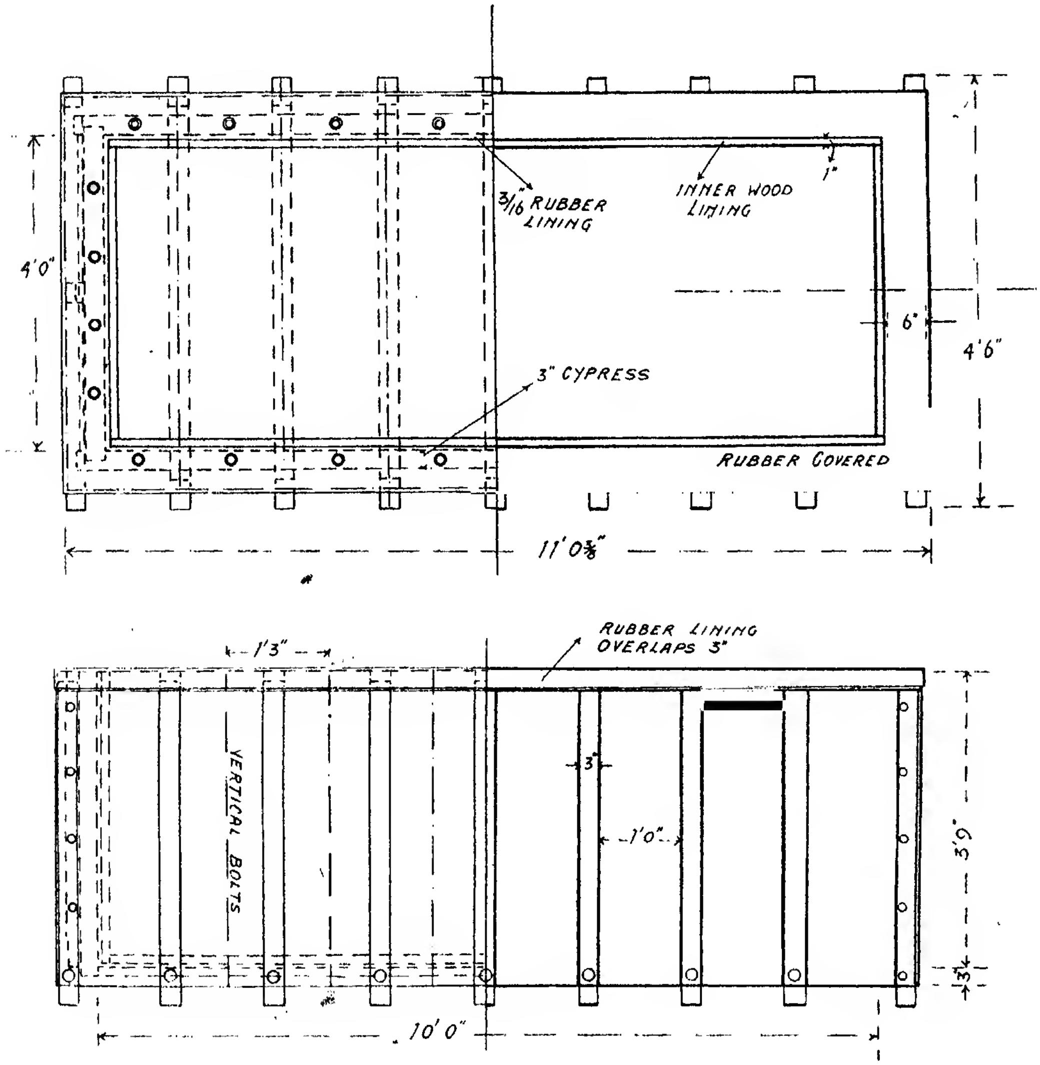


Fig. 6

In the second type of reaction the chemical change is initiated, or accelerated, by reduced or high pressure, and by heat.

Closed vessels must be used, and in order to provide the necessary strength a cylindrical construction is always adopted. It is also very essential to have perfect adhesion between the lining and the wood.

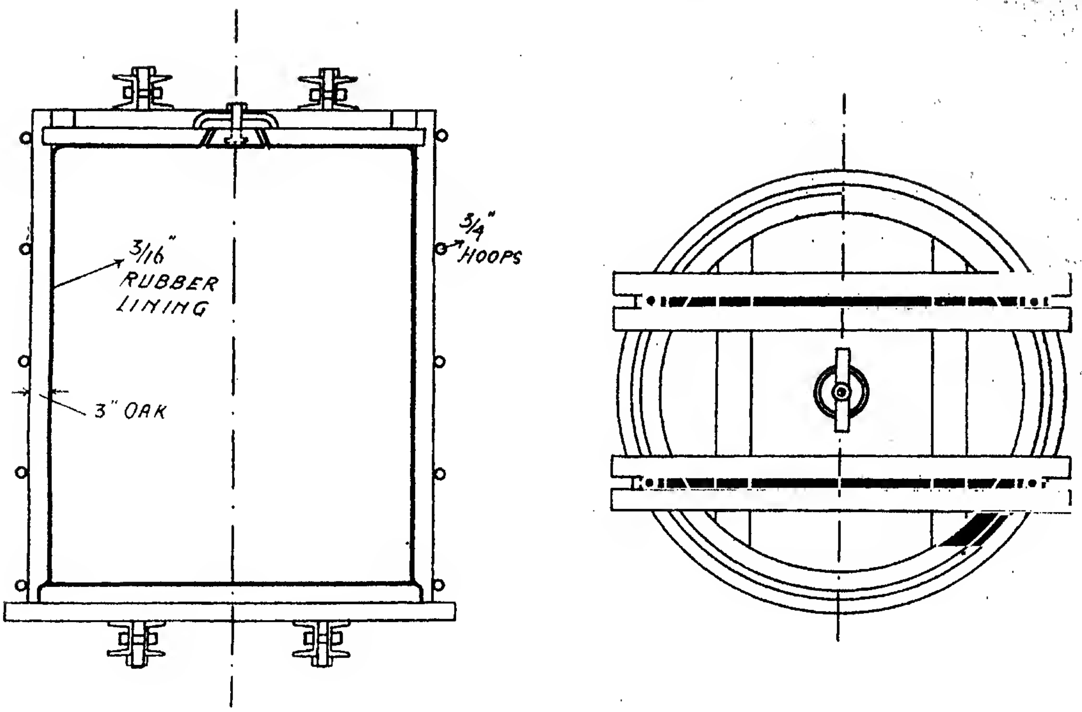
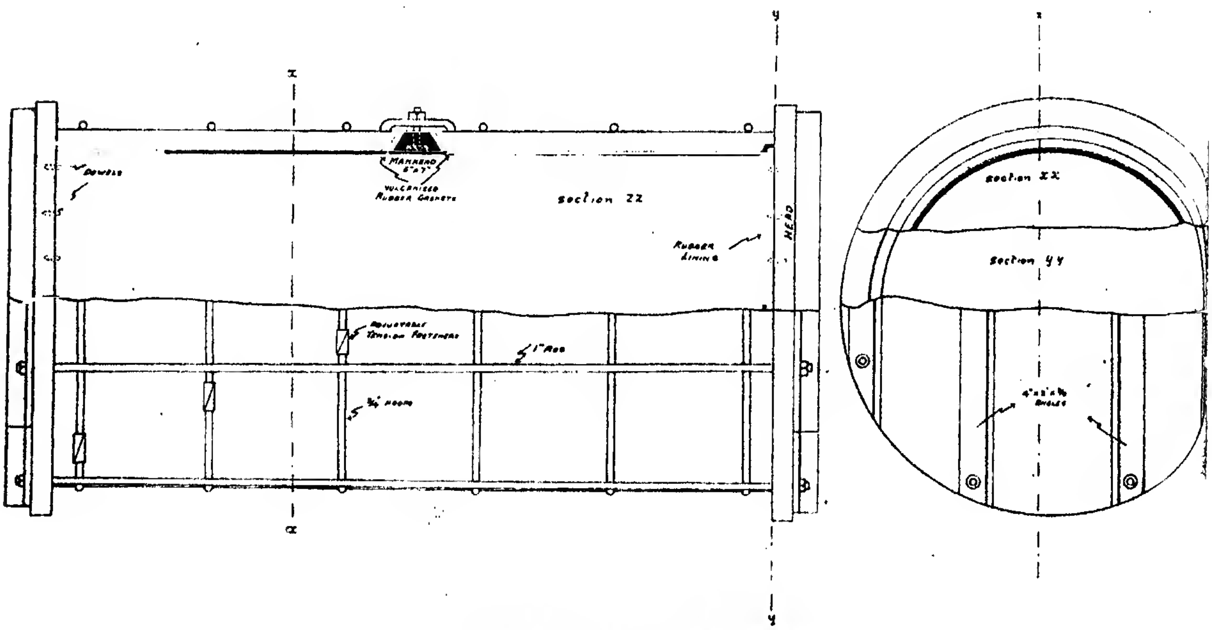


FIG. 7



HYDROCHLORIC ACID WAGON TANK

FIG. 8

Fig. 7 illustrates a form of tank designed to hold 10 lbs. pressure. It is made of 3" oak, lined with rubber. The staves are bound by five, $\frac{3}{4}$" W.I. hoops, and the ends are held in position by two pairs of channel girders connected by iron rods. To permit of lining, repairing and cleaning this tank it is necessary to have a detachable end as shown in the section. The opposite end may then be crozed into the staves, and provided with the necessary exit pipes, pressure gauges, etc.

Other examples of the application of a rubber and wood construction to process vessels will suggest themselves.

Transport

The transport in bulk is a separate and important phase of the handling of acid[4].

A wagon tank is called upon to encounter the mischances of travel by road and rail. It must length of the tank. The lining is a special acid proof rubber $\frac{1}{16}$" thick. The double ends give additional strength and render cleaning and internal repairs easy to carry out. The outside of the tank is coated with coal tar pitch.

The tank is mounted on wooden cradles and strapped in position by wire ropes.

Fig. 9 illustrates the mounting of a 10 ton tank on a standard 15 ton wood underframe of regulation size.

A point often overlooked in the design of wagon tanks is the provision of adequate devices for rapid filling and emptying. The selection of suitable fittings will depend on the power available for pumping the acid at the various works where it has to be delivered. When compressed air of sufficient pressure is available it may be used connected direct to the

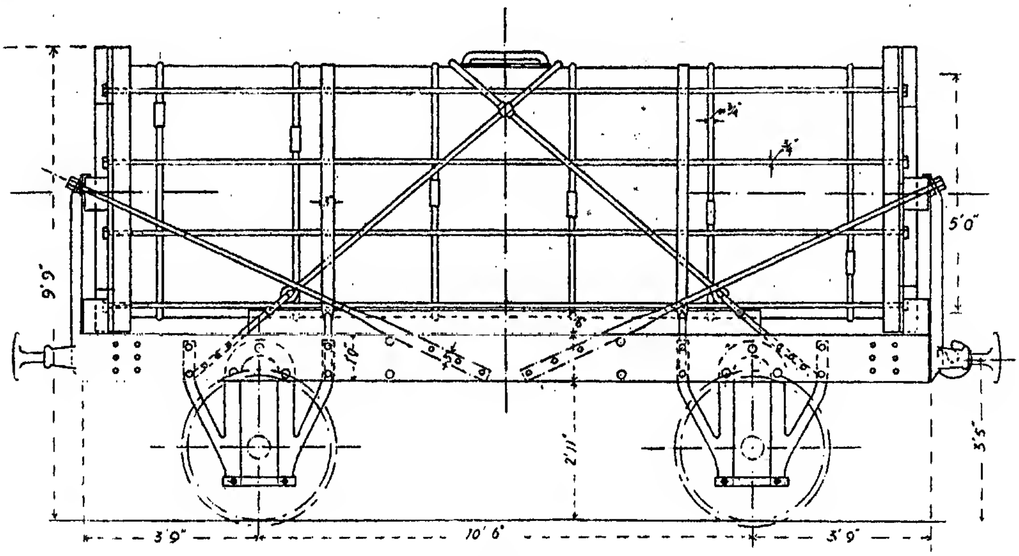


Fig. 9

be so designed as to withstand continual vibration and shocks, and in the event of a collision to remain intact. It has also to stand the internal pressures used in blowing the acid from the wagon to the storage tank, which may be situated a considerable height above ground level. Provision has to be made in the design for rapid cleaning and repair.

The dimensions of such a tank are, in the case of rail transport, governed by the railway companies' regulations for private owners tank wagons, and in the case of road transport by the carrying capacity of the vehicle employed.

Fig. 8 shows in elevation a rubber lined wood wagon tank designed for road transport. It has a capacity of 600 gallons. It is constructed of yellow pine and is cylindrical in shape and double ended. The staves are supported by $\frac{3}{4}$" W.I. hoops and the ends are clamped together by four angles 4" × 3" × $\frac{3}{8}$" connected by $\frac{3}{4}$" bars running the whole wagon tank, or through the medium of an acid elevator of the automatic type. Alternatively a centrifugal pump may be more convenient. Much unnecessary delay and expense will be avoided by an agreement on the question of plant and fittings between the manufacturer and the consumer.

Costs

The chemical and engineering aspects of handling hydrochloric acid in bulk have been considered, but the duties of the chemical engineer do not terminate at this point.

When introducing a new system involving capital outlay, it is necessary to show an adequate return for the expenditure; and this is often a matter of some difficulty. It is seldom possible to express in terms of money the value of time and labour saving resulting from some more efficient method of carrying out a process.

In the present case, however, some definite figures are available which throw an interesting light on the nature of the investment.

It has been seen that there are three methods of handling hydrochloric acid.

Method I. By transporting, storing and distributing in carboys.

Method II. By transporting in wagon tanks, and storing and distributing in carboys.

Method III. By transporting in wagon tanks, storing in bulk, and distributing through pipes.

In Table I the items of expenditure associated with the three methods of handling the acid are enumerated.

An example has been taken where the acid is purchased, weekly, in ten ton lots, and is delivered to a factory, situated 100 miles on a direct route from the acid works.

TABLE 1

	£	s.	d.
Method I. Acid purchased in carboys and stored and distributed in carboys.			
Carriage on carboys in 10 ton lots at £1 1s. per ton	£10	10	0
Carriage on returned empties at 12/6 per ton ..	£1	19	0
Cost of unloading full carboys and loading empties (estimated)	£1	15	0
Distribution of acid (estimated)	£0	10	0
Breakage (at 1%)	£1	14	0
Interest on investment in carboys at 5% ..	£0	3	3
	£16	11	3
Investment by consumer . . . nil			
" by manufacturer . . . 400 carboys at 8/6 each	£170	0	0
Method II. Acid purchased in tank wagon and stored and distributed in carboy.			
Carriage on acid in tank wagon at 18/- per ton including return of tank	£9	0	0
Cost of unloading into carboys (estimated) ..	£1	0	0
Distribution of acid (estimated)		10	0
Breakages (at 1/2%)		8	6
Interest on carboy investment (at 5%) ..		1	8
Interest on tank wagon investment (at 5%) ..		3	10
	£11	4	0
Investment by consumer . . . 200 carboys at 8/6 each	£85	0	0
" " manufacturer . . . 1 rubber lined wood wagon tank	£200	0	0
Method III. Acid purchased in tank wagon and stored in bulk and distributed in pipes.			
Carriage on acid in tank wagon at 18/- per ton (including return of tank)	£9	0	0
Interest on tank wagon investment (at 5%) ..		3	10
Interest on storage tank and distributing system (at 5%)		2	4
Renewals and repairs (at 5%)		2	4
	£9	8	6
Less rebate on price of acid at 5%	£2	0	0
	£7	8	6
Investment by consumer . . . Storage tank and distributing system	£120	0	0
" " by manufactorer . . . 1, rubber lined tank wagon	£200	0	0

In Method I thé consumer, in addition to paying for the acid, has to pay carriage on the full carboys, the cost of unloading and reloading empties and the carriage on the returned empties.

Included in the price of the acid is the allowance for breakages, estimated at 1 per cent., renewal of packing and hampers, and the interest on the capital invested in carboys.

A charge of 10s. for distribution, estimated, has also been allowed.

In Method II the cost of handling and freight charges are reduced. The allowance for breakages no longer appears in the price of the acid, but still exists and must be added to the costs. It is now estimated at ½ per cent. since the carboys require less handling.

The cost of unloading is reduced somewhat, but distribution remains the same.

Interest on the investment in carboys must be allowed, and interest and costs of repairs and renewals to the wagon tank will appear in the price of the acid.

In Method III the freight charges are the same as in Method II. The items of cost of unloading, breakages and distribution disappear. (A small charge should be allowed for unloading, but this is difficult to estimate).

Additional items are the interest on the investment in storage tank and distributing system, and the allowance for renewals and repairs.

From the total costs, however, must be deducted a very considerable rebate allowed by the acid manufacturer to consumers purchasing their acid in bulk and storing it by this method.

This may be between 5 per cent. and 10 per cent. of the purchase price. It represents the increase in efficiency that accompanies a bulk method of handling.

If the price of acid is taken at, say, £4 per ton the rebate, calculated on the lower percentage, amounts to £104 per annum, and is sufficient to pay for the cost of the entire installation in less than two years.

An installation, such as the one described, should last for upwards of twenty years. There is, therefore, a big margin available for the reduction of cost of manufacture in processes using hydrochloric acid.

In conclusion it may be said that a method based on uniting the properties of two substances cannot be regarded as entirely satisfactory, but advantage must be taken of the best materials available until the ideal has been discovered. Possibly this will be found among the new alloys of iron; but it is an annoying circumstance that, so far, these alloys appear to become brittle in proportion as their resistance to acid increases; consequently they share some of the disadvantages that are seen to accompany the use of most inert compound substances.

My thanks are due to Messrs. Boulton & Paul, Ltd., of Norwich, for permission to refer to their new installation, and for the photograph (Fig. 3) of the storage tank which was constructed at their works.

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[1] Industrial & Eng. Chem., Vol. 15, No. 2.

[2] "American Wooden Tank & Vat Practice." *Chem. Age*, Vol. VII., No. 167, P. 270.

[3] Kramer B.P. 4684, 1895. T. D. Owen B.P., 21294, 1892.

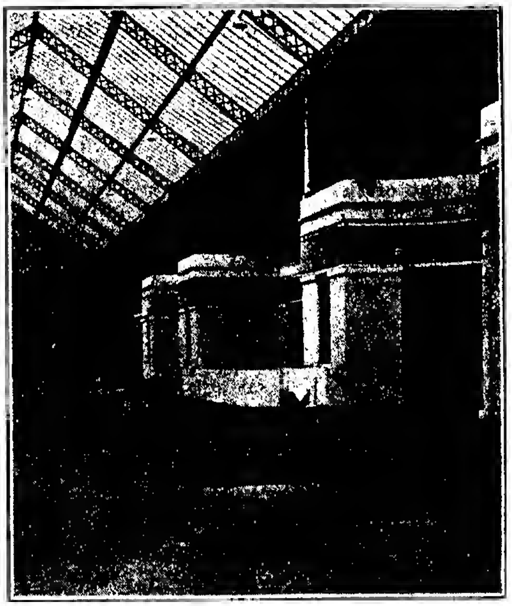
[4] "Carriage of Chemical Liquids on Railways." *Pfeffer Z. agnew. Chem.*, 1908. "Truck for Hydrochloric Acid." *Chem. Trad. Jour.*, 1908, Vol. XLII. J. Turner & J. H. West. Eng. Pat., 124, 997,

THE BRITISH ASSOCIATION OF CHEMISTS

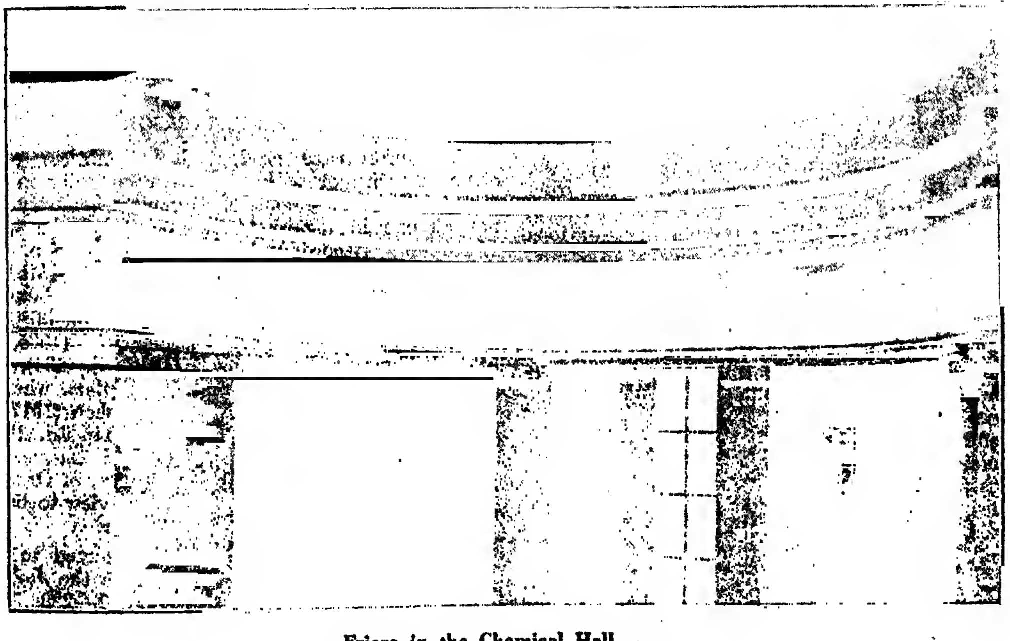
The British Association of Chemists was founded to look after the material welfare of chemists, and it has sections in several parts of the British Isles. In those districts where the chemical industries are active, it seems to have a large membership. There is much work to be done in improving the status and emoluments of chemists and this is the task which the Association has undertaken. Its London section held its third annual dinner on February 16, at the Engineers' Club, Coventry Street. Dr. Herbert Levinstein, the President of the Association took the chair. An excellent musical programme was provided, and the various items were much appreciated by the members present. The chairman proposed the toast of the London section to which Mr. E. R. Redgrove replied. Mr. Price proposed the toast of kindred societies, to which Dr. S. Miall replied. Mr. Cory proposed the toast of the ladies and guests, and to this toast Miss Wright replied. Mr. C. S. Garland proposed the toast of the president, and alluded to the discussions held with the Institute of Chemistry towards some co-operation between the Institute and the Association. Dr. Levinstein, in an interesting speech, made a suitable reply.

AN OBJECT LESSON

Travelling outwards from Baker Street in the gloomy mist of a February morning, one passes after a few minutes' run, a huge sign whose yard-high letters announce the "Site of the Amusement Park." At the same time strange erections in timber appear, out-topped by distant views of stately buildings, minarets and towers. Steam cranes are active, puffs of steam twist away, and men swarm ant-like among structures whose ungainliness little suggests their future fascination. This confusion of buildings, timber structures, and muddy

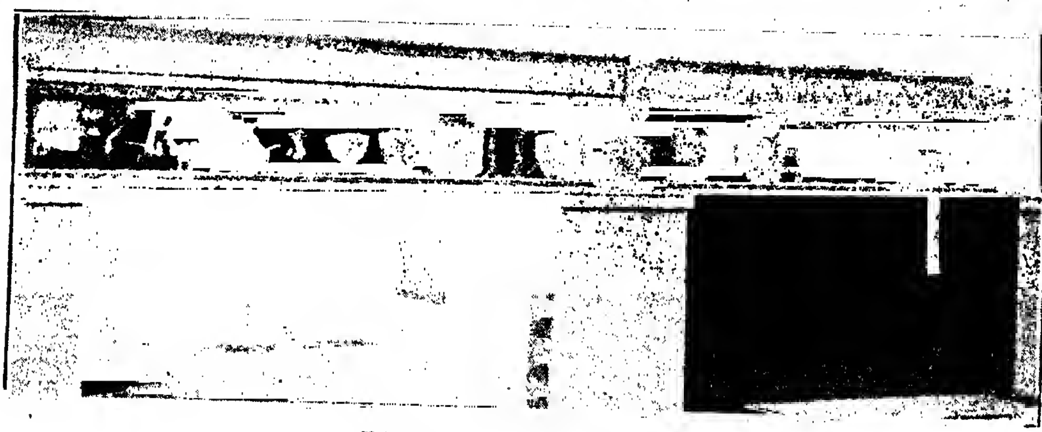


British Empire Exhibition: Part of the Chemical Hall



Frieze in the Chemical Hall

roads will blossom out in a couple of months into the unique attractions of the British Empire Exhibition, an effort of unparalleled magnitude. Governments, Colonies, industries, trades, all will be represented, but the section that will interest the readers of *Chemistry and Industry* most is the Chemical Hall. Passing through the organised muddle of erection one comes to a huge hall, the Palace of Industry, in an ideal position, close to the north entrance near Wembley Park Station. In the Palace of Industry, which covers more acres than one cares to remember, is the Chemical Hall. It will be a source of pride to chemists to know that the largest single exhibit in the Palace of Industry will be that of the Chemical Industry, which will occupy an area of no less than 37,500 sq. ft. But, quite apart from the large area occupied—even the powerful cotton industry occupies no more than 32,187 sq. ft.—the exhibits themselves will be of unusual interest. Already there is a long list of firms which are going to exhibit—there are far too many to mention here—and one can people the Chemical Hall with fascinated throngs gazing at the lovely colours of dyes or of copper sulphate, admiring glistening piles of dry ammonium sulphate or limpid jars of glycerine; or following the representations of chemical life in laboratory or in works, so admirably delineated in the vigorous colours of the frieze by Mr. Cosmo Clark. Drugs, essences, soap, chemicals, fine or heavy, all will be there, and it can safely be prophesied that little will be lacking. This is not all, for there is an exhibit which should drive home to every visitor the fine record of British chemists and chemistry. There will be a complete representation of our present state of knowledge of chemistry, and as the organising committee includes so many eminent exponents of the various branches, the exhibit will be of no small interest. Catalysis, chemical engineering, alkaloids, agricultural chemistry, to mention but a few of the many subjects, will be expounded by specimens, often of great historical interest. If the visitor is interested in explosion waves or terpenes, isotopes or ions, crystals or colloids, he will find something of interest. It is impossible to give an idea, within the covers of this journal, of the vast scope of the scientific exhibit. It is to be hoped that the double, double, double beat of the thundering drum will not be neglected, for such an opportunity to instruct as well as edify is hardly likely to occur again within some generations. The Chemical Hall should be an object-lesson to the many millions of visitors, home and overseas, to teach them at least something of the far-reaching importance of British chemical science and chemical industry. The visitor to the Exhibition sees, first thing, where the Amusement Fair is to be. One feels sure that though the Chemical Section of the Exhibition may not be amusing, it will certainly leave a profound impression on those who see the vast hall decorated, completed and populated.



Frieze in the Chemical Hall

THE DERIVATION OF THE WORD "MERCAPTAN"

By T. S. PATTERSON

The unfortunate student has doubtless often observed, with or without further curiosity in the matter, that text-books of Organic Chemistry are not at one in regard to the origin of the word *Mercaptan*. According to Holleman (1905, p. 78) Bernthsen (Eng. Ed. 1922, p. 91), Walker ("Medical Organic Chemistry," 1913, p. 145), Meyer and Jacobson (1907, **1**, i, 319), Miller ("Elements of Chemistry," 1880, **3**, 661), "Watt's Dictionary" (1865, **2**, 547), "Thorpe's Dictionary" (1912, **3**, 434), the word is derived from *corpus mercurio aptum*, whereas Perkin and Kipping (1904, p. 187), Cohen (1917, p. 195), and Richter (1891, p. 140; German Ed. 1909, p. 160) derive the word from *corpus mercurium captans*. Thomas Thomson ("Chemistry of Organic Bodies," 1838, p. 325), perhaps with a view to being on the safe side, derives it in both ways.

A few years ago attention was directed to the matter in a paper by Paul Diergart in the *Journal für praktische Chemie*, 1919, [ii], **99**, 281—292. The paper, itself perhaps not conspicuous for clarity, is dismissed in the Chemical Society's Abstracts with

the single, almost contemptuous word, "historical," and since the English reader is not much assisted thereby to a judgment upon the subject it is perhaps worth while to explain briefly the true inwardness of the matter.

In 1824 Wilhelm Christopher Zeise (1789—1847), Professor of Chemistry in the University of Copenhagen, examined the action of carbon bisulphide on ammonia, etc., and discovered thereby the xanthates, which, it appeared, might be regarded as carbonates in which some of the oxygen had been replaced by sulphur. This led to other experiments, and by distilling calcium ethyl sulphate with barium hydrosulphide the liquid which is known as mercaptan was obtained—in, or shortly before, the year 1833. The earliest intimation of this discovery was a note in Schweigger-Seidel's *Journal für Chemie und Physik** 1833, **8**, 146, a full account of the work being presented to the Kongelige Danske Videnskabernes Selskab. This account was first issued, in 1834, in the form of a reprint, two years before the appearance of the volume in which it was ultimately published. Copies of this reprint were sent by Zeise to several Journals, and translations or abstracts appeared in at least four. The original reprint had probably very little circulation and is now scarcely or not at all procurable. Even the *Afhandlinger* of the Danish Society after their appearance in 1836, would also not be very easily accessible and Zeise's work therefore became known through the translations or extracts, which were published almost simultaneously.

A preliminary note appeared in the *Journal für praktische Chemie*, 1834, **1**, 186, and in the same volume, pp. 257—268, 345—356, 396—413, 457—475 a full translation was given. As a result of his work Zeise arrived at the constitution $C^4H^{12}S^2$ for mercaptan, and $C^4H^{10}S^2Hg$ for that of the mercury compound. The passage is as follows :—" In accordance with the idea that the metal in this compound, as in the sulphocyanides, forms one member, and $C^4H^{10}S^2$ the other, and that in consequence the ethereal body is $C^4H^{10}S^2+H^2$, I name the substance taken up by mercury *mercaptum*, (*i.e.*, *corpus mercurio captum*) and the other *hydro-mercaptum*, or rather (partly to avoid connecting the nomenclature with an idea still hypothetical, partly for brevity), *mercaptan* (*i.e.*, *corpus mercurium captans*), the final *s* being dropped for euphony.

"This nomenclature may seem offensive to some but hardly more than the names chloral, picamar, oxamid, etc., etc., and those who are acquainted with the present position of our notions of the compositions of the substances in question will surely grant that such, if I may so call them, innocent names, are, temporarily at least, preferable to those which suggest an opinion as to the actual nature of the compound. . . . Against the name mercaptan it might, amongst others, be objected that it is really the *mercaptum* that is seized by the mercury ; but this seems to me to be of little importance." (Pp. 265, 266.)

A different translation of the paper appeared in Poggendorff's *Annalen*, 1834, **31**, 369—431. In this translation (p. 378) *mercaptan* is derived as before from *corpus mercurium captans*, but *mercaptum* is derived differently from *corpus murcurio aptum*, *murcurio* being an obvious misprint, whilst the fact that there is a considerable space between the *o* of *murcurio* and the *a* of *aptum*, might give rise to the idea that the letter *c* had dropped out by chance, the derivation of *mercaptum* from *corpus mercurio captum* having just as much to recommend it as the derivation from *corpus mercurio aptum*. It is a least clear from this that Zeise distinguishes between the substance which we now call *mercaptan*, and its radical $C^4H^{10}S^2$, for which he proposed the name *mercaptum*.

Berzelius—to whom a copy of this reprint was most probably sent—gave an account of Zeise's work in his *Jahresbericht* (1835, **14**, 334) which was presented to the Swedish Academy of Sciences on March 31, 1834. He mentioned that "Zeise names the assumed saltformer $C^4H^{10}S^2$ *mercaptum* (from *mercurio aptum*, because it has a great affinity for mercury) ; but instead of calling its compound with hydrogen *mercaptum*-hydride he calls it *mercaptan* (from *mercurium captans*), dropping the final *s* for the sake of euphony—or, rather, not to drive the dissonnance too far." To this Berzelius added a footnote :—" It becomes constantly more necessary for chemists to harden their ears. Daily a number of new ternary compounds are discovered, for which so far no rational system of nomenclature is possible and for which names are invented from Latin or Greek derived from one or other property of the compound without the slightest regard for euphony. In the course of the past year alone science has been enriched with the following ear-splitting names : Peucil, Peucedanin, Pittakal, Mercaptum, Mercaptan, Thialöl, etc. It is very desirable that those who make discoveries in science should not heap it up with cacophonies." Berzelius added :—" *mercaptum* has not yet been isolated as such but only in combination with metals or hydrogen."

Also in a letter to Wöhler of March 28, 1834, Berzelius wrote :—" A no less curious discovery is Zeise's sulphur mess*, which he has named mercaptan (from *mercurium captans* ! ! !) dealing with it in a paper of seventy-two pages which one reads with much the feelings one would have if driving through sand on a sledge. But the thing itself is excellent." It seems clear from the reference to the length of the paper as well as from the date, that Berzelius must have had the original reprint in his hands, and not one of the translations.

A short abstract of Zeise's paper also appeared in Liebig's *Annalen*, 1834, **11**, 1—10, with an addition pp. 10—14, over the initials J.L., the addition containing, however, mainly other parts of Zeise's paper. In this the derivation of the word is not given but Liebig finished up his note with a remark similar to Berzelius's. "I think I ought to point out to Herr Zeise how much his excellent and masterly investigations lose in interest by diffuseness and the description of experiments which gave no result. The treatment of every chemical compound

*Forerunner of the Journal für praktische Chemie.

*" Schwefelschmiere " applied to a liquid or to a piece of work is a little difficult to translate.

in the same manner would exhaust even the greatest patience." (pp. 13, 14).

Another extract appeared in the *Annales de Chimie et de Physique*, 1834, [2], 56, 87—96, and here *mercaptum* is given as from *corpus mercurio aptum* (p. 93) and *mercaptan* as from *corpus mercurium captans* (p. 88).

The original paper ultimately appeared in 1836 in the first part of Volume VI of the *Naturvidenskabelige og mathematiske afhandlinger der kongelige Danske videnskabernes Selskabs*, the volume however bearing on its title page the date 1837. In the paper (p. 13), *mercaptum* is derived from *corpus mercurio aptum* and *mercaptan* from *corpus mercurium captans*. It is clear therefore that Zeise intended *mercaptum* —derived from *mercurio aptum*—to be name the of the *radical* C^2H^5S, and *mercaptan*—derived from *mercurium captans*—to be that of the *substance* C^2H^5SH.

It is a little difficult to understand why the confusion in the text-books should have arisen at all. That information about mercaptan was originally disseminated by means of the translations has nothing to do with the matter, since in all the translations the derivation of *mercaptan* is correctly given. In the version given in *Journal für praktische Chemie*. the name of the radical mercaptum is incorrectly derived from *mercurio captum* instead of *mercurio aptum*, but this, if anything, should have had the opposite effect to that produced. The fact is, perhaps, that even authors of text-books of Organic Chemistry may nod occasionally, and fail to consult the original sources. In any case it is clear that Zeise, whose right to dictatorship in the matter is inalienable, intended the word *mercaptan* to be derived from *mercurium captans*, and that most of the text-books are wrong on this point.

Organic Chemistry Department,
University of Glasgow

INSTITUTION OF THE RUBBER INDUSTRY

At the meeting held in London on February 4, Mr. F. Kaye, who introduced the process for making rubber-latex paper, described a new use for rubber latex in the manufacture of boards, leather and linoleum substitutes. The amount of latex required in making boards, etc., varied from 30 to 40 per cent. of rubber content (more than is used in making rubber latex paper), the quantity depending on the nature of the fibre and the purpose and quality of the final product. The increase in tensile strength was greater with low-grade materials than with stronger fibres. The development of the manufacture of latex boards should lead to a big range of new products made by paper-making and board machines, *e.g.*, floor-cloth, leather boards, asbestos boards, mill boards and containers. Latex boards are easy to colour and could be used in the electrical industry. As latex boards are well suited for embossed effects, they could find use in book-binding, panelling, etc. The boards can be self-vulcanised during manufacture at very small cost.

FORTHCOMING EVENTS

Feb. 22. Society of Chemical Industry, *Liverpool Section*, with the Manchester Section. "Plant Pigments," by Prof. I. M. Heilbron.

Feb. 22. Society of Chemical Industry, *Glasgow Section*, Engineers' and Shipbuilders' Institute, 39, Elmbank Crescent, Glasgow, at 7.15 p.m. "Notes on Continuous Causticizing and Cresylic Acid," by W. Walmsley and R. F. Stewart.

Feb. 25. Society of Chemical Industry, *Newcastle Section*, Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. "Some Aspects of the Physical Testing of Moulding Sands for Foundries," by C. H. Holmes.

Feb. 25. Royal Society of Arts, W.C. 2, at 8 p.m. "A Study of the Destructive Distillation of Coal," by E. V. Evans, O.B.E. (Cantor Lecture I.).

Feb. 26. Society of Chemical Industry. *Joint meeting of the Chemical Engineering Group and the Institution of Mechanical Engineers* in the Lecture Theatre of the Institution, Storey's Gate, Westminster, S.W. 1, at 6 p.m. A symposium will be held on "The Treatment of Water for Industrial Purposes."

Feb. 26. Institution of Mechanical Engineers *Joint meeting with the Chemical Engineering Group of the Society of Chemical Industry*, at 6 p.m. Particulars as above.

Feb. 27. Royal Society of Arts, W.C. 2, at 8 p.m. "The Use of Psychological Tests in the Selection of a Vocation," by C. S. Myers, B.C.E.

Feb. 27. Hull Chemical and Engineering Society, The Hull Photographic Society's Rooms, Grey Street, Park Street, Hull, at 7.30 p.m. "Indicating and Recording Instruments," by C. F. Newton.

Feb. 27. Royal Microscopical Society, 20, Hanover Square, W. 1, at 7 p.m. "Practical Microscopy in Research on Textile Fibres," by H. J. Denham.

Feb. 28. Institution of Electrical Engineers, Savoy Place, W.C. 2, at 6 p.m. "The Design of Apparatus for the Protection of Alternating Current Circuits," by A. S. FitzGerald.

The Physical Society of London is arranging to celebrate its jubilee from March 20 to 22 next. The preliminary programme of the proceedings will be as follows: On Thursday, March 20, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 2. at 2.30 p.m., there will be an Exhibition of Apparatus, followed by a reception at 3.0 p.m., and at 3.45 the Guthrie Lecture on "Photo-electric Effects in the case of High Frequency and Allied Phenomena" will be delivered by M. le Duc de Broglie. On Friday, March 21, from 4.0 to 5.30 p.m., and from 6.0 to 7.30 p.m., reminiscences by Original Fellows and other Fellows of long standing will be given, and on Saturday, March 22, there will be a continuation of the Exhibition, and at 7.0 p.m. for 7.30 a banquet will be held for Fellows and guests only.

The Council of the Physical Society extends to the members of this Society a hearty invitation to be present at these meetings, and, according to present arrangements, no tickets will be required for this purpose.

SOCIETY OF CHEMICAL INDUSTRY

LIST OF MEMBERS ELECTED,

February 8, 1924

Armstrong, Dr. W. G., Public Health Department, Sydney, N.S.W., Australia. Director-General.

Baird, David, 25, Princes Place, Ardrossan. Student.

Brown, Harold B., Chemical Dept., Rowntree and Co., Ltd., The Cocoa Works, York. Technical Chemist.

Carmichael, Kenneth F., 2, Kirkton Road, Burntisland, Fifeshire. Chemist.

Coates, William M., 28, Admiral Street, Burnley. Assistant Chemist.

Davidson, Wilmot A., Chemist in Charge, Department of Health, Vancouver, B.C., Canada. Dominion Analyst.

Douglas, Mark, 27, Mosley Street, Newcastle-on-Tyne. Analytical Chemist.

Ewing, Charles W., c/o Canadian Woollen Manufacturing Association, 256, McCaul Street, Toronto, Canada. Research Chemist.

Fawcett, Thos. C., Northern Sabulite Explosive Co., Ltd., Tuthill Quarry, Haswell, Sunderland. Engineer.

Gordon, Andrew R., 40, Heath Street W., Toronto, Canada. Assistant.

Gould, Thos. L., 116, Chestergate, Stockport. Manufacturing Chemist.

Lewis, William L., 11, Clifton Wood Road, Clifton, Bristol. Manager.

McGrath, Thomas, c/o The Condensed Milk Co. of Ireland, Lansdowne, Limerick, Ireland. Biological Chemist.

Martyn, George, Latchley, Sandymount Drive, Wallasey.

Murray, Alexander F., 3, Burns Park, Ayr. Works Chemist.

Muspratt, Horace, 15, Alexandra Drive, Sefton Park, Liverpool. Director.

Price, Edward E., The Haven, Dorman's Park, Surrey. Chartered Accountant.

Rhodes, J. E. Wynfield, Gorphwysfa, 1, Deyne Avenue, Prestwich, Manchester. Lecturer.

Thompson, Rudolph E., 596, Milverton Boulevard, Toronto, Canada. Chemist.

Tweedale, Albert E., 26, King Street South, Rochdale. Chemist.

Wright, Carl J., Combustion Utilities Corporation, 8-10, Bridge Street, New York, N.Y., U.S.A. Chief Technologist.

DEATH

Moulsdale, William E. (elected 1917), of 6, Castle Street, Liverpool, Metallurgical Engineer. On January 20, 1924.

ANNUAL GENERAL MEETING, 1924

The Annual General Meeting of the Society of Chemical Industry will be held in Liverpool on Wednesday, July 9. Members are asked kindly to note this preliminary announcement. Further particulars will be published in due course.

INSTITUTE OF CHEMISTRY

LONDON & SOUTH-EASTERN COUNTIES

A special general meeting of the London Section was held on January 23 in the Meeting Hall of the Institution of Mechanical Engineers. All Fellows and Associates of the Institute in the London area were invited to attend.

The Chairman, Mr. E. R. Bolton, in introducing Mr. W. J. U. Woolcock, C.B.E., reminded the members of the discussion which the Section held early in 1923 on the subject of the organisation of chemistry, with special reference to the possibility of greater co-operation.

Mr. Woolcock said that as a looker-on he was possibly able to see some things which chemists might miss. In the published synopsis of his address he had said that there was a need for a serious effort to unite the profession of chemistry by fusing or assimilating the various bodies concerned with the advancement of the profession and the science. He felt that members would take this point for granted, but he would emphasise three points.

First, they could not claim that the public were yet educated as to the functions of the chemist. They could not even invite prominent men of affairs to dine with them without laying themselves open to listen to speeches which clearly indicated that their guest was confusing their profession with the calling of pharmacy. Then, again, he was not satisfied that everything possible had been done to bring the whole body of those who practised chemistry as a profession into one professional organisation. The Institute had on its flank another body which was claiming to do some of the work which a professional organisation might undertake. Finally, scientists, and particularly chemists, had shown a peculiar aptitude for waste. They had specialised in wasteful and uneconomic methods. They had split themselves up into a multitude of small societies, and had, further, taken great care that the headquarters of all those societies should be as far apart as possible, and that, when it was necessary to select officers for any of them, the officers should have had as little contact with the work of the other societies as possible.

He then referred to the Federal Council. In 1918, when the Federal Council was formed, chemistry was in a relatively prosperous condition, and it was comparatively easy for the small body of enthusiasts who had formed this Council to prepare the ground for a larger scheme of co-operation. Nobody could claim now that chemistry or any other profession was flourishing, and the time was at hand when the members were pressing for that more lively action which they could expect from a council containing their own elected representative members. The more intimate fusion of British chemical bodies was especially desirable now, seeing that they all had to contend with financial difficulties. It was not now possible for chemists to keep in touch with all the societies to which they were attracted. He would not like to say exactly how many societies connected with chemistry there were in the United Kingdom —probably only Mr. Pilcher would be able to tell

them—but they were all doing useful work in one sphere or another, and it was clear that the present cost of membership of all of them would be prohibitive. He had suggested that the bodies involved in the proposed amalgamation should be the Chemical Society, the Institute of Chemistry, the Society of Chemical Industry, and all other societies interested in the advancement of the science and its application. All these societies should be linked up at first in a loose manner, so that the advantages of membership of all of them should be available to members of all the other societies at a much less cost than was now possible.

During the last few years the relations between chemists and industrialists had improved wonderfully, but there was still room for great improvement, and therefore he suggested that the associations of British chemical manufacturers (there was more than one association), whilst obviously they could not be constituent societies (since membership of such associations was not individual), should be affiliated to the proposed amalgamated body. He wished to do all he could to bring chemists and industrialists into close contact one with another.

He had already to some extent referred to the objects of the amalgamation. The first he would suggest would be economy in organisation. The societies should co-operate by the election of a General Chemical Council, containing the nucleus of the Federal Council, and elected representatives from each of the bodies, which would manage the affairs of the new body. They would appoint committees corresponding with the councils of the present individual groups or societies respectively, who would carry on the work and maintain the traditions of those groups or societies. Further, they would appoint a joint secretariat. If the latter point were not capable of immediate realisation, great good would inevitably accrue if the secretariats of all the bodies were housed in the same building.

The second object of amalgamation was to secure economy in publication and printing. Something had already been done in this way, and he need not elaborate upon the fact that more economies could be effected.

Thirdly, they would effect the provision of a joint library, which was an extension of the present scheme for the use by other bodies of the library of the Chemical Society.

He referred to the scheme which had been put forward by the Federal Council for the inauguration of Chemistry House. Unfortunately, immediately after this proposal had been made, the present trade depression had set in, and the time was not yet ripe to ask for large sums of money. The ideal was a fine one, and would go a long way towards co-ordinating the interests of all the bodies which had their headquarters at Chemistry House. They must continue to work for this ideal, but they must face the practical fact that the ideal would be difficult of immediate accomplishment in the present circumstances. They would be wise to proceed with plans for federating the interests of the various bodies associated with chemistry without necessarily awaiting the completion of their building; particularly should they aim at joining together those bodies whose interests were more nearly associated. The other similar bodies would join them readily when this was accomplished.

Mr. E. V. Evans said that it was a great pleasure to him to see that the members of the Institute were taking serious thought of the need of co-operation between the various chemical bodies. He reminded the meeting of the steps which had already been taken, first of all in the formation of a joint Library, and, secondly, in the formation of a joint Bureau of Chemical Abstracts, with Prof. Philip as chairman. He hoped that these steps were but an indication of the more complete collaboration which would eventually be brought about. He was spending annually about £30 in subscriptions to various chemical or allied societies, and he spent nearly £50 a year more in getting supplied with technical literature. He agreed, therefore, that any steps which could be taken to relieve this burden upon chemists would be welcome to the members. In this connexion, he had been pleased with the formation of the Chemical Engineering Group, by which it had been found possible to prevent the formation of yet another distinct chemical body, and the Society of Chemical Industry had every reason to be proud of its satelite.

Prof. Philip said that, speaking as one with intimate knowledge of all three of the societies, he did not quite see how the Institute came into such a federation. He could conceive that the Chemical Society and the Society of Chemical Industry, for instance, could usefully co-operate even more than they were already doing or were proposing to do, but if the Institute were to come in there would be immediately a difficulty in that the Institute was mainly a qualifying body. It was possible to belong to either of the other two societies without possessing any serious chemical qualification, provided that a candidate was really interested in chemistry or its applications. The whole subject, was one worthy of every consideration, and he thought that the present efforts in the matter of the Library and publications were an earnest of good things to come.

Mr. E. M. Hawkins had some doubts as to the wisdom of including the Institute in the project; amalgamations were not always a success unless the bodies to be amalgamated had definitely the same aims. He felt that this was the case with the Chemical Society and the Society of Chemical Industry, but was doubtful as to the position of the Institute.

Mr. R. Leslie Collett disagreed entirely with Mr. Hawkins and with Prof. Philip. He maintained that the common ultimate aim, whether of the Institute, or of the Chemical Society, or of the Society of Chemical Industry, was to advance chemistry. This over-ruled any of their immediate objects, whether they were looking after chemists or after the propagation of pure chemical knowledge or of chemical knowledge as applied to the arts and industries. It was true that the immediate functions of the Institute were different from those of the Chemical Society and the Society of Chemical Industry, but that was all the more reason why the

Institute should come in with all its vigour to promote the common aim.

The key to the whole situation, however, was Chemistry House. They were holding this meeting in the hall of the Institution of Mechanical Engineers, because when London members of the Institute or of any other body expected about five per cent. of their members there was not room for them in any chemical building, and they had to seek the hospitality of the Engineers or of some other body who had adequate headquarters. That of itself showed the urgency of the demand for Chemistry House. He did not agree with Mr. Woolcock that the ideal was not immediately obtainable. If they could not immediately get sufficient funds to buy a house, which he doubted (all these bodies had money tied up in capital funds against the rainy day which was with us, but which nobody would believe was wet), they would at least rent a large building and see that all their offices and meeting halls, were in one building. He, therefore, urged that members should set their hearts upon the immediate acquisition of adequate chemical headquarters. It could be bought later when money was forthcoming. Apart altogether from the question of federation, good must necessarily accrue if the officers of the various bodies were housed in the same building. At present the Institute was the only body which had its own building, and nobody could claim that even the Institute was satisfied as to the adequacy of its accommodation. The Chemical Society were notoriously crying out for more space, particularly for the Library. The Society of Chemical Industry was hidden away from the usual place where chemists were to be found, and had no real accommodation. The matter was, therefore, very urgent.

The Registrar of the Institute said that while he was much interested in the idea of federation, he thought that, as Prof. Philip had suggested, it would be found better, in the first place, to federate the bodies which were more closely allied both in their functions and aims.

Mr. C. L. L. Claremont thought that the opener was at fault in discussing the closer organisation of the profession. He was of opinion that the profession was already fully organised by the Institute, and that anybody who was not in the Institute was not in the profession.

Dr. O. L. Brady said that with regard to the Federal Council, the idea was excellent, and it was clearly desirable to have some co-ordinating body. The method on which that idea was worked out, however, was at fault since the net result had been to collect on the Federal Council a number of presidents or other high officials of the constituent societies, all of whom were busy men and unable to give that time to the affairs of the Federal Council which was necessary.

The present Federal Council was in the nature of an advisory council. The council of the new body must have full executive powers if it were to be of any use.

He agreed with Mr. Collett that, though the functions of the various bodies might differ, their ultimate aim was the advancement of chemistry, and the Institute should pull with its proper weight.

Mr. C. E. Sage spoke generally in favour of the proposals. He emphasised that, during the last thirty or forty years, movement had all been in the direction of splitting up chemists into their separate groups, and as each group or society had grown in size and in importance it had engendered the formation of yet other satellites. Latterly the movement had been towards federation, but Mr. Woolcock's proposals would undoubtedly interfere with the liberty of a number of the federating societies. At the same time they must realise that it was most inconvenient to attend a meeting or committee in Bloomsbury, then have dinner at Charing Cross, and go to Piccadilly for another meeting.

Mr. Woolcock was then called upon to reply to the discussion. He made a brief reference to Mr. Claremont's remarks, which he considered very interesting, but as not to be taken seriously by those who realise the progressive position of chemical affairs. It could not yet be claimed, for instance, that membership of the Institute was the sole qualification of a chemist when it was realised that there was more than one prominent professor who was not a Fellow of the Institute. In his opinion, the discussion had brought to light one serious criticism, namely, the position of the Institute in the proposed federation. It had been very properly pointed out that the Institute was in a different category from the other bodies, but he held with Mr. Collett that any body which represented chemists should not be outside the scheme of federation. The proposed federated body would clearly have to make provision for different grades of membership. There would no doubt be a grade corresponding with Fellowship of the Institute and another with Associateship of the Institute. These grades would comprise all who had qualifications entitling them to consideration as members of the Institute. There would have to be another grade, which would comprise those who were interested in a less direct manner in chemistry.

The members of the Institute might possibly not come as readily into the scheme of federation as the members of the other bodies, but, in any case, he thought that the Institute would be doing a great dis-service to chemistry if it held itself violently back.

Dr. Brady then moved:—

> "That this meeting of Fellows and Associates of the Institute of Chemistry of Great Britain and Ireland urges the Council of the Institute to take immediate steps to invite the co-operation of all bodies concerned with the progress of the profession and science of chemistry in order to ascertain the best means for co-ordinating the activities of the various organisations with the ultimate prospect of federation."

The resolution was seconded by Mr. McLachlan. An amendment, moved by Mr. Claremont, to delete the words "the profession and," was not seconded. The resolution was then put to the meeting, and carried unanimously.

The meeting closed with a hearty vote of thanks to Mr. Woolcock

PERSONAL AND OTHER ITEMS

Dr. Alexander Scott, F.R.S., who has completed his work in advising on the preservation of the objects found in the tomb of Tutankhamen, left Egypt on February 10 for England.

From Paris the deaths are announced of Monsieur L. Roman, professor at the Ecole Centrale des Arts et Manufactures de Paris, and of Monsieur J. Bonnardel, president of the Cie Industrielle du Platine and of the Société des Forges et Aciéries de Huta Bankowa.

Dr. T. J. Murray has resigned his post as head of the Chemical and Metallurgical Department of the Wolverhampton Technical School to become Principal of the Smethwick Technical School.

Dr. W. E. Faragher, the author of numerous researches on the chemistry of hydrocarbons, and an authority on petroleum refining, has been appointed an assistant director of the Mellon Institute of Industry Reseatch, University of Pittsburgh.

Dr. I. N. Ivanor, whose death is announced from Berlin, was responsible for the development of numerous factories in Turkestan, including the santonin factory at Tskimkent, non-nationalised by the Soviet Government.

BRITISH INDIA

Final Forecast of the Sesamum Crop, 1923-24

From reports based on a memorandum received from provinces which contain, on an average, 99·6 per cent. of the total area under sesamum, it is estimated that the total yield is 382,000 tons (excluding Hyderabad), as against 425,000 t. of last year. This represents a decrease of 10 per cent. The weather was not very favourable, and the condition of the crop is reported to be, on the whole, fair.—(*Ind. Tr. J., Jan.* 17, 1924.)

RHODESIA

Petroleum and Coal in Rhodesia

As the result of exploration at Inyaminga, 117 miles from Beira, on a concession covering 4200 sq. miles, it is claimed that the presence of coal was proved, and that the geological structure was similar to that of the Persian oilfields. It is suggested that boring at a point near Inyaminga would " in all probability disclose the existence of huge quantities of petroleum."—(*S. Afric. J. Ind., Jan.*, 1924.)

CANADA

Mineral Wealth of Ontario

Up to the end of 1923 the mines of Northern Ontario have produced gold, silver, platinum, nickel and copper worth over $600,000,000. More than 250 million tons of ore and rock has been taken from the nickel-copper mines of the Sudbury district, yielding approximately $255,000,000, and placing in ascertained reserves at least another 100 million tons of ore, with an indicated gross value of two billion dollars. The mines of the Cobalt, South Lorrain and Gowganda district have produced over 340 million ozs. of silver valued at approximately $210,000,000. Dividends from a great many of these silver mines have been exceedingly big—ranging from a few hundred per cent. to as high as 25,000 per cent. on the capital invested. The silver bullion sent out from this few miles square of territory would make up approximately twenty trainloads of about twenty cars to each train.—(*Official.*)

Production in Nova Scotia

During 1923 the products of Nova Scotia yielded in revenue about $168,000,000 including: Coal, $36,410,000; coke and by-products, $3,286,000; gold and other minerals, $255,000; gypsum, limestone, etc., $3,195,200; building materials and clay products, $1,940,500; iron and steel products, $12,620,000; fisheries, $11,779,300; manufactures, ships and freights, $53,185,000; farm products, $26,045,100; forest products, $12,350,600; grand total, $167,846,700.—(*Official.*)

FRANCE

French Imports of Rubber.

During the first eleven months of 1923 French imports of rubber totalled 33,295 metric tons, of which England furnished 15,272 t., British India 7452 t., French Congo 772 t., Indo-China 3179 t., French African Colonies, except Congo, 575 t.

Metallurgy in November

The production of the State coal mines in the Sarre in November, 1923, reached 1,076,587 metric tons, so that the average production per working day was 45,938 t., *i.e.*, 681 kg. per workman per day. The factories attached to the mines produced 14,717 t. of coke, against 16,000 t. in October.

Basic Slag

The consumption of basic slag as a fertiliser is increasing in France. Before the war the import of basic slag averaged 400,000 t., but in 1922 the import was 27,325 t., and the export 308,326 t. In 1923 imports during the first nine months reached 27,270 t. and exports, prohibited since October, reached 197,852 t. on October 1. Imports of basic slag come chiefly from the Sarre region and the exports go to Germany, Belgium, Switzerland and Luxembourg.

The Utilisation of Samba for Paper-Making

Samba (*Triplochiton Scleroxylon*), occurring in Guinea, the Ivory Coast, Dahomey and the Cameroons has been investigated for use in paper-making. The wood contains 60 per cent. of cellulose and 39 per cent. of lignone, but only 33 per cent. of cellulose was obtained in the technical tests, the paper produced being of common type. When bleached, the pulp was a dull white, slightly rough to the touch and fairly supple. Resistance to tearing, rubbing and other tests was mediocre. Very thin sheets can be obtained, the felting power being 0·015. With energetic treatment the lignone is easily eliminated, and the wood seems well suited for paper-making.

Alcohol Production

During the first three months of the season (October, November and December, 1923), the

production of alcohol was 920,793 hectolitros, of which 524,607 hl. was reserved for the State, and 396,186 hl. delivered for sale. Imports amounted to 64,127 hl. The stock in hand on December 31 was 1,158,350 hl. There is a slight excess over the production in 1922-23, but a slight diminution in the stock on hand.

Export Prohibitions

Tho export or re-export of coal, briquettes of lignite, coal or coke is prohibited, save by special permission of tho Ministry of Finance.

GENERAL

Minerals in New Caledonia

The Société le Nickel has just obtained a contract for the delivery of from 600 to 1200 metric tons of nickel ore under advantageous conditions. Exploration for auriferous copper has been less active lately, but a trial shipment of 75 t. has been sent to Newcastle, Australia. As exploration has given such satisfactory results, the company will probably increase its capital.

Radium Production in Czechoslovakia

According to the *Czechoslovak Trade Journal*, roughly 24 g. of radium, or about 12 per cent. of the world's output, was produced at Joachimsthal during the years 1909-22. It is estimated that the total world's production of radium to date is about 204 g. Production in Czechoslovakia in 1920 was 2·2 g. (valued at 22 million kronen), in 1921, 3·2 g. (32 mill. kr.), and in 1922 2·2 g. (11 mill. kr.).—(*Ch. Comm. J., Jan.* 25, 1924.)

Rubber Industry in Japan

In 1923, between 500 and 600 factories in Japan were engaged in manufacturing rubber articles, the most important being rubber toys, the value of which in 1922 was 1,611,982 yen, and which are now being exported in large quantities to Australia, South America, and India. Rubber tyres are also being produced at low prices, and find a market in China and the Dutch Indies. Statistics published in the *Bulletin* of the Tokio Chamber of Commerce show that during 1922 Japanese imports of crude rubber and gutta-percha amounted to 16,581 tons, valued at 11,315,384 yen, as against 23,164 t., valued at 15,742,019 yen, in 1921. To show the growth of the rubber industry in Japan since 1914, it is stated that the total importation in that year of crude rubber and gutta-percha was only 1039 t., valued at 2,146,634 yen. The value of rubber output has grown from 15,028,864 yen in 1917, to 41,635,634 yen in 1921.—(*Ch. Comm. J., Jan.*, 1924.)

Abrasive Materials in 1922

In 1922 natural abrasives were produced in 26 States, the quantities sold being as follows:—Grindstones and pulpstones, 26,524 short tons; oilstones and scythestones, 1016 t.; emery, 1468 t.; garnet, 7054 t.; diatomaceous earth and tripoli, 74,966 t.; pumice, 45,262 t.; grinding pebbles and tube-mill lining, 3159 t. The total value of the sales of natural abrasives was $2,732,674, whereas that of sales of artificial abrasives was $5,317,485, and taking account of imports valued at $1,695,402 and exports worth $1,217,615, the apparent consumption reached the value of $8,527,946. The artificial abrasives, produced to the extent of 103,262,000 lb., were of three kinds, viz., metallic, silicon carbides and aluminium oxides.

Extension of University of Oxford Science Department

It was announced in Convocation on the 19th inst., that the Trustees of the Rockefeller Foundation had offered £75,000 to the University for the development of the Department of Biochemistry, and the University has authorised a large extension of the space allowed in the University Park, for this purpose.

REVIEWS

THE MICRO-ORGANISMS OF THE SOIL. *By* SIR E. JOHN RUSSELL, F.R.S., *and Members of the Biological Staff of the Rothamsted Experimental Station. Pp. viii.+188. London: Longmans, Green & Co.*, 1923. *Price* 7*s*. 6*d*.

Great advance has been made in our knowledge of the micro-organisms of the soil since Pasteur suggested in 1862 that nitrification was probably a biological action, and Schloesing and Müntz produced proof some fifteen years later that this was so. Until the end of last century it was the action of bacteria, and especially of a few classes of bacteria such as those which cause nitrification and denitrification, and those which bring atmospheric nitrogen into organic combination either in symbioses with leguminous plants or otherwise, which attracted most attention, and other classes of micro-organisms were almost neglected. During the past twenty years a great change has been in progress, and the protozoa, the fungi, and the algae of the soil have all become subjects of study, and, though our knowledge of these is still in its infancy, a whole literature concerning them has sprung up and the foundations, at any rate, have been laid of an edifice of exact knowledge concerning them. The older text-books of agricultural science may make some reference to nitrification and fixation of free nitrogen, but the student who wished to know anything of the recent work on tho bacteria, protozoa, algae and fungi of the soil, and the interrelations of these, had practically to dig it laboriously out of the original papers. The time had come for a work which would place this knowledge within the reach of teachers and students of agricultural science.

No place has played a greater part in investigating the micro-organisms of the soil than the Rothamsted Experimental Station. Since the investigation of the partial sterilisation of the soil, started in 1907, led Sir John Russell and Dr. Hutchinson to the fruitful conclusion that the increase in the number of soil bacteria is kept in check by soil protozoa, and that therefore soil fertility depended on the numbers of protozoa as well as on the numbers of bacteria, attention has been turned to soil protozoa, and after these soil algae and fungi also received increased attention. At Rothamsted a staff of

experts has been built up to form a team for the study of all these different soil organisms. This very valuable book has been written by the heads of this staff, and probably there is no other institution which could have produced such a book; certainly there is no other in Britain.

The opening chapter, which is largely historical, deals with the development of the idea of a soil population. This and the closing chapter which gives a summary of the chemical activities of the soil population and their relation to the growing plant, are contributed by Sir John Russell himself. The remaining chapters deal with what is known concerning different classes of soil organisms. Mr. H. G. Thornton writes two chapters on soil bacteria, which he classifies not according to morphological characters, but according to their physiological activities, a method which is much more useful to the soil student. Naturally the special work carried out at Rothamsted in the decomposition of cellulose and the formation of artificial farmyard manure from straw comes in for special attention.

The chapters on Protozoa are contributed by Mr. D. W. Cutler, the head of the Rothamsted Department of Protozoology, whilst Dr. Muriel Bristol contributes a chapter on Soil Algæ and Dr. W. B. Brierley two chapters on Soil Fungi. A chapter on the invertebrate fauna of the soil, other than protozoa, is contributed by Dr. A. D. Imms. Many of these organisms are not micro-organisms, but, very wisely, the picture of the soil population has been completed by their inclusion in the book.

Any student who reads this monograph will have no excuse for cherishing that common student delusion of the certainty and fullness of our knowledge. Each author in turn comments in one way or another on the limitations and uncertainty of the information on the subject with which he is dealing, and points out how much still remains to be investigated. One might almost say that the prevailing note of the whole book is the unsatisfactory state of our knowledge of all the subjects with which it deals. As is natural, the work which has been done at Rothamsted always claims special attention, but other work is not forgotten. At the end of each section an excellent bibliography is given. The work is well and clearly printed, and contains few typographical errors. It can be recommended to all students of agricultural science, and should be in the hands of every agricultural teacher.

JAMES HENDRICK

DIFFERENTIAL EQUATIONS IN APPLIED CHEMISTRY. *By* FRANK LAUREN HITCHCOCK *and* CLARK SHOVE ROBINSON. *Pp. vi*+110. *New York: John Wiley and Sons; London: Chapman and Hall*, 1924. *Price* 7*s*. 7*d*.

This small book is based on a course given to students of chemical engineering at the Massachusetts Institute of Technology, and the practical needs of this type of student are kept in the forefront. Graphical methods are freely used, and perhaps the most useful feature is the inclusion of numerous excellent examples. The answers are not given, and although the authors say that this was deliberate policy, it would probably have been more useful to have given the answers. The main part of the book is taken up by a detailed discussion of such simple types of differential equations as occur in chemical dynamics, and an elementary knowledge of calculus is assumed. The book, therefore, will be a useful supplement to elementary works on the calculus intended for chemical students, and the line of treatment adopted will appeal especially to men studying chemical engineering. Some of the very simple standard types of equations do not seem to be very well known to chemists, and a large amount of space is frequently wasted in journals by the reproduction of detailed calculations leading to results which are well known standard forms, and could have been written down at once by inspection of the primary equation. Perhaps this book may serve as an introduction to some of these forms.

J. R. PARTINGTON

DIRECTORY FOR THE BRITISH GLASS INDUSTRY 1923. *Published by the Society of Glass Technology, Sheffield. Price* 7*s*. 6*d*.

This excellent publication is more than a mere directory. It includes an alphabetical list of glass manufacturers, makers of scientific glass articles and optical apparatus, craftsmen, firms making plant apparatus and raw materials used in the glass industry, trades unions and other associations concerned in the industry, and periodicals in all countries in which articles or abstracts of interest to glass-makers appear. The various lists appear to be complete and accurate, and it is obvious that great pains have been taken with the preparation of the book. The Society of Glass Technology, the compiler, Mr. G. S. Duncan, and the editor, Prof. W. E. S. Turner, are to be warmly congratulated on their work.

ENGINEERING NON-FERROUS METALS AND ALLOYS. *By* L. AITCHISON, D.Met., *and* W. R. BARCLAY, O.B.E. *Pp. xx*+300. *London: Henry Frowde and Hodder & Stoughton*, 1923. *Price* 21*s*.

The authors have supplied a much-needed book. A certain amount of information on the properties of a limited number of non-ferrous alloys has been available for a very long time, having been accumulated as a result of experience in the working and use of these materials, but when compared with similar knowledge available with regard to iron and steel, this has, until quite recently, been exceedingly meagre. The outstanding features of iron and steel as compared with non-ferrous metals are the much greater strength they exhibit and the profound differences in properties obtained by varying the thermal treatment. The latter feature undoubtedly helped in the past to focus the attention of scientific workers on to steel to the partial neglect of non-ferrous metals. Conditions have now changed and, owing to the general advance of scientific knowledge, to the activities of such societies as the Institute of Metals, and to the influence of war requirements, there has recently been an enormous increase in the exact knowledge of the constitution, properties and

uses of a large range of alloys. The authors have done good service in collecting together a large amount of this information (which has previously only been available after a search through journals and technical papers), and presenting it in a suitable manner for engineers and others interested in the manufacture, treatment and use of non-ferrous metals and alloys.

The book is divided into two parts. Part I is devoted to non-ferrous metals generally, and deals with the properties, constitution, casting, working, heat treatment, mechanical properties and mechanical testing of these alloys. Part II is devoted to a consideration of the various classes of alloys, and deals with copper and its alloys, aluminium and its alloys, nickel and alloys of nickel and miscellaneous non-ferrous alloys. A chapter is also devoted to a consideration of the choice and specification of a non-ferrous alloy.

The vast majority of the non-ferrous alloys in industrial use may be classified as copper, aluminium or nickel alloys from the name of the chief constituent in each case. Of these, the copper alloys are most widely used in engineering industries, and receive a considerable amount of attention by the authors. Aluminium alloys have only become of importance to engineers within recent years, but our knowledge of their properties is already considerable. Nickel alloys have received considerable attention during recent years, as they include some of the strongest, toughest, most durable and most ductile of the non-ferrous alloys. About one-half of the book is devoted to these three classes of alloys and 153 tables of analysis, tests, and other data are included in this portion of the book.

The book may be strongly recommended to all interested in non-ferrous metals and alloys.

C. O. Bannister

COMPANY NEWS

MANDER BROTHERS, LTD.

The business of varnish, colour, paint and printing ink manufacturers formerly carried on by Sir Charles T. Mander, G. le M. Mander, C. A. Mander, G. P. Mander, and H. V. Mander, as "Mander Bros.," is now taken over by Mander Brothers, Ltd., with a registered capital of £600,000, the partners becoming directors of the new company.

SOUTH STAFFORDSHIRE MOND GAS CO., LTD.

The directors' report for the year ended December 31, 1923, states that about 5 per cent. more fuel was gasified and 11 per cent. more gas distributed than during 1922, although trade in the districts served by the company's mains was bad throughout the year. There are now indications of improvement and an increasing demand. The gross profit is £18,468, and after deducting debenture and bank interest, there is a net profit of £9308. During the year the bank overdraft was reduced from £55,991 to £52,211. In view of the amount of the overdraft the directors do not recommend the payment of a preference dividend.—(*Oil & Col. Tr. J.*, 16.2.24.)

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

The demand for heavy chemicals is well sustained, but business will, of course, suffer at once from the unfortunate dockers' dispute. Inquiries and orders for the heavy alkalis are particularly good on the export side, in addition to which home consumption is increasing steadily from week to week. There are no fundamental changes in prices to report.

Acetic Acid, 40% tech.	£24 per ton. Fair inquiry.
Acid Hydrochloric	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw.	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime	£7 per ton, packages included.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate	5½d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76%	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports. Business good.
Sod. Acetate 97/98%	£24 per ton.
Sod. Bicarbonate	£10 10s. per ton carr. paid. In fair request.
Sod. Bisulphite Powder 60/62%	£19—£20 10s. per ton according to quantity, f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb. Very quiet.
Sod. Nitrate refd. 96%	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included

RUBBER CHEMICALS

Antimony sulphide	Expected to advance in sympathy with the crude metal.
Golden	5½d.—1s. 3d. per lb., according to quality.

Antimony Sulphide (cont.)
Crimson .. .. 1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow 1s. 11d. per lb.
Cadmium Sulphide .. 4s. per lb.
Carbon Bisulphide .. £24—£26 10s. per ton according to quantity.
Carbon Black .. .. Prices continue low but expected to advance in the Spring. Two or three case lots can now be bought at 6½d. per lb. ex wharf. For direct shipment in quantity the price is about 6d. per lb. c.i.f.
Carbon Tetrachloride .. £56 per ton, drums free.
Chromium Oxide .. 1s. 3d. per lb.
Indiarubber Substitutes, White and Dark 5d.—7d. per lb. Dearer owing to increased cost of rape seed oil. Good demand.
Lamp Black .. .. 40s. per cwt., barrels free.
Lead Hyposulphite .. 7½d. per lb.
Lithopone .. .. £22 10s. per ton.
Mineral Rubber "Rubpron" .. .. .. £15 10s. per ton f.o.r. London.
Sulphur .. .. .. £10—£12 per ton, according to quality.
Thiocarbanilide .. .. 2s. 9d. per lb.
Vermilion, pale or deep .. 3s. 4d.—3s. 6d. per lb.
Zinc Sulphide .. .. 7½d.—1s. 8d. per lb., according to quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade and there appears a more healthy prospect in the charcoal market.

Acetate of Lime—
Brown .. .. .. £14 10s. per ton d/d. Demand active.
Grey .. .. .. £22 per ton.
Liquor .. .. .. 9d. per gall. 32° Tw.
Charcoal .. .. .. £7 5s.—£9 per ton, according to grade and locality. Market quiet.
Iron Liquor .. .. 1s. 7d. per gall. 32° Tw.
1s. 2d. „ „ 24° Tw.
Red Liquor .. .. 10d.—1s. per gall. 14/15° Tw.
Wood Creosote .. .. 2s. 7d. per gall. Unrefined.
Wood Naphtha—
Miscible .. .. 5s. 6d. per gall. 60% O.P. Dull market.
Solvent .. .. 5s. 6d. per gall. 40% O.P. Dull market.
Wood Tar .. .. £5—£6 per ton according to grade. Demand not very brisk. Ample supplies.
Brown Sugar of Lead .. £42 per ton. Demand more active.

TAR PRODUCTS

Acid Carbolic—
Crystals .. .. 8½d. per lb. Some business passing at lower prices.
Crude 60's .. .. 1s. 10d.—2s. per gall. Firmer, with more inquiry.
Crude 60's .. .. 1s. 10d.—2s. per gall. Little business passing, but more inquiry.
Acid Cresylic, 97/99 .. 2s.—2s. 3d. per gall. Steady business.
Pale 95% .. .. 1s. 10d.—2s. 2d. per gall. Good demand.
Dark .. .. .. 1s. 11d. per gall. Steady business.
Anthracene Paste 40% .. 4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—
Strained .. .. 9d.—10d. per gall. Very quiet.
Unstrained .. .. 8½d.—9d. per gall.
Benzole—
Crude 65's .. .. 10½d.—1s. per gall. ex works in tank wagons.
Standard Motor .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure .. .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% .. .. 1s. 4½d.—1s. 7d. per gall.
Pure .. .. 1s. 8d.—1s. 10d. per gall.
Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 11½d. per gall. Few inquiries.
Middle Oil .. .. } 8½d.—9½d. per gall. according to
Heavy .. .. .. } grade and district. Market
Standard Specification } very firm. Demand good.
Naphtha—
Per gall. } More inquiry.
Solvent 90/160 .. 1s. 1d.—1s. 3d. } Prices show up-
Solvent 90/190 .. 1s. 1d.—1s. 3d. } ward tendency.
Naphthalene Crude—
Drained Creosote Salts £6—£8. Fair business.
Whizzed or hot pressed £8—£14 per ton. Price nominal. No business.
Naphthalene—
Crystals .. .. £16 10s. per ton.
Flaked .. .. .. £17 per ton.
Pitch, medium soft .. 52s. 6d.—62s. 6d. per ton, f.o.b. Market weak. Few sellers.
Pyridine—90/140 .. 14s.—14s. 6d. per gallon. Fewer inquiries.
Heavy .. 11s.—12s. Steady with fair business.

INTERMEDIATES AND DYES

Business in dyestuffs has improved appreciably with orders being given for larger quantities. Prices of intermediates made directly from pure benzol have been raised, owing to the increased cost of the latter.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. .. 4s. 6d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 11d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 6d. per lb. Better demand.
Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 7¾d.—8½d. per lb. naked at works.
Aniline Salts .. .. 7¾d.—9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 3d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 29/31° C. .. 5½d.—6d. per lb. Demand quiet.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Market quiet.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Market quiet.
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethyaniline .. .. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 3s. 3d. per lb. d/d.
Monochlorbenzol .. £63 per ton.
α-Naphthol .. .. 2s. 6d. per lb. d/d.
β-Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. 1s. 5d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.

m-Nitraniline	5s. 3d. per lb. d/d.
p-Nitraniline	2s. 5d. per lb. d/d.
Nitrobenzene	5¼d.—5½d. per lb. naked at works.
o-Nitrochlorbenzol	2s. per lb. 100% basis d/d.
Nitronaphthalene	11¾d. per lb. d/d.
p-Nitrophenol	1s. 9d. per lb. 100% basis d/d.
p-Nitro-*o*-amido-phenol	4s. 6d. per lb. 100% basis.
m-Phenylene Diamine	4s. 0d. per lb. d/d.
p-Phenylene Diamine	10s. 6d. per lb. 100% basis d/d.
R. Salt	3s. per lb. 100% basis d/d.
Sodium Naphthionate	2s. 7d. per lb. 100% basis d/d.
o-Toluidine	7d.—8d. per lb.
p-Toluidine	3s. 10d.—4s. 5d. per lb. d/d.
m-Toluylene Diamine	4s. 0d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P.	£52 per ton.
Acid, Acetyl Salicylic	3s. 6d.—3s. 9d. per lb. Steady demand.
Acid, Benzoic	Commercial acid dearer at 2s. 9d. per lb. B.P. quality remains unobtainable.
Acid, Boric B.P.	Cryst. £54 per ton, Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric	18s.—20s. per lb.
Acid, Citric	1s. 5¼d. per lb., less 5% for ton lots. Market firm.
Acid, Gallic	3s. per lb. for pure crystal. Steady market.
Acid, Pyrogallic, Cryst.	6s. per lb., for 28 lb. lots.
Acid, Salicylic	2s. 4d.—2s. 7d. per lb. For ton lots 2s. 3d. is quoted. Market slightly easier.
Acid, Tannic	3s. 3d. per lb. for B.P. quality.
Acid, Tartaric	1s. 1½d. per lb. less 5%. Very firm. Considerable inquiry and buying.
Amidol	9s. per lb. d/d.
Acetanilide	3s. per lb. Weak.
Amidopyrin	14s. per lb. Demand negligible.
Ammon. Benzoate	4s. per lb.
Ammon. Carbonate B.P.	£35 per ton.
AtropineSulphate	12s. 6d. per oz. for English make. Market neglected.
Barbitone	17s. per lb.
Benzonaphthol	5s. 9d.—6s. 3d. per lb. Supplies scarce.
Bismuth Salts	A steady market. Prices according to quantity:
Bismuth Carbonate	12s. 9d.—14s. 9d. per lb.
„ Citrate	11s. 4d.—13s. 4d. „
„ Salicylate	10s. 2d.—12s. 2d. „
„ Subnitrate	10s. 9d.—12s. 9d. „
Borax B.P.	Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides—	Per lb.
Potassium	9d.—10d. } Steady market.
Sodium	9½d.—10d. } Steady market.
Ammonium	11d.—1s. } Steady market.
Calcium Lactate	2s. 9d. per lb. for best English make. Market firm.
Chloral Hydrate	3s. 9d. per lb. Weak.
Chloroform	2s. per lb. for cwt. lots.
Creosote Carbonate	6s. 6d. per lb. Little demand.
Guaiacol Carbonate	13s. per lb. for small stocks available. More inquiry. available. Slightly weaker.
Hexamine	3s. 9d.—4s. per lb. for foreign makes.
Homatropine Hydrobromide	30s. per oz.
Iron. Ammon. Citrate, B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	1s. 6d.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B. P.	56s. per lb.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Prices reduced. Market quiet.
Red oxide	4s. 9d.—4s. 10d. per lb.
Corrosive sublimate	3s.—3s. 1d. „
White precip.	4s. 1d.—4s. 2d. „
Calomel	3s. 5d.—3s. 6d. „
Methyl Acetanilide	20s. per lb.
Methyl Salicylate	2s. 11d.—3s. per lb. for carboys. Firmer.
Methyl Sulphonal	22s. per lb.
Methylene di-tannin	7s. 6d. per lb. In good demand.
Paraformaldehyde	3s. 6d. per lb., without much inquiry.
Paraldehyde	1s. 8d. per lb.
Phenacetin	7s. per lb. Weaker.
Phenazone	8s. per lb. Dull.
Penolphthalein	7s. 6d. per lb. Weaker.
Potass. Bitartrate—99/100% (Cream of Tartar)	88s.—90s. per cwt., less 2½%. Firm market. Inquiry good.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Ferricyanide	3s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. lb., 1-cwt. kegs included.
Potass. Permanganate	9d. per lb. for B.P. crystal English make. In good demand.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	6s. 3d. per lb.
Salol	3s. 9d. per lb.
Silver proteinate	9s. 6d. per lb.
Sod. Benzoate, B.P.	3s. 3d. per lb. Ample supplies of British manufacture will soon be available.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity.
Sod. Hyposulphite—Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	76s. 6d.—81s. 6d. per cwt., according to quantity. Prices reduced.
Sod. Salicylate	Powder 2s. 10d.—3s. 1d. per lb., Crystal at 2s. 11d.—3s. 2d. per lb.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	18s. 6d. per lb.
Tartar Emetic	1s. 4d. per lb.

Thymol	13s. 6d.—14s. 6d. per lb. for good white crystal from ajowan seed. Distinctly firmer.	

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine	13s. 6d. ,,	
Amyl Acetate	3s. ,,	
Amyl Butyrate	7s. 3d. ,,	
Amyl Salicylate	3s. 6d. ,,	
Anethol (M.P. 21/22° C.)	3s. 9d. ,,	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. ,,	
Benzyl Alcohol free from Chlorine	3s. 3d. ,,	
Benzaldehyde free from Chlorine	3s. 3d. ,,	
Benzyl Benzoate.. ..	3s. 9d. ,,	
Cinnamic Aldehyde Natural	18s. 6d. ,,	
Coumarin	21s. ,,	
Citronellol	19s. ,,	
Citral	10s. ,,	
Ethyl Cinnamate ..	10s. ,,	
Ethyl Phthalate.. ..	3s. 9d. ,,	
Eugenol	11s. ,,	
Geraniol (Palmarosa) ..	37s. 6d. ,,	
Geraniol	10s.—17s. 6d. per lb.	
Heliotropine	8s. 6d. per lb.	
Iso Eugenol	15s. 9d. ,,	
Linalol ex Bois de Rose..	20s. ,,	
Linalyl Acetate	20s. ,,	
Methyl Anthranilate ..	8s. 6d. ,,	
Methyl Benzoate ..	6s. ,,	
Musk Ambrette	52s. 6d. ,,	
Musk Xylol	19s. ,,	
Nerolin	4s. ,,	
Phenyl Ethyl Acetate ..	10s. ,,	
Phenyl Ethyl Alcohol ..	16s. ,,	
Rhodinol	65s. ,,	
Safrol	1s. 10d. ,,	
Terpineol	2s. 6d. ,,	
Vanillin	26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	14s. 6d. per lb.	
Anise Oil	1s. 11d. ,,	
Bergamot Oil	14s. 6d. ,,	
Bourbon Geranium Oil ..	29s. 6d. ,,	
Camphor Oil	75s. per cwt.	
Cananga Oil, Java ..	9s. 4½d. per lb.	
Cinnamon Oil, Leaf ..	5¾d. per oz.	
Cassia Oil, 80/85% ..	9s. 6d. per lb.	
Citronella Oil—		
Java 85/90%	4s. 10d. ,,	
Ceylon	3s. 6d. ,,	
Clove Oil	8s. 9d. ,,	Cheaper.
Eucalyptus Oil 70/75%..	2s. 3d. per lb.	
Lavender Oil—		
French 38/40% Esters	24s. 6d. per lb.	
Lemon Oil	3s. 1d. ,,	
Lemongrass Oil ..	2¾d. per oz.	
Orange Oil, Sweet ..	12s. 6d. per lb.	
Otto of Rose Oil—		
Bulgarian	34s. per oz.	
Anatolian	26s. per oz.	
Palma Rosa Oil	19s. 3d. per lb.	Cheaper.
Peppermint Oil—		
English	70s. per lb.	
Wayne County ..	16s. 6d. per lb.	
Japanese	13s. 9d. per lb.	Advanced.
Petitgrain Oil	9s. 6d. per lb.	

PATENT LIST

The dates given in this list are, in the case of Applications for Patents, those of applications, and in the case of Complete Specifications accepted, those of the Official Journals in which the acceptance is announced. Complete Specifications thus advertised as accepted are open to inspection at the Patent Office immediately, and to opposition within two months of the date given; they are on sale at 1s. each at the Patent Office, Sale Branch, Quality Court, Chancery Lane, London, W.C.2, 15 days after the date given.

I.—GENERAL; PLANT; MACHINERY

Applications

A.-G. Kummler u. Matter. Liquid evaporators. 2391. Jan. 29. (Ger., 29.1.23.)

Alexander. High-temperature radiant drying systems, 2230. Jan. 28.

Bishop, and Lilleshall Co. Filter-presses. 3162. Feb. 7.

Cheyne. Mixing and grinding mills. 2304. Jan. 29.

Clapham and Clare. Apparatus for purifying gases. 2819. Feb. 4.

Dempster and Sons, and Toogood. Regenerator furnaces. 2510. Jan. 31.

Dini. Producing agglomerates for compressing into moulds. 2252. Jan. 28. (Ital., 29.1.23.)

Fuller. Drying apparatus. 3368. Feb. 8.

Geisel. Solvent recovery plant. 2543. Jan. 31. (Ger., 28.3.23.)

Haneman and Speichert. Vacuum furnaces. 2272. Jan. 28. (Ger., 17.2.23.)

Kautny. Apparatus for liquefying and separating gases. 2220. Jan. 28.

Koppers Coke Oven Co. Apparatus for washing liquids with liquids. 2355. Jan. 29. (Ger., 30.1.23.)

Low, and Low Engineering Co. Mixing-apparatus. 2677. Feb. 1.

Major and Taylor. Distillation etc. of liquids. 3208. Feb. 7.

Mewes and Mewes. Separation of gas mixtures. 2908. Feb. 4.

Paterson. Filtering apparatus. 2382. Jan. 29.

Complete Specifications Accepted

19,845 and 27,715 (1922). Shaw. Separating and removing matter suspended in a fluid. (210,101.) Feb. 6.

28,250 (1922). Rigg and McBride. *See* X.

33,296 (1922) and 17,944 (1923). Taylor and Oldfield. Gas-cleaning apparatus. (210,233.) Feb. 6.

5957 (1923). Agthe. Continuous production of emulsions, suspensions, and similar disperse systems. (210,307.) Feb. 6.

9392 (1923). Maison Beer, and Charlior. Separating, washing, and classifying solid materials. (210,663.) Feb. 13.

18,071 (1923). Fraser and Egleston. Grinding or mixing apparatus. (210,702.) Feb. 13.

24,976 (1923). Loke. *See* VIII.

26,806-7 (1923). Shaw. Separating and removing matter suspended in a fluid. (210,376.) Feb. 6.

II.—FUEL; GAS; DESTRUCTIVE DISTILLATION MINERAL OILS; LIGHTING

Applications

Alden and Green. Gas-producers. 3381. Feb. 9.

Bettisfield Trust Co., and Perkin. Distilling and carbonising coal etc. 2590. Jan. 31.

Black. Extraction of oils, spirits, and gases from polionite, shale, etc. 2487. Jan. 30.

Briketthar z-Ges. Manufacture of combustible briquettes. 2267. Jan. 28. (Ger., 29.1.23.)

British Electrical and Allied Industries Research Assoc. 3363. *See* XI.

Bruce. Carbonisation etc. of wood. 3092. Feb. 6.

Clapham and Clare. 2819. *See* I.

Donald. Drying peats etc. 26[illegible] and 3432. Feb. 1 and 9.

Evans. Briquette binders. 31[illegible]. Feb. 7.

Fabry. Coke-oven heating flues. 2805. Feb. 4.
Fabry. Purification of coal-gas. 3159. Feb. 7.
Gros. Manufacture of hydrogen and acetylene. 2759. Feb. 2. (Fr., 8.2.23.)
Gros. Pyrogenic transformation of acetylene or gaseous mixtures derived from acetylene. 2760. Feb. 2. (Fr., 14.2.23.)
Hanna. Manufacture of carbon black. 3135. Feb. 6.
Hersey, Stokes, and Kirkham, Hulett, and Chandler. Gas washer-scrubbers. 3427. Feb. 9.
Hinselmann. Obtaining products from fuels, oil shale, etc. 3379. Feb. 8. (Ger., 6.6.23.)
Hydro-Carbon Distillation Synd., Knapp, and Winzer. Distillation of oils etc. 3115. Feb. 6.
Kernot. Treatment of hydrocarbon-yielding materials. 2369. Jan. 29.
Knapen. Washing coal dust etc. 3300. Feb. 8. (Belg., 8.2.23.)
Koppers Coke Oven Co. (Koppers). Continuously distilling liquid hydrocarbons. 3446. Feb. 9.
Lamplough and Porter. Conversion of heavy hydrocarbons into lighter hydrocarbons. 2698. Feb. 1.
Lederer. Manufacture of filamentary incandescing bodies. 2268. Jan. 28. (Austria, 21.2.23.)
Loebell. Manufacture of combustible gas. 2567-8. Jan. 31.
Mackay. Bituminous emulsions. 3312. Feb. 8.
Odell. Gas-producer. 3305. Feb. 5.
Syndikat f. Gasforschung. Dry distillation of bituminous fuel. 2694. Feb. 1. (Ger., 1.2.23.)
Umpleby. Gas-generators. 3039. Feb. 6.
Wallace. Treatment of liquid hydrocarbons, oils, or fats. 2704. Feb. 1.
Whitfield. Suction-gas producers. 3281. Feb. 8.

COMPLETE SPECIFICATIONS ACCEPTED

20,827 (1922) and 1123 (1923). Woodall, Duckham, and Jones, and Duckham. Briquetting fuel. (210,466.) Feb. 13.
23,948 (1922). Sutcliffe. Machines for briquetting, compressing, etc. coal etc. (210,474.) Feb. 13.
25,377 (1922). Aguillon. Recovery of benzol from coal gas. (210,114.) Feb. 6.
28,225 (1922). Marks (Chem. Research Synd.). Production of hydrocarbons of relatively low boiling point. (210,131.) Feb. 6.
28,963 (1922). Electrical Improvements, Ltd., and Merz. Fuels. (210,147.) Feb. 6.
33,296 (1922) and 17,944 (1923). Taylor and Oldfield. *See* I.
7728 and 12,672 (1923). Heyl. Utilisation of the carbon residue of distillation retorts. (210,317.) Feb. 6.
14,260 (1923). Mond (American Shale Reduction Co.). Extracting volatile matter from oil-bearing shale etc. (210,691.) Feb. 13.
16,960 (1923). Travers and Clark. Manufacture of gas from coal etc. (210,356.) Feb. 6.
18,092 (1923). Meister, Lucius, u. Brüning. Manufacture of highly-active charcoal. (201,163.) Feb. 13.

III.—TAR AND TAR PRODUCTS

COMPLETE SPECIFICATIONS ACCEPTED

25,377 (1922). Aguillon. *See* II.
28,225 (1922). Marks. *See* II.

IV.—DYESTUFFS AND INTERMEDIATES

APPLICATIONS

Chem. Fabr. Griesheim-Elektron. 2377. *See* VI.
Coke and Maxted. Manufacture of phthalimide. 2713. Feb. 2.
Colloisil Colour Co. (Eberlein). Manufacture of silicates of basic dyestuffs. 3249. Feb. 7.
Imray (Meister, Lucius, u. Brüning). Manufacture of indigoid vat dyestuffs containing sulphur. 2279. Jan. 28.
Imray (Soc. Chem. Ind. Basle). Manufacture of indigoid dyestuffs. 2474. Jan. 30.
Scottish Dyes, Ltd., Thomas, and Thomson. Dyestuffs. 3021. Feb. 5.
Soc. Chem. Ind. Basle. Manufacture of a thionaphthisatin. 2379. Jan. 29. (Czech., 29.11.23.)
Soc. Chem. Ind. Basle. Manufacture of an indigoid dyestuff. 2473. Jan. 30. (Swiss, 9.2.23.)

COMPLETE SPECIFICATIONS ACCEPTED

26,021 (1922) and 16,634 (1923). Masters. Manufacture of β-naphthol 2.3.6- and 2.6.8-disulphonic acids. (210,120.) Feb. 6.
32,090 (1922). Bloxam (Chem. Fabr. Griesheim-Elektron). Manufacture of azo-dyestuffs. (210,217.) Feb. 6.
10,894 (1923). Imray (Soc. Chem. Ind. Basle). Manufacture of dyestuffs derived from pyrazolone. (210,669.) Feb. 13.

V.—FIBRES; TEXTILES; CELLULOSE; PAPER

APPLICATIONS

Alsa Soc. Anon. Manufacture of artificial threads. 2699. Feb. 1. (Fr., 13.4.23.)
Bader, Eggert, and Wagner. Manufacture of artificial silk etc. fabrics from viscose. 3404. Feb. 9.
Bergen. Manufacture of viscose threads etc. 3196. Feb. 7. (Holland, 7.2.23.)
Courtaulds, Ltd., and Hegan. Manufacture of filaments etc. from cellulose compounds. 2758. Feb. 2.
Nebrich. Apparatus for separating cellulose etc. 3147. Feb. 6.
Pokorny. Treatment of material of cellulose fibres. 2264. Jan. 28.
Soc. de Stéarinerie et Savonnerie de Lyon. Manufacture of cellulose esters. 3112. Feb. 6. (Fr., 31.7.23.)
Strüdel. Machine for dissolving or unthreading fabrics etc. 2705. Feb. 1.

COMPLETE SPECIFICATIONS ACCEPTED

19,647 (1922) and 10,535 (1923). Cook and Co., and Cook. Treatment of cotton etc. (210,100.) Feb. 6.
20,003 (1922). Kampf. Manufacture of artificial threads etc. of viscose. (184,449.) Feb. 6.
21,915 and 27,083 (1922). Dreyfus. Manufacture of artificial silk, artificial horsehair, etc. (210,108.) Feb. 6.
29,245 (1922). Medhurst. Manufacture of paper. (210,166.) Feb. 6.
29,491 (1922). Fues. Manufacture of water-resisting paper. (187,987.) Feb. 13.
29,885 (1922). Schidrowitz. Manufacture of paper etc. (210,526.) Feb. 13.
1029 (1923). Dreyfus. Manufacture or treatment of artificial threads. (210,266.) Feb. 6.
17,967 (1923). Soc. Chim. Usines du Rhône. Removal of size from cellulose acetate silk etc. (206,113.) Feb. 6.

VI.—BLEACHING; DYEING; PRINTING; FINISHING

APPLICATIONS

Chem. Fabr. Griesheim-Elektron. Producing on the fibre azo dyes from arylamides of 2.3-hydroxynaphthoic acid. 2377. Jan. 29. (Ger., 22.1.23.)
Lindsay. Steaming, ageing, etc. 2365. Jan. 29.

COMPLETE SPECIFICATIONS ACCEPTED

24,602 (1922). Durand et Huguenin. Manufacture of products for dyeing or printing. (186,057.) Feb. 13.
30,452 (1922). Davies and Haigh. Scouring, bleaching, dyeing, carbonising, etc. (210,545.) Feb. 13.
8933 (1923). Brandwood, Brandwood, and Brandwood. Dyeing and subsequent handling of yarns wound in the form of cheeses. (210,601.) Feb. 13.

VII.—ACIDS; ALKALIS; SALTS; NON-METALLIC ELEMENTS

Applications

Casale. Synthesis of ammonia. 2608. Jan. 31.
Chem. and Metallurgical Corp., and Smith. Treatment of lead chloride etc. 2472. Jan. 30.
Chem. Fabr. Grünau, Landshoff u. Meyer. Manufacture of cast and moulded articles from borates etc. 2255. Jan. 28. (Ger., 12.2.23.)
Gros. 2759. *See* II.
Makow and Wolffenstein. Production of hydrogen peroxide. 2782. Feb. 2.
Soc. Chim. Usines du Rhône. Manufacture of alkalinoearth arsenates. 2581 and 3230. Jan. 31 and Feb. 7. (Fr., 15.5.23 and 27.4.23.)

Complete Specifications Accepted

20,353 (1922). Scott. Manufacture of hydrogen and oxygen. (210,102.) Feb. 6.
29,040 (1922). Roberts. Manufacture of lime. (210,153.) Feb. 6.
3476 (1923). Cocksedge (Sundstrom and Tirziev). Manufacture of a sodium compound. (210,628.) Feb. 13.
6595 (1923). Henkel et Cie., and Weber. Treatment of iron chloride lyes. (195,947.) Feb. 6.
14,508 (1923). Titan Co. Akt. Treatment of titanium-nitrogen compounds. (199,713.) Feb. 13.
18,250 (1923). Vogel. Manufacture of colloidal sulphur. (210,363.) Feb. 6.

VIII.—GLASS; CERAMICS

Applications

Chem. Fabr. Grünau. 2255. *See* VII.
Comp. Générale des Cables de Lyon. Enamelling wire. 3253. Feb. 7. (Ger., 5.4.23.)
Royer. Furnaces for baking pottery. 2945. Feb. 5.

Complete Specifications Accepted

23,956 (1923). British Thomson-Houston Co. (General Electric Co.). Working quartz. (210,707.) Feb. 13.
24,976 (1923). Loke. Furnace linings, crucibles, etc. 210,708.) Feb. 13.

IX.—BUILDING MATERIALS

Applications

Angelis. Heat-insulating material. 2269. Jan. 28. (Fr., 27.1.23.)
Bercott. Manufacture of artificial stone. 2638. Feb. 1.
Evans, Simkin, and Perfect Kiln Co. Brick etc. kilns. 2409. Jan. 30.
Heyl. Cement. 2584. Jan. 31.
Mackay. 3312. *See* II.

Complete Specifications Accepted

29,041 (1922). Roberts. Portland cement compositions. (210,154.) Feb. 6.
13,675 (1923). Zimmer and Frankl. Manufacture of artificial asphalt-limestone. (210,343.) Feb. 6.
18,940 (1923). Patrouilleau. Manufacture of bauxite cements. (210,366.) Feb. 6.

X.—METALS; METALLURGY, INCLUDING ELECTRO-METALLURGY

Applications

Bedford. Rendering metals rustless. 2791. Feb. 2.
Boucher and Shorter. Heat treatment of steel articles. 3080. Feb. 6.
Chemical and Metallurgical Corp., and Smith. Treatment of ores etc. containing zinc. 2376. Jan. 29.
Comp. Gén. des Cables de Lyon. 3253. *See* VIII.
Dürkoppwerke A.-G. Iron separation and desulphurising in cupola furnaces. 3034. Feb. 5. (Ger., 5.3.23.)
Fox. Treating surface of bronze etc. 2878. Feb. 4.
Levoz. Direct reduction of iron ores. 2686. Feb. 1. (Belg., 1.2.23.)
Marks (Sumet Corp.). Metallic composition. 2904. Feb. 4.
Marks (Sumet Corp.). Purifying metals. 2905. Feb. 4.
Martin, and Sankey and Sons. Pickling stainless steel etc. 2205. Jan. 28.
Meker. Manufacture of metals coated with aluminium etc. 2601. Jan. 31. (Fr., 7.2.23.)
Ormiston. Alloy. 2441. Jan. 30.
Perkins and Taplin. Treatment of ores containing oxidised copper compounds. 2322. Jan. 29.
Sumpter, and Vickers, Ltd. Surface-hardening steel articles. 3243. Feb. 7.

Complete Specifications Accepted

25,973 (1922). Meehan. Manufacture of grey iron. (210,118.) Feb. 6.
28,250 (1922). Rigg and McBride. Drying ores, concentrates, etc. (210,133.) Feb. 6.
29,616 (1922). Fink. Composite metal articles or materials. (210,508.) Feb. 13.
29,785 (1922). British Aluminium Co., and Gwyer. Aluminium alloys. (210,517.) Feb. 13.
34,251 (1922). Sulman and Picard. Froth-flotation test apparatus. (210,245.) Feb. 6.
34,716 (1922). Archer and Jeffries. Aluminium base alloys. (190,721.) Feb. 13.
20,595 (1923). Katsumori. Manufacture of porous iron. (210,369.) Feb. 6.
29,567 (1923). Foerster. Art of electro-plating. (207,544.) Feb. 13.

XI.—ELECTRO-CHEMISTRY

Applications

British Electrical and Allied Industries Research Assoc. and Flight. Insulating and lubricating oils. 3363. Feb. 8.
Eltax Elektro A.-G. Electric batteries. 2372. Jan. 29.
Leitner. Electric accumulators. 2861. Feb. 4.
Pehrson. Electric furnaces. 2259. Jan. 28.
Tribelhorn. Filling paste for lead accumulators etc. 2389. Jan. 29. (Switz., 1.2.23.)
Wade (Nederlansch Techn. Handel Maatsch. Giro). Manufacture of electric resistance material. 3033. Feb. 5.

Complete Specifications Accepted

34,747 (1922). Oldham and Son, and Wilde. Galvanic batteries. (210,593.) Feb. 13.
605 (1923). Case. Light-reactive cells. (210,604.) Feb. 13.
7259 (1923). Soc. Anon. Lo Carbone. Electric battery cells. (197,301.) Feb. 6.
7651 (1923). Chloride Electrical Storage Co., and Dean. Electric accumulators. (210,316.) Feb. 6.
7981 (1923). Wild and Barfield. Electric furnaces. (210,652.) Feb. 13.
19,952 (1923). Pepper. Electric batteries. (201,933.) Feb. 13.
29,567 (1923). Foerster. *See* X.

XII.—FATS; OILS; WAXES

Applications

McNicoll. Treating crude cotton oils etc. 3070. Feb. 6.
Wallace. 2704. *See* II.

XIII.—FATS ; OILS ; WAXES

APPLICATIONS

Barber. Manufacture of lac. 3307. Feb. 8.
Edser and Marshall. Paints. 3364. Feb. 8.
Evans. Separation of kauri gum from foreign matter. 2787. Feb. 2.
Farbw. vorm. Meister, Lucius, u. Brüning. Manufacture of sulphobenzyl esters of resinous condensation products from phenols. 3237. Feb. 7. (Ger., 7.2.23.)
Shepherd. Production of paint. 2717. Feb. 2.

COMPLETE SPECIFICATION ACCEPTED

20,265 (1922). Shawinigan Laboratories. Phenolic condensation products. (183,830.) Feb. 6.

XIV.—INDIA-RUBBER ; GUTTA-PERCHA

APPLICATIONS

Anode Rubber Co. Production of rubber sheets etc. from latex. 2773 and 2783. Feb. 2.

COMPLETE SPECIFICATIONS ACCEPTED

29,202 (1922). Plauson's (Parent Co.), Ltd. (Plauson). Colouring of rubber. (210,495.) Feb. 13.
22,351 (1923). Frerichs. Production of a substance resembling ebonite or vulcanite. (203,695.) Feb. 13.

XV.—LEATHER ; BONE ; HORN ; GLUE

COMPLETE SPECIFICATIONS ACCEPTED

25,275 (1922). Duckworth. Treatment of skins. (186,608.) Feb. 6.
9507 (1923). Soc. Anc. Etabl. A. Combe et Fils et Cie. Production of washable printings on leather. (207,778.) Feb. 6.

XVI.—SOILS ; FERTILISERS

COMPLETE SPECIFICATION ACCEPTED

14,304 (1923). Coppée et Cie. Production of mixed manure using distillers' wash etc. (200,070.) Feb. 6.

XVII.—SUGARS ; STARCHES ; GUMS

COMPLETE SPECIFICATIONS ACCEPTED

20,168 (1922). Sauer. Treatment of sugar juices. (183,485.) Feb. 13.
33,252 (1922). Russell. Filtration or decolorisation of sugar etc. (210,232.) Feb. 6.
14,400 (1923). Mitchell and Wuthrich. Extraction of juice and obtaining fuel from sugar cane. (210,692.) Feb. 13.

XVIII.—FERMENTATION INDUSTRIES

COMPLETE SPECIFICATIONS ACCEPTED

12,805 (1923). Continentale Industrie Verwertung Ges. See XIX.
14,304 (1923). Coppée et Cie. See XVI.

XIX.—FOODS ; WATER PURIFICATION ; SANITATION

APPLICATIONS

Heyerdahl. Preservation of milk etc. 2624. Feb. 1.
Heyerdahl. Production of edible products rich in vitamins. 2728. Feb. 2.
Heyerdahl. Manufacture of food products containing vitamins. 2729. Feb. 2.
Heyl. Purification of sewage etc. 2583. Jan. 31.
Huch. Manufacture of preserved goods. 2311. Jan. 29.
Sando. System for treating activated sludge. 2562. Jan. 31. (U.S., 5.2.23.)

COMPLETE SPECIFICATIONS ACCEPTED

26,652 (1922). Benoit. Purification of liquids. (210,480.) Feb. 13.
33,324 (1922). Marsan. Manufacture of substitutes for meat extract and meat powder. (190,147.) Feb. 13.
12,805 (1923). Continentale Industrie Verwertung Ges. Manufacture of food products from yeast. (197,695.) Feb. 6.
17,388 (1923). Imray (Soc. Chem. Ind. Basle). Manufacture of alkaline-earth metal compounds of the organic phosphorus compound of milk casein. (210,698.) Feb. 13.

XX.—ORGANIC PRODUCTS ; MEDICINAL SUBSTANCES ; ESSENTIAL OILS

APPLICATIONS

Chemosan A.-G. Production of solutions of mercury derivatives of hydroxybenzenesulphonic acids for therapeutics etc. 2276. Jan. 28. (Austria, 30.4.23.)
Dreyfus. Manufacture of organic compounds. 2454 Jan. 30.
Johnson (Badische Anilin u. Soda Fabr.). Manufacture of methyl alcohol etc. 3326. Feb. 8.

COMPLETE SPECIFICATIONS ACCEPTED

31,786 (1922). Loriette. Process for dehydrating alcohol (189,453.) Feb. 13.
17,388 (1923). Imray (Soc. Chem. Ind. Basle). See XIX

XXI.—PHOTOGRAPHIC MATERIALS AND PROCESSES

APPLICATIONS

Major. Photographic developers. 3419. Feb. 9.
Martinez. Self-fixing photographic papers. 2847. Feb. 4
May. Taking and reproducing pictures in natural colours 3256. Feb. 7. (Austria, 8.2.23.)
Tompkins. Production of photographic images. 2413 Jan. 30.

COMPLETE SPECIFICATIONS ACCEPTED

29,053 (1922). Hydroloid, Ltd. (Exportingenieure f. Papier u. Zellstofftechnik). Sensitised papers and the manufacture thereof. (210,493.) Feb. 13.

TRADE NOTES

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following enquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number.

Australia.—Oils, chemicals, dyes, rubber, crockery (Refs. 412/7/1/1/210 and 412/7/1/1/211, Official Secretary, Commercial Bureau, Australia House, Strand, W.C. 2) ; *Belgium.*—Metallurgical products (180), steel rails (21994/F.W./E.P.) ; *Danzig :* Oils (182) ; *Egypt :* Paint, oil, varnish (12352/F.E./G.C.) ; Paint, saddlery, cellulose (12407/F.E./G.C.) ; *Netherlands :* Iron and steel (185) ; *New Zealand :* Leather (176) ; Hardware, earthenware, enamel ware, china (177) ; Copper wire, vulcanised rubber (13096/E.D./CC.) ; *Poland :* Oils (182) ; *South Africa :* Brass, tyres, paper (High Commissioner for the Union of South Africa, London) ; *Spain :* Chemicals (195) ; Drugs, pharmaceutical products, rubber (196) ; *Uruguay :* Fuel oil (9346/F.L./C.C.2).

FRANCE

French Market News

Prices of turpentine are well maintained, and it appears that all stocks will be cleared before the new production appears on the market; the price on February 11 was 6·20 francs. A similar tendency holds with resins (price on February 11 W.W. 155 frs.). Numerous purchases of resins have been made by English houses, and the low stocks may lead to a rise in prices.

Nitrogen Fixation

The French Senate recently discussed the proposed agreement for the manufacture of synthetic ammonia and it appears that the Senate wishes to replace the company proposed by the Chamber of Deputies (*cf. Chem. and Ind.*, p. 228, 1923) by a National Nitrogen Office under the Ministry of Finance. This Office would be controlled by Parliament, to which its accounts would be presented each year.

Mining and Metallurgy in December

The following are statistics of production in December, 1923: Bauxite, 32,272 metric tons; iron ore, 2,034,759 t.; iron pyrites, 14,992 t.; coal and lignite, 3,346,690 t. (plus coke, 189,532 t.; briquettes, 263,324 t.); iron, 564,665 t. (536,749 t. in November); steel, 525,509 t. (an increase of 32,982 t. over November).

Imports of coal during December were: Coal and lignite, 2,347,524 t.; coke, 357,252 t.; briquettes, 79,383 t., compared with exports of 227,696 t. of coal; 45,678 t. of coke, and 14,073 t. of briquettes.

German Deliveries of Fuel

German deliveries of fuels to France and Luxemburg during 1923 comprised 1,690,000 tons of coal; 2,276,500 t. of coke, and 156,800 t. of lignite briquettes a total of 4,123,000 t. compared with deliveries in 1922 of 12,632,265 t. The delivery was fixed by the Reparations Commission at an annual total of 14,918,800 t., so that deliveries in 1923 were only 28 per cent. of the agreed amount.

Absolute Alcohol

Until 1921, absolute alcohol was solely a laboratory product, but the experiments on mixtures of petrol and alcohol with a view to developing the new motor fuel led to the examination of processes for producing alcohols of over 99·6°. In one process due to Monsieur Loriette, the alcohol is dehydrated in the cold by potassium carbonate, the potassium carbonate being regenerated by heating to from 133 to 140°. By warming with quicklime a similar result can be obtained. In the process due to Professor Young, the ternary azeotropic mixture of 18·5 per cent. alcohol, 74 per cent. benzene, and 74 per cent. water is distilled, the first distillation removing the water, the second removing the benzene, leaving pure alcohol. This method has been applied on an industrial scale by MM. Barbet and Delemard. Glycerin is also used to obtain absolute alcohol, as in the Van Ruijmecke process (1921). MM. E. and R. Urbain utilised the velocity of diffusion through porous walls to obtain an alcohol up to 99·8° in an apparatus which combines distillation with atmolysis.

PUBLICATIONS RECEIVED

DIE BLATTFARBSTOFFE. *By* PROF. R. WILLSTÄTTER, HANDBUCH DER BIOLOGISCHEN ARBEITSMETHODEN. *Edited by* PROF. E. ABDERHALDEN. *Abt. I. Chemische Methoden, Teil 11, Heft 1. Pp. 70. Berlin: Urban and Schwarzenberg,* 1924. *Price* 3.40 *Swiss francs.*

PRÉCIS DE CHIMIE PHYSIQUE. *By* H. VIGNERON. *Pp.* xii.+408. *Paris: Masson et Cie.* 1924.

THE VEGETABLE PROTEINS. *By* T. B. OSBORNE. *Monographs on Biochemistry. Pp.* xiii. 154. *Second edition. London: Longmans Green and Co.,* 1924. *Price* 9*s.*

THE RECOVERY OF NITRATE FROM CHILEAN CALICHE. *By* A. W. ALLEN, M.A. *Pp.* xi. 50. *London: C. Griffin and Co., Ltd.,* 1921. *Price* 6*s.*

PFLANZENUNTERSUCHUNGEN. METHODEN DER VISCOSITÄTSBESTIMMUNG DES LEBENDEN PROTOPLASMAS, *by* F. WEBER, *and* METHODEN ZUR FESTSTELLUNG DER KEIMFÄHIGKEIT VON PFLANZENSAMEN, *by* K. MÜLLER. *Handbuch der biologischen Arbeitsmethoden, edited by Prof. Abderhalden. Abt. XI. Methoden zur Erforschung der Leistungen des Pflanzenorganismus. Teil 2, Heft. 4. Pp.* 656—764. *Berlin: Urban and Schwarzenberg,* 1924. *Price* 5·25 *S. frs.*

PUBLICATIONS OF THE DEPARTMENT OF COMMERCE, BUREAU OF STANDARDS. *Washington: Government Printing Office,* 1923.

RECOMMENDED SPECIFICATION FOR QUICKLIME AND HYDRATED LIME FOR USE IN THE MANUFACTURE OF BRICK. *No.* 153. *Pp.* 7. *Price* 5 *cents.*

RECOMMENDED SPECIFICATION FOR QUICKLIME AND HYDRATED LIME FOR USE IN THE MANUFACTURE OF SAND-LIME BRICK. *No.* 150. *Pp.* 6. *Price* 5 *cents.*

A MEASURE OF THE COLOUR CHARACTERISTICS OF WHITE PAPERS. *By* R. E. LOFTON. *No.* 244. *Pp.* 667—675. *Price* 5 *cents.*

EMBRITTLEMENT OF MALLEABLE CAST IRON RESULTING FROM HEAT TREATMENT. *By* L. H. MARSHALL. *No.* 245. *Pp.* 677—693. *Price* 5 *cents.*

WET-PROCESS ENAMELS FOR CAST IRON. *By* R. R. DANIELSON *and* H. P. REINECKER. *No.* 246. *Pp.* 695—735. *Price* 10 *cents.*

AMERICAN TUNG-OIL CULTURE. *By* H. A. GARDNER. *Circular No.* 195. *Scientific Section, Educational Bureau Paint Manufacturers' Association of the United States. National Varnish Manufacturers' Association (co-operating). Pp.* 209—239. 1924.

ANNUAL REPORT, 1922—23, DEPARTMENT OF INDUSTRIES. *Bombay Presidency. Pp.* 28. *Bombay: Government Central Press,* 1923. *Price* 5 *as.* 6 *ps.*

INTERNATIONAL PAINT CO.

The profit of the International Paint and Compositions Company for 1923, after writing off bad debts, was £55,689, less income-tax £3082, and provision for depreciation fund, £5677, leaving £46,929, plus £3798 brought in, making £50,727. Directors recommend transferring to reserve fund £15,000, dividend of 5 per cent. on Ordinary shares for year, carrying forward £4727.

JOURNAL of THE SOCIETY OF CHEMICAL INDUSTRY

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EDITORIAL

We have read with much interest Prof. W. A. Noyes' little book, "Building for Peace II." As an American Professor of Chemistry who has recently lived for many months in France, has repeatedly visited England and has many friends in those two countries and in Germany, he is able to approach the subject in a dispassionate and broad-minded manner. A better understanding between all countries is slowly coming about, and a pamphlet such as this is helpful, but no such literature can hasten the progress very much. So far as European politics is concerned, we all have our own views, whether our knowledge of history, politics or economics justifies them or not. This great problem is outside the province of *Chemistry and Industry*, but nevertheless chemists may do a good deal towards promoting a better understanding between the English-speaking and the various Continental chemists, and there is no reason why *Chemistry and Industry* should not play its part in such a desirable enterprise. So far as concerns all countries, except Austria and Germany, their chemists meet once a year at the Congresses of the Union Internationale de la Chimie Pure et Appliquée, and this body has already played an important part, and is destined to play a still more important part in the future. Let us face the unpleasant parts of the landscape fairly and dispassionately. The Union Internationale meets next summer in Copenhagen; now a good many Danes believe, rightly or wrongly, that Denmark during the last sixty years and even during the last ten years, has been badly treated by Germany. This is a matter of history and politics, not of chemistry, but it is unfortunate all the same. Have the German men of science identified themselves with the doings of the German Government in this respect? In some measure by their famous manifesto, we fear that they have. Would it not be desirable that the German chemists should try to put themselves in the right, *vis-à-vis* their Danish neighbours? It would not be difficult for them to take some steps in this direction, if they wish to promote a better understanding. As between the German and the French chemists this is more difficult. Both nations have serious and important grievances. During the last sixty years France has twice been invaded by Germany in a manner which we suppose no intelligent chemist in either country would now defend, and the French chemists are, rightly or wrongly, of opinion that Germany has not done all in her power to repair the damage caused by the German Government, and they consequently, the majority of them, approve of, at any rate, some of the steps taken by the French Government in the occupation of the Ruhr and other districts. The German men of science on the whole—there must, without doubt, be exceptions—publicly proclaimed their approval of the acts of the German Government which had such unfortunate results to the harmony of European chemistry. We do not know whether they still approve of them, but if half-a-dozen or ten of the leading German chemists were to write a letter to us merely, and briefly, expressing their regret that France was invaded in 1914, and the succeeding years, and that the property of chemists was destroyed in the way it was, their letter through our columns would immediately be circulated in every European country and would have a good effect. Such a letter need not be an admission that all the faults were on one side, nor need it deal with those matters of policy which properly belong to the domain of history, but it would be an indication that some of the chemists in the year 1924 are able now to realise that the hopes, ambitions and methods of the German Government of the year 1914 were not in accordance with those peaceful ideas of progress with which science and, in particular, chemistry has already achieved so much.

* * *

The difficulty in the case of Germany and Belgium is very much the same. In the case of all other countries the obstacles to a good understanding of chemists are of trifling importance. We have only to look at the situation in Holland, Austria, Poland, Italy, Sweden, Switzerland and Czecho-Slovakia to realise that there is no cause in those countries to interfere with agreeable international relations between chemists. In spite of differences of language, of modes of thought, of political views, and of many other differences, the friendship between English and French chemists steadily grows. There is no reason why the German chemists, if they wish—as we assume they do—to co-operate with the other chemists of the world for the advancement of science, should not give the world some slight indication that they do not now identify their views with the views of the late German Government, and there is every reason why they should co-operate with us with the same friendliness, the same fairness, the same willingness to acknowledge the achievements of other countries, the same unalloyed scientific spirit which is characteristic of the Union Inter-

nationale. The chemists of countries which have produced such men as Arrhenius, Avogadro, Bunsen, Cailletet, Crookes, Curie, Davy, Dumas, Faraday, Fischer, Hofmann, Langmuir, Lewis, Liebig, Mendeléef, Moyer, Millikan, Ostwald, Pasteur, Perkin, Perrin, Ramsay, Stas, Van't Hoff, and scores of others should be large-minded enough to work together, so far as chemistry is concerned, quite apart from the political differences which separate their respective countries. We hope that German chemists will always be good citizens and supremely patriotic, that they will have a due, and even an undue, pride in their country, its history and its achievements, but in their purely chemical pronouncements and in their official chemical literature, it is prudent as well as neighbourly to eliminate all political theories and propaganda. The discovery of the cure for sleeping sickness, " Bayer 205," was an important and interesting scientific piece of work. The Association of Tropical Diseases might with advantage have refrained from publishing its Hamburg declaration that the other countries should only participate in this discovery conditionally on the restoration to Germany of her colonial empire. We could recall other instances but we refrain, hoping that these ideas belong to the past and not to the future.

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Our correspondent J. V. M. makes us sigh. There is no pleasing some people ; they do not wish to be pleased, they prefer to be free to criticise. We cannot imagine there are many chemists who think like J. V. M., at any rate, not in London. A few visits to the Chemical Industry Club would dispel many of his delusions. " Fleet Street," said Dr. Johnson, " has a very animated appearance, but I think the full tide of human existence is at Charing Cross." Let J. V. M. seek the full tide in that vicinity, but to save him trouble, we will at once answer some of the points in his letter. The Federal Council was discussed by a few chemists prior to the year 1918, and in November that year a preliminary meeting was held to form such a body. The details required some considerable lapse of time, and the first meeting of the Council was not held until November, 1919, when Sir William Pope was elected President. The rules provide for twenty-five elected members and not more than six co-opted ones in addition. The Chemical Society elects three, the Society of Chemical Industry elects three, the Association of British Chemical Manufacturers elects three, the Iron and Steel Institute two, the Institute of Chemistry one, the Society of Public Analysts, the Faraday Society, the Ceramic Society, the Dyers and Colourists, and some other societies one each. Such members hold office for three years and are eligible for re-election. The President is elected by the Council, and may not hold office for more than five consecutive years. The Council now consists of the following: Sir William Pope, Professors Philip, Armstrong and [illegible]pe, Sir Robert Hadfield, Sir Thomas Rose, Sir Herbert Jackson, Sir Robert Robertson, and Messrs. Carr, Woolcock, Miall, Armstrong, Evans, Bolton, Cooper, Chaston, Chapman, Cross, Turner, Harbord, Drummond, Mellor, Colman, Wood, Prior, Voelcker, Forster, Mond and Coley. There is only one Committee, whose sole function is the collection of the Fund, so that every member of the Council has an equal opportunity of taking part in the decisions of the Council. It is true that most of the members are busy men, but they manage somehow to attend to the business of the Federal Council. As to the Federal Council being run by a clique, we suppose our correspondent means that the bulk of the work falls on some dozen men who contrive to attend a fair proportion of the meetings—even in their case the night comes so soon that half they propose very seldom is done. Stop, reader, and sigh while thou thinkest on the rest ! Now what are the objects of the Federal Council ?

First, to act as the British organisation of the Union Internationale de la Chimie Pure et Appliquée. It is to be representative in some way for international purposes of British chemistry, and to send a suitable British delegation to attend the Annual Meetings of the Union Internationale. Last year the Federal Council invited the Chemical Society, the Institute of Chemistry and the Society of Chemical Industry to choose the delegation. It is probable that those three Societies are as competent to choose the delegates as any organisations in the country. Next, the Federal Council strives to effect such co-operation between the various chemical bodies as is possible. It is obvious that until there is a great deal of such co-operation the duties of the Federal Council, as representing all organised chemistry, are light and vague. As matters are constituted now, if some community of action seems to be possible between, say, the Chemical Society and the Faraday Society, or the Gas Engineers and the Biochemists, the utmost the Federal Council can do is to discuss informally the possibilities and suggest a joint committee of the two bodies to investigate the practicability. It is hard work for those who serve on such a committee ; many of the members are towards the close of the day tired with the exposition of chemistry, and the few who have a scheme resemble the man who "thought of convincing while they thought of dining." In any case, it is not easy for the Federal Council to advertise the consideration of such an idea. The matter becomes the concern of the two Societies involved, and in the fulness of time their decision is duly announced in their special Transactions. The Federal Council has been helpful in many instances of this character, but its real work will not begin until Chemistry House is a reality. It seems to us the Federal Council has done much to keep this project in the minds of chemists. As to the secrecy with which its doings are shrouded, a hasty glance through our pages reveals some news about the Federal Council on pages 461, 473, 709 and 1071 of our *Journal* last year, and on page 135 of this year. We can ill afford greater space, and the Honorary Secretary of the Federal Council informs us that he blushes to ask for as much as he has received. Some progress in co-operation is already achieved, and the Bureau of Chemical Abstracts may thrust more upon us. Nevertheless, it takes time, and while we plan, and plan, our hair is grey before we know it.

MAGNESIUM OXYCHLORIDE CEMENT

By J. H. PATERSON, D.Sc., F.I.C.

Discovered in 1868 by the French chemist Sorel, magnesium oxychloride has long been recognised as a cement with unique and very valuable properties. It is, in fact, the strongest cement available which is cheap enough to be used on a large scale. It is rather astonishing, therefore, that so little is known or has been written about this very useful material and it is the purpose of this article to set out some of its more important features and applications.

When magnesium oxide in a proper physical condition is mixed with a sufficient quantity of a dilute solution of magnesium chloride to form a plastic mass, the whole sets in a few hours to a hard stone-like solid. This setting is brought about by the combination of the two constituent materials with water to form the compound, magnesium oxychloride. It is not possible to express the composition of this substance by an exact formula, but it probably consists mainly of the compound 3 MgO. $MgCl_2$. 10 H_2O mixed with various solid solutions of a more basic nature. It will be seen that this cement differs from the more commonly used Portland cement and plaster of Paris in that a chlorine compound is required to complete the setting, in addition to the usual water.

Sorel cement, as this material is often called, has very remarkable properties. The neat cement can be made nearly twice as strong as Portland cement and its binding powers are so great that it can be made to hold together very large volumes of filling materials, such as the sand and stones commonly used when making concrete, or if required, saw-dust, cork-dust and leather waste. In fact so much saw-dust, for example, can be bound together into a solid and strong mass that a most important use of this cement is to produce a hard floor covering which has some of the properties of wood, in that it is not too cold to the feet and can have nails and screws driven into it without trouble.

In this country the use of this wood substitute was almost exclusively confined in pre-war days to the shipbuilding industry; large areas in the living quarters of merchant vessels were covered by such materials as Litosilo, Veitchii and Dexton, these being the trade names for varieties of Sorel-cement flooring. The finished floor was generally stained to a dull red colour and very often was merely polished in order to keep it clean.

During the war the shortage of timber led to an extended use of these and similar preparations, and with the advent of the housing schemes a great impetus was given to their application, particularly in laying the ground level floors of cottage and working class properties. In America, Germany and France a good deal of exterior stucco work is carried out in this material, but so far it has not found much favour for this purpose in Great Britain.

The magnesia sold for the manufacture of this cement is made by calcining magnesite rock at a carefully controlled temperature. In pre-war days the bulk of the magnesia used in this country was imported from Hamburg and was there made by the calcination of magnesite rock imported from Euboeia, one of the Grecian Isles. During the war a large amount of magnesite was shipped from India and calcined in this country, but it did not yield a very satisfactory product, and the high cost of carriage has made its use prohibitive since that period. At the present day a certain amount of Grecian magnesite is calcined in Scotland, but the German material is again coming across in increasing quantities.

A good quality magnesia is manufactured from selected stone only. This after breaking up, is carefully hand-picked to remove impurities and then calcined in special furnaces at temperatures regulated between 750° C. and 950° C. The calcined material is again sorted to remove overburned pieces and ground in tube or ball mills to the required degree of fineness.

The product is placed on the market in this country as fine ground calcined magnesite, or in America, as plastic magnesite.

If the temperature of burning is carried above 1000° C., the resulting magnesite will not re-act with magnesium chloride, so that a clear distinction must be made between magnesite burned for cement making, and that which is burned for the manufacture of refractory materials.

A long experience of commercial calcined magnesite has led to the conclusion that a large number of tho faults which develop from time to time in oxychloride cements, is due to the improper burning of the raw material. The kilns, frequently of the beehive type, are so constructed that at the comparatively low temperature required, even distribution of heat is impossible, and some considerable proportion of the charge is overburned and some underburned. In some kilns the bags, or vertical flues, in the interior of the furnace, are built up out of pieces of raw magnesite, which become strongly overburned and useless for cement making. It is, of course, usual to sort out the overburned material before grinding it, but this is not an easy matter, even to a highly experienced workman. The presence of overburned magnesite in a consignment cannot be detected by chemical analysis, and thus a material with quite a satisfactory chemical composition may be nearly useless for cement making.

The magnesium chloride used comes almost exclusively from the Stassfurt or Alsatian deposits, and is imported as the solid $MgCl_2 \cdot 6H_2O$, usually contained in thin iron drums. It is normally about 98 per cent. pure, but its quality can be easily determined by analysis.

Aqueous solutions having a specific gravity round about 22° Bé. are used for all ordinary purposes, and one of the drawbacks of the extended use of the cement is the cost of carriage and labour involved in the distribution of this solution, as it must be made at some convenient place in large dissolving tanks and distributed in drums to the actual work.

The various applications of this cement demand considerable experience and skill, and most operators

preserve a certain amount of secrecy about the exact details. As has been already stated, the most extensive use of the cement is for the making of floor compositions and the methods employed are all variations of the following process.

Ground calcined magnesite is mixed with hard-wood saw-dust in the proportion of 1 part of magnesite to $3\frac{1}{2}$ parts of saw-dust by volume. This mixture is gradually moistened with a magnesium chloride solution of about 22° Bé. until a portion squeezed in the hand adheres well together, but does not exude any moisture. The wet material is then spread evenly over the floor with a rake and carefully rammed down with a light wooden rammer. The surface is finally worked up with a steel float and the whole floor allowed two or three days to harden. If a coloured floor is required, the requisite amount of coloured earth (Indian red, burnt umber, or yellow ochre are commonly used) is added to the magnesite at the commencement of the operations.

In spite of the widespread use of this cement, there appears to be remarkably little known of the mechanism of setting, or of the factors which control it, and there are no published standards which enable the prospective purchaser of material to judge of its value. A very informative paper was read by Mr. M. Y. Seaton before the American Society for Testing Materials in June, 1921 (*Chem. and Met. Eng.*, August, 1921). The paper contains a great many useful suggestions and physical standards, but the author obviously labours under the difficulty of not being able to publish all he knows, particularly with reference to the effect of manufacturing conditions on the quality of the finished material. In spite of this fact, however, this paper contains more valuable information on the practical side of the question, than all the others which have been written. The difficulties in the way of obtaining accurate experimental data concerning the mechanism of setting are very great, and they will be best appreciated by considering the actual conditions which govern the practical application.

The concentration of the magnesium-chloride solution must be kept under careful control, as experience has shown that above a certain gravity, viz., 24° Bé., the setting cement will expand to such an extent as to destroy the shuttering or moulds, if it is being used "en masse," or to cause it to rise up in blisters if it is being laid as flooring. The setting time also is greatly accelerated as the concentration of the chloride increases, and the use of comparatively dilute solutions is necessary to ensure that the material can be properly worked before it hardens.

As previously stated, the usual strength is about 22° Bé., and with this concentration it is not possible to add sufficient actual magnesium chloride to combine with all the magnesia, without making the mass too wet to set at all; thus in a standard mixture containing 12·5 per cent. by volume of magnesia, the rest being an aggregate of coarse and fine sand, only about 50 per cent. of the chloride required to combine with all the magnesia is added, assuming, of course, that the compound $3\ MgO.\ Mg\ Cl_2.\ 10H_2O$ is actually formed. This means that a large proportion of the magnesia in a cement mixture merely acts as a filler and, as on account of its previous treatment, it can have very little structural strength, it detracts from, rather than adds to, the strength of the set cement. The apparently remarkable fact is therefore noticed with this cement, that test briquettes made of neat cement always show a lower tensile strength than briquettes made to the same consistency with cement and sand. Fig. 1 illustrates this very clearly. The continuous curve shows the variation in strength which takes place during a given period when a cement is prepared which contains 12·5 per cent. of

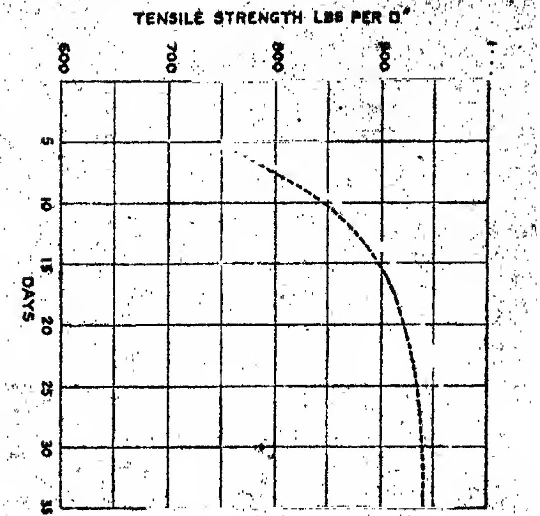


Fig. 1

magnesia by volume and 87·5 per cent. of siliceous aggregate. The dotted curve gives the strength of the cement made from pure magnesia only.

The expansion which takes place when the cement sets is a source of constant trouble to users of this material, particularly to floor layers, and as the amount increases with the strength of the chloride used, it must be obvious that a considerable volume change occurs in that portion of the material which is actually converted into magnesium oxychloride. Unfortunately, different samples of magnesite give widely different expansions on setting and there appears to be no observable reason for these differences so far as our present knowledge goes, except that a coarsely ground magnesite will produce a much greater expansion on setting than the same magnesite in a finely ground condition.

It is well known that when wetted throughout, a magnesite cement loses a great deal of its strength. In fact, a thoroughly soaked magnesite cement has practically no strength at all, and if left long enough in water will crumble away with the gradual dissociation of the magnesium oxychloride and the production of hydrochloric acid in the water.

The setting of the cement, therefore, depends to a very large extent on the rate of drying of the cement, and a fruitful cause of the lifting and cracking of flooring compositions is lack of ventilation, the air above the flooring becoming so saturated with moisture that drying practically ceases. Under these conditions the inevitable expansion which takes place in the cement when setting causes the floor to lift and crack in all directions, the material not attaining sufficient strength to prevent this from happening.

A floor which hardens normally must always contain a fair amount of internal stresses and cases are not unknown where the material has cracked and lifted, even after a lapse of years, consequent on the gradual weakening of the mass either through damp or excessive vibration. In the anxiety of the floor layer to prevent trespassers from spoiling his carefully trowelled surface he frequently closes all doors and windows in a completed room or passage, and thus invites the trouble he gets at a later stage.

It is easy to see that the mechanism of the setting of oxychloride cement is obscured by so many factors that exact knowledge is difficult of attainment, and a great deal of very necessary work remains to be done in order to ensure that this most valuable material shall give constant and reliable results.

It seems very likely that the actual cementing material exists in forms with widely differing degrees of hydration, and that the strength and degree of expansion of the set cement stands in close relationship to the aqueous content of these hydrates. Cylinders made some years ago of pure magnesite and magnesium chloride only, lost in weight regularly for the first fourteen days, and since then have been found to vary in weight constantly, being always heavier in damp weather than in dry weather. The variation is as much as 1 per cent. of the total weight of the cylinder.

It is probable, as in Portland cement, that the cementing material is the weakest portion of the set concrete, and hence the smaller the quantity which can be used the stronger and more permanent will the concrete be. Calcined magnesite itself is undesirable as one of the constituents of the aggregate as its particles have no physical strength, but other finely powdered materials which are not acted upon chemically by magnesium chloride, as for instance ground silica, will help to make a stronger and more resistant cement. The ideal cementing material in an oxychloride concrete is one in which the proportion of magnesite is made to correspond very closely to the theoretical amount of magnesium chloride required, the rest of the mass being siliceous or other neutral material at least as finely ground as the magnesite, and of course very thoroughly mixed with it. Thus, Seaton finds that if the cement be made from a mixture of 1 part of magnesite with 2 parts of fine silica, and the aggregate consist of standard sand, very strong concretes can be formed which do not contain more than 4 or 5 per cent. of magnesia.

As with Portland cement, the quality of the materials used must be as high as possible, and in order to ensure this, certain arbitrary limits indicating the physical and chemical properties must be laid down. In this country, unfortunately, little or no attempt is made by the user to buy his materials to specification, and this want of foresight is reflected in the large number of unsound jobs which are carried out.

TABLE I.

From article by M. Y. Seaton.

Magnesite No.	Chemical composition, per cent. Loss on Ignition	CO_2	SiO_2	R_2O_3	CaO	MgO	Cements made from 1 part magnesia, 2 parts ground silica and 5 parts sand; 22° Be chloride. Setting time in hours and minutes: Initial	Final	Modulus of rupture in lb. per sq. in.: Dry	Wet	Recovered
1	9·20	4·05	9·58	0·95	7·50	73·7	2 : 15	3 : 0	1500	828	1218
2	6·05	4·20	17·7	4·50	11·10	60·6	2 : 00	6 : 00	1362	654	1374
3	8·35	3·25	5·07	0·80	3·58	82·0	2 : 30	4 : 30	1232	642	977
4	6·98	1·68	7·01	0·42	3·64	82·8	3 : 45	4 : 30	1010	618	854
5	10·65	4·07	8·09	1·32	4·34	75·6	2 : 15	4 : 00	1277	594	1188
6	7·91	2·08	1·41	0·59	2·44	87·6	2 : 15	4 : 00	1580	525	967
7	9·09	1·54	2·09	1·20	3·40	85·0	3 : 45	6 : 00	1486	273	605
8	8·69	3·44	13·34	2·03	4·28	71·6	2 : 30	3 : 30	1011	252	810
9	2·95	2·80	3·45	0·88	4·48	88·2	2 : 30	3 : 30	1604	132	198
10	6·95	2·54	7·65	1·21	3·75	80·5	2 : 00	4 : 00	1378	97	300

A chemical analysis of magnesite is useful in determining the probable source of the material and for making sure that it is free from adulterants; some typical compositions are given in Table I. Among some users, the belief is firmly fixed that the presence of lime as an impurity in calcined magnesia has a very deleterious effect on the strength of the cement, mainly due to the reaction of the lime with magnesia chloride which, as it does not result in a cementing material naturally weakens the finished product.

Messrs. Seaton, Hill and Stewart have written a long and informative article (*Chem. and Met. Eng.*, August 17, 1921) in which they give detailed results of their tests and indicate a satisfactory analytical method for determining the active lime present in a given sample. The results of their tests show that the most serious effect of the lime is in the reduction of the "wet strength" of the cement.

Experience has shown that the analysis alone is no guide to the behaviour of the material, much

more important factors being the rate and temperature of calcination, the age of the material, and the fineness of grinding. As the first two of these factors cannot be determined by either a physical or a chemical test it becomes necessary to rely on standard physical tests in order to gauge the suitability of the magnesite for cement making purposes.

Test briquettes can usefully be made in the same moulds as are used for testing Portland cement, the neat cement being made from magnesite and magnesium chloride only and the aggregate being made from Leighton Buzzard sand and ground silica which has passed a 120-mesh sieve. Seaton objects to the shape of these briquettes, as they are thicker than the material which is usually placed, when laying floors. He recommends long flat slabs ½ in. thick, made and dried on a sheet of oiled paper, in order to imitate as closely as possible the drying of an ordinary floor. The wet strength should be determined at the same time as the dry strength. Setting time can be determined by means of the Vicat needle, observing the same precautions as with Portland cement.

The expansion of the setting cement is of considerable importance, but, unfortunately, there is no standard method of determining it which gives satisfactory results. The best method is probably to lay a flat slab ½ in. thick on a piece of slightly greased plate glass and measure by suitable means the movement of two metal stops provided with "hair lines" and set about 8 in. apart. In order to put these suggestions on a proper footing the following tentative specification is given for a fine ground calcined magnesite to be used for laying floors :—

Fineness.—Eighty per cent. of the material should pass a 200-mesh screen and 99 per cent. should pass a 100-mesh screen.

Tensile Strength.—A mixture consisting of one part magnesite, two parts finely ground silica and five parts standard sand, should be used for these tests. The strength of the chloride solution should be 22° Bé. and the mixture should be just sufficiently wetted to allow of its proper working in the mould.

Standard briquettes of the type used in an ordinary cement testing machine are made and broken after 7 and 28 days, the test pieces being freely exposed to the air after taking out of the mould at the end of 48 hours. The moulds should be very slightly greased before use.

The average strength should be about 500 lb. per square inch at 7 days and about 850 lb. at 28 days.

Seaton recommends as previously explained a flat bar of concrete ½ in. thick, 2 in. wide and 24 in. long. These bars are supported at the ends for test purposes, and broken by loading the centre with shot in the same manner as in a cement testing machine. From this result the modulus of rupture is calculated and should be about 2·2 times the tensile strength given above.

Wet Strength.—The wet strength of set cement is important and should be determined by spraying the set briquettes with water three or four times during 8 hours and then testing in the usual manner. The wet strength of a good mortar should be not less than 30 per cent. of the strength of the dry mortar.

Setting Time.—The setting time of the same mixture as used above is determined in the ordinary way with a Vicat needle. The initial set should not take place before 90 minutes and the final set should be attained within 5 hours.

Expansion.—It was stated above that the exact causes of expansion are not thoroughly understood. In addition, occasional contractions in volume may take place in a setting cement, the causes of this phenomenon being also obscure. Undoubtedly too much liquid added to a cement will cause contraction just as it will with Portland cement, but there are certainly other factors at work. It may be taken, however, for all practical purposes that an expansion or contraction of 0·3 per cent. or over, within 24 hours after the initial set, indicates a cement of questionable quality.

CO-ORDINATION OF ORGANIC MOLECULES

By PROF. T. MARTIN LOWRY, F.R.S.

1. Organic Compounds of the Second Order

Werner's theory of co-ordination was developed in order to account for the existence of "molecular compounds," for which the ordinary laws of valency made no provision. This enterprise was remarkably successful in two branches of inorganic chemistry, namely, (i) those which deal with double salts, such as K_2PtCl_6, $K_3Co(NO_2)_6$ or $K_3Cr(C_2O_4)_3$, and (ii) those which deal with the addition of ammonia or of water to metallic salts, giving rise to amines or hydrates, such as $CrCl_3.6NH_3$, $CoCl_3.5NH_3.H_2O$, $NiCl_2.6NH_3$ or $NiCl_2.6H_2O$. Since these salts can include organic as well as inorganic radicals, whilst the ammonia of the amines can be replaced by organic nitrogenous bases, and the water of the hydrates by alcohols and ethers, Werner's theory acquired long ago a definite foothold in organic chemistry, and in recent years has extended its area of occupation considerably ; but even so, that area has been in the main confined to acid and basic radicals, which can play a part in the formation of those complex salts, with which Werner's theory was in the main concerned. On the other hand, it is becoming increasingly clear that organic chemistry includes a number of compounds of the second order, for the existence of which Werner himself had no clear explanation to offer, but which demand recognition just as definitely as the double-salts and hydrates of inorganic chemistry.

2. Addition-compounds of Alcohols, Ethers, Ketones and Esters

Just as in the case of inorganic molecular-compounds, many addition-products formed by organic compounds can be represented by means of formulæ which conform to the ordinary rules of valency, although it is by no means certain that such formulæ are always correct. Thus the addition-compounds of alcohols and ethers with acids[1], such as

$CH_3.OH,HBr$ $C_2H_5.OH,HBr$

$(CH_3)_2O,HCl$ $(CH_3)_2O,HBr$ $(CH_3)_2O,HI$

can be represented as oxonium salts, containing a quadrivalent atom of oxygen as the centre of the complex; and the opening out of a double bond will supply points of attachment for the acid in the analogous addition-compounds of acetone and of ethyl acetate[1], such as

$COMe_2,HBr$ and $CH_3.CO_2Et,HBr$.

But even in these cases it is disconcerting to have to recognise the existence of compounds such as

$(CH_3)_2O,3HCl$ and $(CH_3)_2O,4HCl$

or $2CH_3.CO_2Et,5HBr$ and $CH_3.CO_2Et,4HBr$.

Again, by subjecting the idea of salt-formation to a somewhat severe strain, and also taking into account the amphoteric character of the halogens, for which a considerable amount of evidence has now been accumulated[2], it is possible to formulate in a similar way the less stable compounds formed by the union of alcohols, ether, ketones and esters with the halogens[3], *e.g.*,

$2CH_3.OH,Br_2$ and $2C_2H_5.OH,Br_2$

$COMe_2,Cl_2$ and $COMe_2,Br_2$;

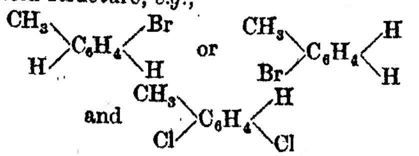
but, again, it is necessary to allow for the existence of more complex compounds, such as

$2CH_3.CO_2Et,3Cl_2$ and $2CH_3.CO_2Et,3Br_2$.

This method of formulation breaks down, however, in the analogous addition-compounds of toluene, such as

$C_6H_5.CH_3,HBr$ and $C_6H_5.CH_3,Cl_2$;

and in order that the ordinary rules of valency may be maintained these must be shown as possessing a quinonoid structure, *e.g.*,



3. Complexes Formed by the Union of Two Organic Molecules

The devices suggested above serve to explain the formation of addition-products by the union of organic compounds with simple inorganic substances; but they fail to account for most of the addition-products that are formed by the union of two organic compounds with one another, and it is difficult to see how they can be extended to cover all the compounds set out below, *e.g.*,

(*a*) Bimolecular acetic acid $(C_2H_4O_2)_2$.

(*b*) Camphoric acid and acetone $2C_8H_{14}(CO_2H)_2$, $COMe_2$[4].

(*c*) Picrates of hydrocarbons such as naphthalene, anthracene, phenanthrene and fluorene, *e.g.*, $C_{10}H_8$, $C_6H_2(NO_2)_3OH$.

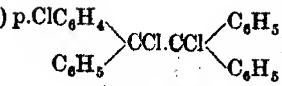
(*d*) The addition-compounds of aromatic amines, such as α and β naphthylamine, with trinitro-derivatives of benzene, studied by Sudborough[5], as well as the analogous compounds of phenols, phenolic esters and cyclic oxygen-compounds with aromatic polynitro-compounds.

(*e*) The addition-compounds of complex aromatic hydrocarbons (or their halogen-derivatives) with CCl_4, $CHCl_3$, CBr_4, $CHBr_3$, SO_2Cl_2, $COMe_2$, $COMeEt$[6].

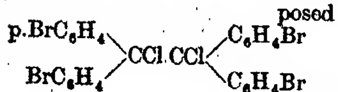
The addition-products studied by Norris under the last heading include the following compounds:—

(*a*) $(C_6H_5)_2CCl.CCl(C_6H_5)_2$ M.p. 160–161°

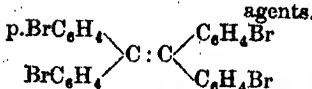
+ $2CHCl_3$	Quickly becomes cloudy and opaque; melts at 134–135° C. with decomposition.
+ $2CCl_4$	Decomposed in two months in a vacuum desiccator; in four days at 90–100°. Melts at 178–9°.
+ $2CHBr_3$	Crystals were dried in air and analysed by heating to 92°.
+ $2CBr_4$	Crystallised from CS_2; analysed by heating at 92° for 38 hours; melts at 144–147°.
+ $2CHBrCl_2$	Completely decomposed in 1 hour at 92°.
+ $2SO_2Cl_2$	Unstable in air; decomposed by recrystallising from acetone; effloresces rapidly.

(*b*)  M.p. 135–137°.

+ $CHCl_3$	Melts at 58–59°, loses $CHCl_3$ rapidly in air.
+ $2CCl_4$	Melts at 91–92°, decomposed very quickly.

(*c*) 

No addition-compounds formed with the above agents.

(*d*) 

+ $3COMe_2$	Crystals become opaque in air.
+ $COMeEt$	Much more stable.
+ $COEt_2$	Stability not stated.
+ CCl_4	Effloresces rapidly.
+ CH_3CO_2Et	Relatively stable. Lost 0·1 per cent. in 10 minutes.
+ C_6H_6	Stability not stated.

(*e*) $4(C_6H_5)_3COH + 3CCl_4$	Effloresces rapidly.
$(C_6H_5)_3COH + 2COMe_2$	Effloresces slowly.
$2(C_6H_5)_3CCl + COMe_2$	Product relatively stable
$(C_6H_5)_3CCl + CCl_4$	Does not effloresce rapidly.
$(C_6H_5)_3CH + C_6H_6$	

[1] Maass and McIntosh, *J. Amer. Chem. Soc.*, 1912, **34**, 1273.
[2] Especially by W. A. Noyes.
[3] Maass and McIntosh, *loc. cit.*
[4] *Trans. Chem. Soc.*, 1896, **69**, 1696.
[5] *Trans. Chem. Soc.*, 1901, **79**, 522; 1906, **89**, 583; 1910, **97**, 773; 1911, **99**, 209. Compare J. C. Philip, *Trans. Chem. Soc.*, 1903, **83**, 814; 1905, **87**, 1735.
[6] Norris, *J. Amer. Chem. Soc.*, 1916, **38**, 702.

4. Aggregation of Molecules in Crystals

It will be seen that the compounds formulated above contain only carbon, hydrogen, oxygen and halogens; they do not lend themselves, therefore, at all readily to the ordinary form of centric co-ordination, since none of these elements possesses any very conspicuous powers of aggregation. It is, of course, by no means certain that it is necessary in every case to postulate the existence of a definite co-ordination, by means of localised linkages, between the constituent molecules of an addition-compound, in view of the possibility that molecules of "solute of crystallisation" may be used merely to fill up hollows in the open lattice of the crystals of an organic compound. Thus, even in inorganic chemistry, zeolites can be dehydrated without destroying the structure of the crystals, of which the transparency can be restored, and the original optical properties reproduced, by exposing once more to the access of moisture. Again, the proportions of water of crystallisation that separate with typical co-ordination-compounds are so variable that Werner was, as a rule, obliged practically to ignore all those molecules of water that are not obviously included in the primary sphere of co-ordination of the central atom of the complex; thus, after tabulating the number of molecular proportions of water in 81 double oxalates[7] he does not even hint at the existence of any rules by which these proportions can be predicted.

The case of the optically-active oxalates[8] is particularly interesting, since the d and l salts of the composition

$$K_3[Co(C_2O_4)_3] + H_2O$$
$$K_3[Rh(C_2O_4)_3] + H_2O$$
$$K_3[Ir(C_2O_4)_3] + H_2O$$

yield racemates of the composition

$$2K_3[Co(C_2O_4)_3] + 7H_2O$$
$$2K_3[Rh(C_2O_4)_3] + 9H_2O$$
$$2K_3[Ir(C_2O_4)_3] + 9H_2O$$

In these cases it can scarcely be supposed that the optically-active ions of the d and l salts and of the racemic d and l mixture are differently hydrated in solution. The different composition of the crystals is clearly due to the fact that, when ions of uniform sign are assembled, there is only room in the interstices of the complex oxalate-ions for one molecular proportion of water, together with the three potassium ions shown in the formula of the salt; but when the d and l ions of the racemic compound are assembled, in pairs of ions of opposite sign, each pair can make room for 5 or 7 additional molecules of water, giving the totals of 7 or 9 H_2O set out above. Even in cases such as these, however, chemists will be reluctant to admit that the formation of addition-compounds, of exact stoichiometrical composition, are dependent only on the filling up of molecular ca[illegible] and will in general seek to detect the existe[illegible] definite chemical forces between the molecule[illegible] united, even when the points at which these [illegible] act must be ascertained by crystallographic [illegible]er than by purely chemical methods.

[7] *New Ideas*, pp. 114-116.
[8] Jaeger, *Rec. Trav. Chim.*, 1919, **38**, 284.

5. The Cementing Power of Electrons and of Protons

Physicists have postulated, and chemists have concurred in the view, that electrons provide the cement by which atomic nuclei are united to one another. Physicists have even gone further, and suggested that, in an α-particle or helium-nucleus four protons are held together by their mutual attraction for two nuclear electrons, and, indeed, are held so strongly that the union, if represented as an exothermic chemical action, would correspond to a "heat of reaction" of 6,000,000,000,000 calories.[9] In these circumstances it was almost inevitable that it should be recognised, sooner or later, that the reciprocal action of protons in attracting electrons must play a special part in chemistry, in view of the fact that the proton, like the α-particle, has no surrounding shell of electrons to help it to curb its attraction for electrons belonging to other atoms.

The entirely heterodox idea that hydrogen (the strict univalency of which has generally been regarded as above suspicion) can act as a link between two other atoms was foreshadowed by Werner, but has recently been put forward as a definite hypothesis, under the title of "Co-ordinated Hydrogen,"[10] or "Bivalent hydrogen."[11]

The ability of a proton to link together two complete octets of electrons is seen most clearly: (i) in the complex anion of the acid fluorides, which Werner wrote as (F.HF), but which may now be formulated symmetrically as $[\overset{-}{F}\overset{+}{H}\overset{-}{F}]$, (ii) in the polymerisation of water, and (iii) in the formation of crystals of ice, which are represented by Bragg as being built up in the form of a lattice containing a repeating pattern of the type

$$\begin{array}{ccccccc}
 & :\ddot{O}: & & :\ddot{O}: & & & \\
 & \mathrm{H} & & \mathrm{H} & & & \\
H & :\ddot{\mathrm{O}}: & \mathrm{H} & :\ddot{\mathrm{O}}: & \mathrm{H} & :O: & \\
 & H & & H & & &
\end{array}$$

This conception was applied by Burgess and myself mainly to organic molecules, in which the closing of a ring by a "[illegible]" (as Lewis calls it) or co-ordinated hydrogen [illegible] can be used to explain the absence of free rotation and other related phenomena. Lewis' applications are mainly in the field of inorganic chemistry, and include the suggestion that this novel type of linkage may be present in compounds such as ammonium hydroxide, which may have the electronic structure

$$\begin{array}{c}
\mathrm{H} \\
\mathrm{H}:\ddot{\underset{..}{\mathrm{N}}}:\mathrm{H}:\ddot{\underset{..}{\mathrm{O}}}:\mathrm{H} \\
\mathrm{H}
\end{array}$$

[9] Sommerfeld, *Atomic Structure*, p. 95.
[10] Lowry and Burgess, *Trans. Chem. Soc.*, 1923, **123**, 2111.
[11] Lewis, *Valence*, 1923, p. 109.

instead of the ionised structure shown in the formula

$$\begin{array}{c}\mathrm{H}\\ \mathrm{H:\ddot{N}:H}\\ \mathrm{H}\end{array}\ \text{plus}\ \mathrm{:\ddot{O}:H}\ \text{or}\ \overset{+}{\mathrm{N}}\mathrm{H_4}\ \text{plus}\ \bar{\mathrm{O}}\mathrm{H}$$

This representation is attractive in that it indicates at once the probable formation of the more symmetrical addition-compound $(NH_3)_2H_2O$ or $(NH_4)_2O$; which can be formulated as

$$\begin{array}{ccccccccc} & & \mathrm{H} & & & & \mathrm{H} & & \\ \mathrm{H} & : & \mathrm{N} & : & \mathrm{H:\ddot{O}:H} & : & \mathrm{N} & : & \mathrm{H} \\ & & \mathrm{H} & & & & \mathrm{H} & & \end{array}$$

instead of as

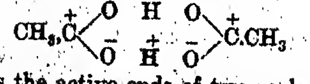
$$2\begin{array}{c}\mathrm{H}\\ \mathrm{H:\ddot{N}:H}\\ \mathrm{H}\end{array}\ \text{plus}\ \mathrm{:\ddot{O}:}\ \text{or}\ 2\overset{+}{\mathrm{N}}\mathrm{H_4}\ \text{plus}\ \overset{=}{\mathrm{O}}$$

In general, the formation of complexes of this type depends on the fact that a proton can be attracted simultaneously by duplets belonging to the octets or outer electron-shells of *two* other atoms or ions; but it appears also to be essential that the proton should not be embedded too deeply in the electronic system of either atom. In other words, a hydrogen atom which is to act as a link between two atoms must be capable of being detached from either of them, in the form of a "mobile hydrogen atom" or hydrogen ion, or in combination with some other atom.

6. Co-ordination of Hydrogen with Halogens and With Oxygen, as an Aid to the Formation of Molecular Compounds

Whilst it would be premature to attempt to assign definite co-ordination-formulæ to all the addition compounds set out in Section 3 above, it is suggested that the co-ordination of hydrogen with halogens, or with oxygen, may provide a key to the origin and general character of the force which holds many of these organic complexes together.

(*a*) Lewis has already suggested that the formation of double molecules of acetic acid can be interpreted by a locking together of two carboxyl-groups, such as I have postulated as an explanation of the absence of free rotation in certain dicarboxylic acids.[12] This view can be expressed by a formula of the type



which shows the active ends of two molecules interlocked, leaving the inert hydrocarbon radicals on the outside, as in the films of fatty acids recently examined by Müller and Shearer.[13]

(*b*) Norris points out that the formation of addition-compounds is apparently related to reactivity in one or both of the component molecules. In this respect he lays special stress on the mobility of chlorine and hydroxyl in $(C_6H_5)_3CCl$ and $(C_6H_5)_3COH$, as well as of the hydrogen in triphenylmethane, $(C_6H_5)_3CH$. He also refers to the reactivity of the halogen in the dichloride of tetraphenylethylene, as indicated, for instance, by the fact that the hydrocarbon will not form a dibromide. Reactivity can also be ascribed to the halogens, not only in sulphuryl chloride, SO_2Cl_2, but also in compounds such as carbon tetrachloride and chloroform, both of which can be converted without difficulty into the still more reactive carbonyl chloride $COCl_2$.

(*c*) In the same way, attention may be directed to the presence of reactive atoms of hydrogen in one component of many of these complexes. This does not need stressing in the case of the carboxylic acids; but it is not unreasonable to think that the usefulness of acetone and ethyl acetate in forming addition-compounds may depend, not so much on the direct influence of the oxygen which they contain, as on the reactivity of the hydrogen atoms in these compounds. The *para* hydrogen atom of the phenyl group is also reactive, and easily displaced by halogens; and it is noteworthy that the hydrocarbons which form picrates are also more reactive than benzene, behaving in this respect rather like substitution-products of this hydrocarbon.

(*d*) It is suggested that the attraction of a proton for a "lone pair" of electrons on nitrogen, oxygen or a halogen (it cannot find one on carbon, *e.g.*, in methane) may be responsible for the co-ordination of many of the compounds now under discussion, and that this attraction is perhaps strongest between halogen-atoms which are readily replaced by hydrogen, and hydrogen-atoms which are readily replaced by halogens. This view of the origin of the attraction is supported by the fact that, in Norris' compounds, substitution of all the *para*-hydrogens by a halogen prevents almost completely the formation of addition-products with CCl_4, CBr_4, etc., whilst the substitution of only one hydrogen already makes the addition-products much less stable. On the other hand, this substitution appears to promote the formation of addition-products with $CO(CH_3)_2$, etc. The principal exceptions to this classification are a very unstable addition-compound of $(BrC_6H_4)_2C{:}C(C_6H_4Br)_2$ with CCl_4, and an addition-compound of triphenylmethane with benzene which contains neither oxygen nor a halogen.

In conclusion, it is not claimed that a clear statement can yet be made as to the mechanism by which organic compounds are united into dissociable addition-products. The object of this paper is rather to direct attention to the problems which are presented by this class of compounds, and to suggest lines along which a solution of this problem may be sought.

7. Summary

(*a*) Attention is directed to the existence of molecular-compounds formed by the union of organic molecules, and to the difficulty of assigning definite co-ordination-formulæ to them, in view of the fact that many of them contain only carbon, hydrogen, and oxygen or a halogen.

(*b*) It is suggested that the co-ordination with chlorine or oxygen of a hydrogen atom already attached to another atom of oxygen or to carbon affords a possible explanation of the linking together of molecules of this kind.

[12] *Trans. Chem. Soc.*, 1923, 123, 2115.
[13] *Trans. Chem. Soc.*, 1923, 123, [illegible]

THE NEWER ELECTROCHEMICAL VIEW OF THE CORROSION OF METALS

By ULICK R. EVANS, M.A.

At one time the corrosion of metals was regarded as due to a simple chemical attack by oxygen and water, possibly with the co-operation of other substances, such as carbonic acid or hydrogen peroxide. The capricious and often local nature of the attack has, however, suggested that the mechanism may be more complicated, and recent research has afforded an insight into the nature of that mechanism.

As a matter of fact, the simple oxidation of metals in the manner suggested above can actually take

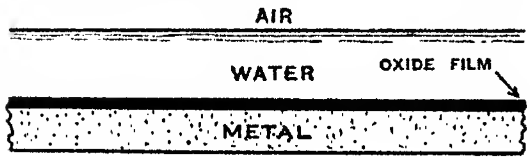


Fig. 1

place, but, through its very nature, it is unlikely to cause much damage to a metallic article. Consider (Fig. 1) a piece of metal immersed horizontally beneath a shallow layer of water. If the metal is perfectly uniform (both chemically and physically), and if the oxygen diffusing from the air through the water has equal access to all parts of the surface, then it would seem probable that the formation of oxide or hydroxide would go on equally all over the surface; and since the oxide will be formed *in situ*, we should expect to get an adherent layer of oxide all over the metallic surface. This will clearly hinder the continuance of attack upon the underlying metal. It seems possible that if the condition of absolute uniformity postulated above could be realised, the film would, in many cases, become perfectly protective, before ever it reached visible thickness.

If, however, the uniformity either of the metal, or of the oxygen-supply, is not perfect, the result may be different. Let us first take an extreme case, and imagine (Fig. 2) an article, one end of which is composed of zinc and the other of copper; suppose it to be immersed in water containing traces of a soluble salt, say, sodium chloride or calcium sulphate, salts which occur in most samples of ordinary water. As is well known, an electric current will be set up, the zinc being the anode and the copper the cathode. At the zinc surface, a soluble zinc salt (chloride or sulphate) will be formed, whilst hydrogen ions will be discharged upon the copper, the hydrogen being destroyed, as it is produced, by the dissolved oxygen; the rate of corrosion is indeed controlled by the supply of oxygen to the surface. This destruction of hydrogen ions from the copper surface leaves the water alkaline along that surface. The zinc salt and the alkali (sodium or calcium hydroxide) diffuse together, and near the junction of the zinc and copper a precipitate or membrane of insoluble zinc hydroxide will appear. Since this hydroxide does not coat the main portion of the zinc surface, it will not interfere with the subsequent course of corrosion.

It might easily be imagined that a similar electrochemical action would be set up in alloys, or even impure metals having a duplex structure. But it must be remembered that most alloys do not consist simply of a mosaic of the pure component metals. The brasses, for instance, consist not of a mosaic of copper and zinc, but of one or more solid solutions containing both metals; the commonly employed brass containing 70 per cent. of copper consists of a single solid solution, and may be just as homogeneous as a piece of pure copper. There is no reason to expect corrosion-couples to be set up in such a material more easily than in the pure metal.

Even if we consider a hypothetical alloy consisting of a mosaic of the two constituent metals, it is unlikely that we shall get very rapid corrosion. No doubt at first, on the immersion of such an alloy in saline water, we shall get a soluble salt produced upon the particles of the anode-metal and alkali produced upon the particles of the cathode-metal. These products will interact to form the insoluble hydroxide, but, since this will be formed very close to the metal surface, it will almost certainly tend to "blanket" the surface, and so retard further corrosion. Of course, it will not be so perfectly protective as the oxide-film formed *in situ* by direct oxidation; indeed, under some conditions it may be loose enough to permit corrosion to proceed at an appreciable rate; the corrosion-product seems to be least protective if produced in the presence of chlorides. But in general, *if the blanket is formed all over the surface*, it will tend to retard corrosion as it becomes thicker. Furthermore, if the alkali from the cathode-metal should gain access to the surface of the anode-metal, we may get an insoluble hydroxide as the direct anodic product, and this body being formed *in situ* will efficiently protect the underlying metal and interfere with further electrochemical action.

We see, therefore, that whereas *duplex structure on a coarse scale* (*e.g.*, in an article composed of one metal at one end and a second metal at the other) is apt to stimulate corrosion very considerably, *duplex structure on a fine scale* (*e.g.*, in a heterogeneous

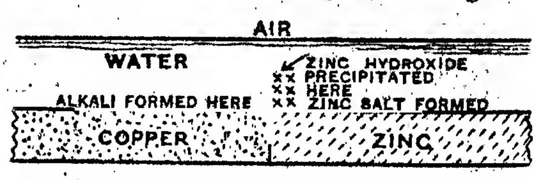


Fig. 2

alloy) is much less dangerous. This is well shown by an example described by Murray[1], who studied the rusting of "double-faggoted" iron (consisting of alternate layers of wrought iron and mild steel). He found that this material rusted more readily than ordinary steel, and that the rusting took place at the junction between the layers of wrought iron

[1] M. T. Murray, *J. Chem. Met. Min. Soc. S. Africa*, 10

and steel. Microscopic observation, however, showed no special corrosion at the junction of the ferrite and pearlite areas within the steel.

The danger of having two dissimilar metals in contact (except in certain cases) is so well known that examples of corrosion due to this cause are now met with comparatively seldom, although one still hears of trouble caused at soldered joints. There is, however, a possibility of obtaining cathodic and anodic areas on a coarse scale in another way, which is not generally appreciated. I have shown[2] experimentally that it is possible to produce an electric current from a cell consisting of two strips of the same metal immersed in the same solution, one strip being aerated by bubbling air over it, whilst the other is protected from access of oxygen; the current is provided by the corrosion of the *unaerated* metal, and, if the resistance of the whole circuit is small, the unaerated strip actually suffers more corrosion than the aerated strip. This production of current by "differential aeration" can be shown in zinc,

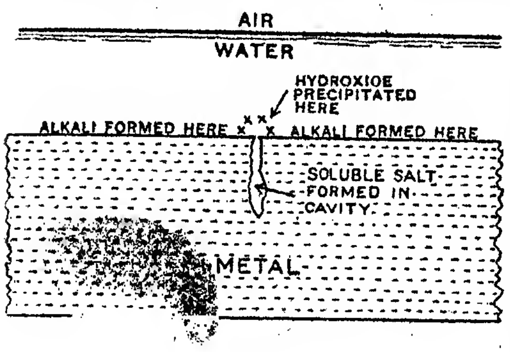


Fig. 3

cadmium, iron and lead; in copper other factors come in which tend to mask or even prevent the current. In the case of articles made of zinc, iron and lead, however, currents of this kind seem to be responsible for practically the whole of the corrosion observed when they are exposed unequally to the action of oxygen; for instance, when they are partly immersed in water, or covered with drops of water over part of their surface. It also accounts for the special corrosion set up in cavities. Suppose (Fig. 3) that a small cavity exists in the surface of the metal into which oxygen cannot diffuse quickly. A current will be produced between the unaerated area within the cavity, which will become anodic, and the aerated part of the surface outside, which will be the cathode; soluble salt will be formed at the anodic surface within the cavity, but this will not, of course, interfere with further anodic attack. At the mouth of the cavity where the soluble metallic salt from the interior mixes with the alkali from the cathodic part outside, hydroxide may be precipitated, but it will not put a stop to the anodic attack proceeding within. Since the rate of attack is determined by the supply of oxygen to the whole surface outside the pit, and since it is all concentrated on the small area within the pit, the rate at which the corrosion bores into the metal will be very great; and perforation of the article may occur at this one point before any appreciable thinning has occurred at other parts of the surface. Thus we get an explanation of *pitting*.

A similar explanation serves to interpret the special corrosion which occurs at parts of the surface covered up by sand or other debris. The part below the debris is protected from oxygen and therefore becomes anodic. The same reasoning serves to show why rust (if of a loose, flocculent character) tends to promote further corrosion of the underlying metal; this explanation, which was first given by J. Aston[3], is undoubtedly the correct one; there is no need to assume that the iron hydroxide (colloidal or otherwise) serves as a catalyst.

The description just given may serve to convey a brief idea of the *newer electrochemical theory of corrosion*. It rests upon a clear experimental demonstration of the current passing between the aerated and unaerated parts of a metallic article, and has an interest for the practical man which the older theories have never had, because it is able to explain the phenomenon of pitting and local corrosion at inaccessible places—the types of corrosion which cause most anxiety in practice; the chemical theories and even the older electrochemical theory of Whitney failed to account for this specially rapid corrosion observed *at just the points which were the least accessible to oxygen*. The distinctive feature of the newer theory is that it takes account, not merely of currents set up by contact between dissimilar metals, but also of those set up through unequal distribution of dissolved oxygen. We are thus led to the practical conclusion that contact with porous non-conductors may be just as dangerous in setting up corrosion as contact with a second metal.

Although in the majority of instances, the direct action of oxygen on metals does not lead to appreciable destruction of the parts so affected, owing to the protective character of the product, there are conditions under which direct chemical (as opposed to electrochemical) corrosion may occur quite rapidly. The dissolution of metals by oxidising acids, for instance, may consist in part of a direct oxidation of the metal, the oxide-film being dissolved away as quickly as it is formed. The action of hot cupric chloride solution on copper also seems to be a case of direct chemical action; the product, cuprous chloride, although insoluble, is non-adherent, and does not protect the copper.

[2] U. R. Evans, *J. Inst. Met.*, 30 (1923), 239.

[3] J. Aston, *Trans. Amer. Electrochem. Soc.*, 29 (1916), 449

Monsieur A. Meyer, a well-known Parisian journalist who played a particularly prominent part in the organisation of the Pasteur Day for the benefit of French laboratories, died recently in Paris at the [illegible]

PULVERISED FUEL FIRING IN COMBINATION WITH MECHANICAL STOKING

(From a Correspondent)

Considering the controversy as to the advantages and disadvantages of pulverised fuel firing for steam generation, the ordinary industrial steam user is perhaps more particularly interested in the matter from the point of view of his own individual conditions. It is admitted that for large water-tube boilers with the proper setting, and particularly the correct volume of combustion chamber, pulverised fuel gives results approached by no other method of firing solid fuels, *i.e.*, sustained efficiencies of 85–88 per cent., with only 15–25 per cent. excess air over the theoretical according to the rating of the boiler.

What the chemical works manager or engineer wants to know, however, is how can the advantages of pulverised fuel be obtained with "Lancashire," or ordinary water-tube boilers and the existing setting. It is thus of interest to note that Dr. Lulofs, the chief engineer of the Amsterdam Electricity Works, has combined the use of pulverised fuel firing with that of the ordinary chain-grate or similar travelling-grate mechanical stoker. The method consists in the installation of a number of small pulveriser fuel burners supplied by a unit pulveriser at the back of the stoker so that the pulverised fuel flame is almost parallel with the chain-grate pointing slightly inwards and at right angles to the mechanical stoker flames. The arrangement, the patent rights of which are controlled by the Underfeed Stoker Co., Ltd., is said to have a number of advantages, particularly that the chief defect of the chain-grate stoker, the hollow fires at the back with consequent excess of air, is obviated. This is very efficient, giving 13–14 per cent. of carbon dioxide, instead of the 5–6 per cent. usual with chain-grate stokers. In working, the unit pulveriser is adjusted so that a reduced amount of air is mixed with the pulverised coal in the machine, so as to use up the excess of air due to the inefficiency of the mechanical stoker in burning the pulverised coal. The results are stated to be of particular value in peaked load periods, the flexibility of pulverised fuel being of great assistance in this respect and in that of reducing stand-by losses in starting up and shutting down. This method therefore enables steam users possessing a chain-grate or other travelling grate stoker considerably to increase the efficiency of the existing boiler plant by taking advantage to a partial extent of the very high efficiency and flexibility of pulverised coal without any alteration to the setting of the boilers and the size of the combustion chamber and at only a small capital cost for a unit type of pulveriser.

According to the *Manchester Guardian* the firm of Brunner, Mond and Co., Ltd., has given £300 to the Department of Physics of Manchester University in aid of research.

FORTHCOMING EVENTS

Mar. 3. SOCIETY OF CHEMICAL INDUSTRY, *London Section*, at the Chemical Society's Rooms, Burlington House, Piccadilly, W. 1, at 8 p.m. "The Setting of Cacao Butter with Special Reference to the Development of 'Bloom' on Chocolate," by R. Whymper and A. Bradley. "The Determination of Pentosans in Wood Cellulose," by W. J. Powell and H. Whittaker.

Mar. 3. INSTITUTION OF THE RUBBER INDUSTRY, *London Section*, the "Kelvin" Room, Engineers' Club, Coventry Street, W., at 8 p.m. "Life and Work of Thomas Hancock," by H. Rogers and B. D. Porritt.

Mar. 3. SOCIETY OF ENGINEERS, Apartments of the Geological Society, Burlington House, W. 1, at 5.30 p.m. Discussion on "Development of Methods for the Collection and Disposal of House (Domestic) Refuse," by James Jackson.

Mar. 3. SOCIETY OF CHEMICAL INDUSTRY, *Newcastle Section*. Joint meeting with the Cleveland Institution of Engineers, Middlesbrough, and the *Newcastle and North-East Coast Section* of the Institute of Chemistry, in the Technical Institute, Corporation Road, Middlesbrough, at 6.30 p.m. "Engineers, and the Interpretation of Chemical Specifications for Iron and Steel, in Relation to Analytical Accuracy," by C. H. Ridsdale.

Mar. 4. SOCIETY OF CHEMICAL INDUSTRY, *Chemical Engineering Group*, and the Hull Chemical and Engineering Society, in the Rooms of the Hull Photographic Society, Grey Street, Park Street, Hull, at 7.45 p.m. "Centrifugal Dryers and Separators: Their Construction and Use," by E. A. Alliott.

Mar. 4. INSTITUTE OF METALS, *North-East Coast Local Section*, Armstrong College, Newcastle-on-Tyne, at 7.30 p.m. Discussion on "Alloys for Use with Superheated Steam," by H. J. Young.

Mar. 4. BIRMINGHAM UNIVERSITY CHEMICAL SOCIETY, Chemical Lecture Theatre, Edgbaston, at 5.30 p.m. Lecture on "Atomic Weights and Isotopes," by F. W. Aston, D.Sc., F.R.S.

Mar. 4. HULL CHEMICAL AND ENGINEERING SOCIETY, Hull Photographic Society's Rooms, Grey Street, Park Street, Hull, at 7.45 p.m. Joint meeting with the Chemical Engineering Group.

Mar. 4. ROYAL INSTITUTION OF GREAT BRITAIN, 21, Albemarle Street, W. 1, at 5.15 p.m. "The Respiratory Pigments in Animal Life," by Prof. J. Barcroft.

Mar. 5. SOCIETY OF PUBLIC ANALYSTS, the Chemical Society's Rooms, Burlington House, Piccadilly, W., at 8 p.m. (1) "The Composition and Examination of Beef and Malt Wine," by G. D. Elsdon. (2) "The Determination of Coconut Oil in Margarine," by G. D. Elsdon. (3) "Effect of Fatty Diet on the Composition of Butter Fat," by J. C. Drummond and H. J. Channon. (4) "What is Bondon Cheese?" by G. D. Elsdon. (5) "Cream Cheese," by T. R. Hodgson. (6) "Some Facts on the Composition and Decomposition of Eggs," by R. T. Thompson. Informal dinner will be held at 6.30 p.m. at St. James's Restaurant, 172, Picca-

Mar. 6. THE CHEMICAL SOCIETY. Ordinary Scientific Meeting at Burlington House, Piccadilly, London, W. 1, at 8 p.m. "The Reaction Between Lime and Nitrogen Peroxide," J. R. Partington and F. A. Williams. "Tellurium Monoxide," J. J. Doolan and J. R. Partington. "The Dimorphism of Diphenylarsenious Chloride (Diphenylchloroarsine)," C. S. Gibson and (the late) D. C. Vining. "The Isomerism of the Oximes. Part XVII. The Action of 2:4-Dinitrochloro-benzene on Some Isomeric Aldoximes," O. L. Brady and R. Truszkowski.

Mar. 6. SOCIETY OF CHEMICAL INDUSTRY, *Bristol Section*, the Chemical Department, the University, Woodland Road, Bristol, at 7.30 p.m. "Combustion Control in Boiler Houses," by H. T. Ringrose, and "Fuel Economy Questions," by H. Womersley.

Mar. 6. INSTITUTION OF MECHANICAL ENGINEERS, *Glasgow Section*, Royal Technical College, Glasgow, at 7.30 p.m. "Repair and Upkeep of Pneumatic Tools," by R. W. Wilson.

Mar. 7. INSTITUTION OF MECHANICAL ENGINEERS, *Leeds Section*, the Philosophical Hall, Park Row, Leeds, at 7.30 p.m. "The Commercial Testing of Materials of Construction," by Prof. G. F. Charnock.

Mar. 7. SOCIETY OF CHEMICAL INDUSTRY, *Manchester Section*, the Textile Institute, 16, St. Mary's Parsonage, Manchester, at 7 p.m. "Some Chemical Qualities of the Living Cell," by Prof. F. Gowland Hopkins.

Mar. 7. ROYAL INSTITUTE OF GREAT BRITAIN, 21, Albemarle Street, W. 1, at 9 p.m. "The Inner Structure of Alloys," by Dr. W. Rosenhain.

Mar. 7. INSTITUTE OF METALS, *Sheffield Section*, the University, St. George's Square, Sheffield, at 7.30 p.m. "Some Aspects of Alloy Plating," by S. Field.

Mar. 7. SOCIETY OF CHEMICAL INDUSTRY, *South Wales Section*, the Technical College, Cathays Park, Cardiff, at 7.30 p.m. "Metal Colouring" by E. A. Rudge.

Mar. 8. ROYAL INSTITUTE OF GREAT BRITAIN, 21, Albemarle Street, W. 1, at 3 p.m. "Properties of Gases in Vacua," by Prof. Sir E. Rutherford. Also on March 15.

The Physical Society of London is arranging to celebrate its jubilee from March 20 to 22 next. The preliminary programme of the proceedings will be as follows: On Thursday, March 20, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C. 2, at 2.30 p.m., there will be an Exhibition of Apparatus, followed by a reception at 3.0 p.m., and at 3.45 the Guthrie Lecture on "Photo-electric Effects in the case of High Frequency and Allied Phenomena" will be delivered by M. le Duc de Broglie. On Friday, March 21, from 4.0 to 5.30 p.m., and from 6.0 to 7.30 p.m., reminiscences by Original Fellows and other Fellows of long standing will be given, and on Saturday, March 22, there will be a continuation of the Exhibition, and at 7.0 p.m. for 7.30 a banquet will be held for Fellows and guests only.

The Council of the Physical Society extends to the members of this Society a hearty invitation to be present at these meetings, and, according to present arrangements, no tickets will be required for this purpose.

SOCIETY OF CHEMICAL INDUSTRY

LIVERPOOL AND MANCHESTER SECTIONS

A joint meeting of the above Sections was held in Liverpool, on February 22, Mr. Edwin Thompson in the chair. Those present included Dr. E. F. Armstrong, F.R.S., President of the Society, Dr. H. Levinstein, Chairman of the Manchester Section, Mr. L. Guy Radcliffe, Hon. Secretary of the Manchester Section and about 100 members of the two Sections. A paper was read by Professor I. M. Heilbron on "Plant Pigments."

Professor Heilbron commenced by pointing out that the pigments of nature may be divided broadly into two classes, on the one hand the plastid pigments—chlorophyll and the carotinoids—and on the other, soluble sap pigments of which many well-defined groups are known, notably the yellow-coloured flavonols and the highly-coloured anthocyans. Dealing with chlorophyll, the lecturer explained its occurrence in the chloroplasts and broadly discussed the constitution of the pigment. An examination of chlorophyll was undertaken by Berzelius as early as 1838, but until 1906, when Willstätter began his investigations, our knowledge regarding the constitution of the pigment was extremely meagre. An explanation was then given of the methods employed by Willstätter in attacking the problem, and the lecturer showed how the purely chemical evidence arrived at clearly indicated the presence of two chlorophyll components in the green leaf. Complete justification for these views was reached by Willstätter's isolation of the pigment in the solid state and its subsequent separation into its two components: chlorophyll "a" and chlorophyll "b."

A brief account was next given of the carotinoid pigments and it was pointed out that these were common to both the plant and animal kingdoms. The occurrence and properties of various carotinoids were described and specimens of pure carotin and xanthophyll exhibited. A brief discussion of the part played by chlorophyll in the life-processes of the plant followed and experimental evidence was given in support of the hypothesis (*cf.* Baly and Heilbron, *J.S.C.I.*, 1921, 40, 277 R) that carotin and xanthophyll actually play a part in the photosynthetic process. The soluble sap pigments were also considered and the close relationship existing between flavones, flavonols and anthocyans discussed. Professor Heilbron illustrated by direct experiment the ease with which ring closure and the formation of the strongly-coloured pyrylium nucleus could be induced by the action of mineral acids on *o*-hydroxy cumar ketones, and showed the important bearing of the position of the hydroxyl groups in the molecule on the colour of the compounds formed.

In the afternoon a party of about 70 was conducted through the works of Messrs. Johnson Brothers (Dyers) Ltd., Bootle, by the kind invitation of the directors, who also provided the visitors with tea. The day's proceedings ended with an informal dinner at the

NOTTINGHAM SECTION

At a meeting on February 20 two papers were read by Mr. S. R. Trotman, M.A., and Mr. R. W. Sutton, B.Sc :—

I. "A Note on the Estimation of Poisonous Metals in Gelatin for the U.S.A. Food Laws." There is no limit in the United Kingdom for the impurities present in gelatin such as arsenic, sulphur dioxide, lead, copper and zinc, but in the United States and other countries gelatin for food purposes has to conform to certain standards. The authors, who have had a large experience in estimating small amounts of these impurities, gave brief details of various methods. Estimations of arsenic by standard mirrors, lead and copper colorimetrically and zinc gravimetrically as oxide (finally), gave accurate results even when present in very small quantities. Sulphur dioxide is best determined by distillation (steam) into bromine water and weighing as sulphate.

II. "The Weathering of Cotton and Wool with Special Reference to the Action of Bacteria." One of the chief properties of any textile fibre is its permanence in air under ordinary conditions. The term "weathering" is applied to the factor which causes gradual disintegration—apart from the strains and stresses of ordinary wear—and the power of resistance to weathering is lessened by faulty physical and chemical processes in the preparation of the material.

In general the two chief causes of the deterioration of textile fabrics appears to be actinic light and atmospheric oxygen. Actinic light, together with traces of ozone, brings about deterioration of wool Cotton is affected chiefly by actinic light, although traces of ozone (especially in presence of water) act as a contributory cause of deterioration.

The action of bacteria as a cause of weathering has received much less attention than the other causes and experiments were described showing the importance of the presence of micro-organisms—especially *B. subtilis* and *B. mesentericus*. Cotton fibre attacked by *B. subtilis* first swelled up, lost its natural twist, and in some places globular swellings caused rupture of the cuticle, the latter being completely destroyed in 48 hours. During a period of seven days it was noted that at first that an increase in tensile strength occurred, followed by a decrease (after three days), and this decrease was found to correspond with an increased number of globular swellings. The nitrogen content of the cotton suffered very little diminution during the experiments, so that the removal of proteins could not be effected by the action of *B. subtilis*; neither was the removal of starch as rapid as by the action of diastase. The action of *B. mesentericus* gave similar results, although the action was less marked. Wool attacked in a similar way soon became rotten, and showed a greater affinity for acid and basic dyes.

In the discussion, Mr. Pentecost inquired whether hydrogen peroxide would not be better than sulphur dioxide for bleaching and preserving gelatin to be used for food purposes. Would the cause of the rotting of garments found in the tomb of Tut-ankh-Amen be due to the action of micro-organisms? Dr. Prideaux referred to some of the points dealt with in analytical work, and asked what was the cause of the globular swellings in cotton produced by *B. subtilis*? Mr. Burford asked as to the fate of the bacteria which brought about deterioration of fabrics. Mr. Heyes mentioned that recent researches gave results in close agreement with those of Mr. Trotman; the action of bacteria on wool was greatly increased by alkalinity. Mr. Barber inquired as to the best method for sterilising wool and cotton.

In reply, Mr. Trotman said that hydrogen peroxide was not used as a preservative or bleaching agent for gelatin because sulphur was cheaper, and hydrogen peroxide in alkaline solution would hydrolyse the gelatin. If used in acid solution the peroxide would not bleach, and, further, the gelatin would act as a protective colloid, and subsequent decomposition of the peroxide with liberation of oxygen would give the gelatin a bubbly appearance. The swelling of cotton cuticle was due to the cotton assuming a true colloidal condition. Bacteria would grow in a medium until they produced enough toxin to kill. The p_H value was an important determining factor for the type of bacteria which will grow in a medium. Cotton was best sterilised by boiling, wool by keeping in contact with chloroform. The disintegration of fabrics in the tomb at Luxor was certainly due to bacteria, as no actinic light could have gained access.

SOUTH WALES SECTION

On February 8, at the Technical College, Cardiff, Mr. H. W. Webb, M.Sc., opened a discussion on the action of acids on metals, Mr. W. R. Bird being in the chair.

Mr. Webb dealt exclusively with the acids hydrochloric, nitric and sulphuric in their action on iron, lead and copper. The sources of error in laboratory tests were mentioned, points such as the influence of impurities in the acids, change in concentration of acids during test, aeration, surface, homogenity of metal, etc., being dealt with. The influence of arsenic in the sulphuric acid used for pickling, of the nitrous acid in nitric acid, and of aeration in the solution of copper in acids were each discussed. Acid attack on metals was shown to be divisible into two classes: (*a*) Those in which hydrogen evolution occurs, and (*b*) Oxidation reactions. Sulphuric acid belongs apparently to both classes, since at low temperatures the gas evolved by a solution of a metal such as iron is mainly hydrogen, irrespective of the concentration of the acid, while at high temperatures the gas is exclusively sulphur dioxide. The influence of impurities in lead on the rate of attack by sulphuric acid was also treated in detail, and it was shown that small percentages of copper (0·1—0·75 per cent.) increase the resistance of the lead at high temperatures, whereas at ordinary temperatures pure lead was more resistant than lead containing antimony (hard lead), or regulus. The temperature at which gas evolution commences was not considered to be the best criterion of rate of attack. Mr. Webb concluded by referring to the

use of iron-silicon alloys in acid plant, and reviewed their intrinsic difficulties and the present position in chemical industry of such acid resisting alloys.

A very interesting discussion ensued. Mr. W. R. Bird dealt with the value of nickel and chromium steels for resisting acids, and mentioned some of the difficulties connected with iron-silicon alloys. Mr. Clegg gave an account of his experience in the use of antimony pumps for hydrochloric acid, and mentioned the importance of temperature in this respect. Prof. Edwards (Swansea) pointed out that, as regards the action of acids on alloys, the addition of a metal B to a metal A, in general, gave a product more resistant to acids, and that the continued addition of B increased this resistance to attack until the eutectic composition had been passed, when further addition of B accelerated the rate of attack by galvanic action. Prof. Edwards also described some very interesting work he had carried out on the passage of hydrogen through metals. Mr. J. R. Green stated that pure tin is more rapidly soluble in hydrochloric acid than tin containing small quantities of impurities, such as lead and iron. Mr. Rudge described the importance of aeration in the parting of copper-gold alloys by sulphuric acid.

BIRMINGHAM AND MIDLAND SECTION

At the meeting held at the University of Birmingham on February 21, Mr. F. R. O'Shaughnessy (vice-chairman) being in the chair, a paper entitled "A New Determination of the Specific Gravity of Solutions of Ammonia" was read by Messrs. N. W. Price and C. S. L. Hawkins (of Messrs. Chance and Hunt, Ltd., Oldbury).

The table published by Lunge in 1889 showing the relationship between the specific gravity and ammonia content of pure liquor ammonia had up to the present been accepted as the standard one. After a great number of determinations it was realised that the data given by Lunge were not strictly accurate. Invariably the analyses showed a lower percentage of ammonia than would be expected from the published tables. The authors concluded that the only satisfactory way of making new determinations was to weigh the ammonia solutions in a sealed vessel and then to estimate the whole of the ammonia contained in that vessel. A comparison of the tables brought out the following points: For specific gravities between 0·880 and 0·885 the new figures obtained were lower than Lunge's, the maximum difference being 0·33 per cent.; for specific gravities between 0·885 and 0·996 the new figures were higher than Lunge's, although the difference was very small.

Mr. F. R. O'Shaughnessy said the value of the great efforts made to eliminate error, experimental and personal, was alike commercial and scientific. Mr. W. A. Calder said the research followed a study of the behaviour of the curves produced from Lunge's figures. Dr. A. Parker said it would be interesting to work out, assuming the gravity of water to be 1 in the ammonia solutions, the volumes occupied by one gram of NH_3 in the solutions of different strengths.

Dr. A. C. Monkhouse (Fuel Research Department, Leeds University) next read a paper on "The Nitrogen of Coal and Ammonia Recovery."

The growing demands for nitrogen products, particularly for agriculture, were reviewed and the relative position of the by-product ammonia to the whole nitrogen industry was outlined. The respective merits of the Dumas and Kjeldahl methods of estimating nitrogen were discussed, the Dumas yielding a higher value of 0·1 to 0·2 per cent. for bituminous coals, due in the main to the Kjeldahl method taking no account of occluded nitrogen. An account of the present knowledge of the origin and nature of the nitrogen of coal was given and adventitious sources such as animal albuminoid matter and adsorbed nitrogen were mentioned. On distilling coal 11–18 per cent. of the nitrogen is obtained as ammonia, 50–80 per cent. is left in the coke, the remainder being found as free nitrogen, cyanogen and in the tar. The amount of nitrogen remaining in the coke was emphasised and the influence of carbonising coal in different atmospheres on the nitrogen of the coal was described in detail.

The nitrogen compounds in coal were converted on carbonisation into compounds which could be classed under three heads. (1) Those which yield ammonia direct on heating. (2) Those which yield ammonia on combination with hydrogen. (3) The so-called carbon "nitrides" which are split up by steam with the formation of ammonia. Hydrogen increased the yield of ammonia during carbonisation, but it was impossible to obtain ammonia by passing hydrogen over metallurgical coke, because the nitrogen was present in a form only decomposable by steam. During carbonisation the maximum evolution of hydrogen occurred at the time of maximum evolution of ammonia, thus increasing the yield of ammonia.

The passage of water gas through a retort did not increase the concentration of hydrogen, owing to the similarity in hydrogen content of the coal gas and water gas, but merely preserved the ammonia formed by diminishing the time of contact with the red hot coke. The work of Salmang, Pexton and Cobb has shown that with high temperature (1100° C.) coke and metallurgical coke the carbon-nitrogen remained constant during gasification by steam. In conclusion, the increased yields of ammonia of vertical retorts with steaming and the high yields of Mond producers were mentioned.

Mr. I. Graham thought there was a danger of error in dealing with low-temperature cokes, because the amount of gas adsorption was greater than with coal. Experiments with steam at high pressure, which appeared to have an oxidising action, were being carried out and these seemed to show an increased production of nitrogen. Dr. A. Parker said there was no doubt that steaming increased the nitrogen recovered as ammonia. Mr. E. C. Rossiter observed that in the course of seven years the production of synthetic nitrogen compounds had increased from 10 per cent. of the world's supply to a little over 21 per cent.

CHEMICAL SOCIETY

Presiding at an ordinary meeting on Thursday, February 21, Prof. W. P. Wynne announced, amid applause, that the Council had awarded the Longstaff medal to Prof. F. G. Donnan.

Mr. H. Hunter dealt with the first, and Prof. T. M. Lowry with the remainder, of the papers presented at the meeting :—

Investigations on the dependence of rotatory power on chemical constitution. Part XXII. Simple and complex rotatory dispersion. Harold Hunter.

A FORMAL and graphical analysis of the four possible cases of the Drude rotatory dispersion equation with one or two terms reveals the fact that, with the methods at present available, the classification of rotatory dispersion into "simple" and "complex" corresponding respectively to a one-term and a two-term Drude equation, is impracticable. It is shown that the method of plotting the reciprocal of the rotatory power against the square of the wave length does not distinguish between simple and complex rotatory dispersion, but that it serves to differentiate normal from potentially anomalous dispersion. A return to this older system of classification is therefore inevitable.

It thus follows that some current ideas on the chemical significance of rotatory dispersion must be considerably modified, and that there is no evidence that complexity of dispersion is ever symptomatic of chemical heterogeneity.

The rotatory dispersive power of organic compounds. Part XI. Sec-octyl alcohol and sec-octyl oxalate. T. M. Lowry and E. M. Richards.

(*a*) THE rotary dispersion of *sec.*-octyl a cohol can be expressed completely by one term of Drude's equation.

(*b*) The rotatory dispersion of *sec.*-octyl oxalate, like that of sodium tartrate, approximates closely to the inverse square law of Biot, but a two-term equation is required to express it accurately.

The rotatory dispersive power of organic compounds. Part XII. Borneol, camphor, and camphorquinone. Asymmetric atoms and asymmetric molecules. J. O. Cutter and T. M. Lowry.

(*a*) THE rotatory power of a strong solution of camphor in benzene has been measured for a series of 41 wave-lengths in the visible and ultra-violet regions. Shorter series of measurements have been made of a more dilute solution in benzene, and of solutions in cyclohexane and in acetone. Solutions in benzene of borneol and of camphorquinone (for a short series of wave-lengths only) have also been examined.

(*b*) The rotatory dispersion of camphor and its derivatives is complicated (i) by the presence of selective as well as of general absorption, (ii) by the presence of two dissimilar asymmetric carbon atoms in camphor and of 2, 3 or 4 in its derivatives, (iii) by the tendency of camphor to form molecular compounds with the solvent.

(*c*) The rotatory power of camphor in benzene (33·827 g. per 100 grams of solution) can, however, be represented very satisfactorily over a wide range of wave-lengths by the equation

$$[a] = -\frac{20{\cdot}138}{\lambda^2 - 0{\cdot}05428} + \frac{29{\cdot}384}{\lambda^2 - 0{\cdot}08720}$$

It is, therefore, thought likely that these two terms may actually express the two opposing factors which give rise to the "complex" rotatory dispersion of the compound. The negative term in this equation has a smaller dispersion-constant than the positive term; since the rotation-constant is also smaller, the resultant rotations are always positive. The dispersion is therefore *complex*, but not *anomalous*.

(*d*) The rotatory power of camphorquinone, over a narrow range of wave-lengths, is expressed by the equation

$$[a] = -\frac{13{\cdot}170}{\lambda^2 - 0{\cdot}22352}$$

This restricted equation is simple only because the rotation is here dominated completely by a strong absorption-band at 4830 A.U., the general absorption of the compound being too remote to influence its rotatory power in this region.

(*e*) In other cases only empirical equations have been deduced. In these, the various terms of the ideal complete equation are blended into one positive and one negative term, but it is doubtful whether these equations have any real physical meaning.

(*f*) Strong support is given to the view that, in studying the rotatory power and rotatory dispersion of complex compounds containing asymmetric atoms it is not sufficient to consider the dissymmetry of the molecule as a whole, since each asymmetric atom may contribute a separate share to the rotatory power of the compound, and a separate term or terms to the equations of rotatory dispersion.

The rotatory dispersive power of organic compounds. Part XIII. Halogen-derivatives of camphor. Optical superposition in the camphor series. J. O. Cutter and H. Burgess.

(*a*) MEASUREMENTS have been made of the rotatory dispersion of α- and α′-chlorocamphor, of αα′- and β-bromocamphor and of five isomeric dibromocamphors.

(*b*) In nine cases out of ten, the curves are *complex but normal*, *i.e.*, the rotation increases progressively as the wave-length diminishes, giving rise to quasi-hyperbolic dispersion curves, which do not exhibit any obvious anomalies; the dispersion is, however, not *simple* since it cannot be represented by a single term of Drude's equation.

(*c*) The dispersion can usually be represented by two terms of the Drude equation; but in one or two cases imaginary values are obtained for the constants, showing that the dispersions are of still greater complexity.

(*d*) In the one case of α′-bromocamphor, the negative term predominates over the positive term, and the complex dispersion becomes *anomalous*. The inflexion at 5455 A.U., maximum at 4710 A.U.,

3890 A.U., have all been [illegible] experimentally.

In opening the discussion, Dr. R. H. Pickard complimented Prof. Lowry on the painstaking manner in which he and his collaborators had performed the experimental work; despite the refinements employed, however, polarimetry must still be regarded as a comparatively crude operation. Mr. Hunter's contention that the difference between a one-term and a two-term equation could only be observed much below λ-3600 was significant. It appeared to the speaker that, although equations might be found to fit the results, it was not possible to use such equations for the classification of compounds.

Dr. T. Slater Price, remarking that the question at issue seemed to be one of accuracy of measurement, referred to the difficulty and uncertainty of visual comparisons of spectrum photographs, and recommended the use of an instrument, which had recently been described, whereby the diminution in intensity of a beam of light is balanced, using a selenium cell, against that produced by a neutral wedge in another beam from the same source.

Mr. J. O. Cutter said that the essential difference between simple and complex dispersions remains as evidenced by the cases of the octyl alcohol on the one hand, and camphor or camphorquinone on the other, although the difficulty of distinction was admitted. Variation of the characteristics of photographic plates was responsible for greater errors than the visual method of comparison of densities.

Mr. L. F. Hewitt cited the case of the aliphatic and aromatic secondary alcohols in support of the opinion that there is some connexion between the dispersive properties of a compound and its constitution; he agreed, however, that the distinction between simple and complex dispersion was frequently impossible in practice. It was of interest to note that in the case of the hydrogen phthalates of optically active secondary alcohols, the rotation of the ester appeared to be reversed in its alkaloidal salts.

Mr. Hunter suggested that the dispersion of *sec.*-octyl alcohol might become obviously complex if examined in the ultra-violet region beyond 3800Å., and nearer its characteristic absorption band. He asked how Prof. Lowry reconciled the position of the observed absorption band in the spectrum of camphor at 3500 Å., with that demanded by his equation at 3000 Å.

Prof. Lowry, replying, remarked that the graphical method was replaced, for exact work, by a more extended numerical test. The difficulty of detecting a complex dispersion made up of two positive components had already been emphasized, and experience had confirmed the practical difficulty of detection by visual readings only. Concerning the general question of the relation between optical and chemical complexity, complex dispersion may be ascribed (as in the case of tartaric acid) to the presence of two molecular species, or it may suggest a plausible explanation in suspicion of the chemical homogeneity of the medium—a suspicion which does not exist in the case of compounds showing simple dispersion. In any case, it was only the origin of the difference between the hyperbolic and more complex dispersion curves that was open to question. The absorption band of camphor at 3450 was measured in alcohol, whilst the rotatory dispersion was measured in benzene. The observation that a solution of camphor in benzene was more transparent than a solution in *cyclo*hexane suggested that benzene forms a loose molecular compound which is more transparent than camphor itself.

CORRESPONDENCE

LEAD SMELTING IN ENGLAND

SIR,—In your issue of February 8, Mr. H. L. Terry, in referring to a review by me of Dr. Smythe's "Lead: Its Occurrence in Nature, etc," calls attention to the small proportion of lead smelted in England as compared with the total quantity of that metal used here. Mr. Terry considers that my statement to the effect that the "lead produced by smelting does not exceed one-fifth of the total quantity of metal used for all purposes," over-estimates the quantity of English smelted lead.

It is probable that the war and post-war periods are more accurately represented by the figures quoted by Mr. Terry and this was known to me when reviewing Dr. Smythe's work, but in view of the fact that these figures are in every way abnormal, I considered it proper to utilise the figures for 1913 contained in Dr. Smythe's work, on pages 44 and 45, where it is shown that in that year, the United Kingdom produced 48,962 metric tons of lead, of which 30,000 was obtained from imported ores—the consumption of lead during that period being 191,400 metric tons. The figures contained in the monograph issued by the Mineral Resources Committee, written by T. C. F. Hall, 1921, do not seriously differ from those of Dr. Smythe.

I am grateful to Mr. Terry for his letter because it will help to focus attention on a question of great national importance, viz., the accelerated rate of decline of English lead mining since 1913, and it appears to be an open question whether English mining will recover or whether this industry, which is one of the oldest of English industries, will entirely disappear.

In discussing this point, the following extract from the monograph of Mr. Hall is of particular interest:—

"Since 1914 the abnormal conditions created by the war have had a serious effect upon the mining industry, and difficulties connected with shortage of labour and machinery have considerably curtailed outputs. On the other hand, the demand created for home ore supplies and the increase in the price of the metal have had the effect of directing attention to many derelict properties which, under normal conditions, were considered worthless, though the extensive nature of the operations necessary in most cases to bring these properties again to a

productive state has prevented any immediate results. Moreover, it is very doubtful whether, so far as lead is concerned, any considerable tonnages are available from many of these sources, for although in some instances increased mining costs combined with a fall in the value of the metal were the main factors in causing abandonment, it cannot be doubted that in others the root cause is to be found in the exhaustion or impoverishment of the deposits. With respect to financial burdens, reference may be made to the heavy pumping charges and to the difficulties of transport with which many mines had to contend. With regard to the former, attention is now being directed to the driving of deep adits in order to effect efficient and cheaper drainage, and such schemes are under construction or consideration in Shropshire, Flintshire and Leadhills. The latter difficulty may be met by means of aerial ropeways, as has been done in Shropshire."—I am, Sir, etc., C. A. Klein

Brimsdown, Middlesex
Feb. 20, 1924

THE FEDERAL COUNCIL

Sir,—I have read with interest your recent appeals for funds on behalf of the Federal Council. I am reminded of childhood days when I was requested by a larger and more knowing boy for pence to aid in sending missionaries to Central Africa. As a very ordinary chemist, the territory of Uganda and the reality of the Federal Council appear equally vague to me. You ask for funds, so you give the right to ask: What is the Federal Council? What does it do with its funds when it gets them? Who are its members, and how are they elected? It certainly may be a very able body, but its methods seem like those of certain Hush Committees that flourished in Whitehall during the late and, it would seem, forgotten, war. If one were presented with a full and definite statement as to the composition and activities of this mysterious body, one's purse strings *might* be loosened. At present it seems to be run by a small clique who carefully conceal from the general public what the Federal Council does.—I am, Sir, etc., J. V. M.

PATENTS

Sir,—I notice in your issue of January 25, 1924, a letter from a Limited Liability Company offering professional services in connexion with the obtaining of Patents and the registering of Trade Marks in Russia.

The facts referred to in this communication are, of course, well known in the profession, but it may be that your readers are not aware of the fact that Fellows of the Chartered Institute of Patent Agents, who are subject to [illegible] professional conduct of that Institute, ar[illegible]ed to solicit business.

Advertising "boost[illegible]e kind of the letter in question are discourag[illegible] prohibited in practically all the professions, and although the information itself may have been of interest to some of your readers, yet as the Society which publishes your *Journal* is composed very largely of professional men, I am surprised that you should have seen fit to publish it in such a form. Can it be that the Editorial vigilance was temporarily relaxed at the request of the Advertisement Manager? Perish the thought!

I enclose my card, but not for publication.—I am, Sir, etc.,

Chartered Patent Agent

[Note.—The Editorial vigilance is never relaxed; the letter referred to was published because we thought the information in it would be of interest to some of our readers.—Ed. *C. & I.*]

THE EPILATION OF SKINS

Sir,—Dr. H. C. Ross is to be congratulated upon the isolation and study of saproprotease, as described in his paper on "The Epilation of Skins," published in your issue of January 18, and I am sure that all chemists will rejoice that a medical man has made observations of such technical importance. It is all the more strange, therefore, that in some of his statements regarding matters which verge more toward the purely medical, that Dr. Ross has made some errors which I think must be pointed out lest they pass into current belief.

In the first place, Dr. Ross says: "The ancient Egyptians were the greatest of all embalmers. . . ." As scientific advisor to the National Selected Morticians I have had occasion to look up the Egyptian methods and compare them with those used by modern embalmers; and while everyone must marvel at the astounding skill and knowledge of these ancient people even over 5000 years ago, and realise that the submergence of their civilisation by Aryan inroads probably set the world's civilisation back many centuries, nevertheless no embalmer in any modern civilised community could possibly succeed with the methods they used.

Both Herodotus and Diodorus give accounts of the methods used by the Egyptian embalmers, and while these differ somewhat, it seems evident that there were several grades of embalming, that the process took much time (about 1–3 months), that it was very expensive, and that it would be forbidden by the local board of health in any community where one might attempt to practice it to-day. The body or face of the deceased was not shown to the family, but the mummy was swathed in bandages, drenched in perfumes, and hidden in a number of nested cases, on the outside of which were painted or carved pictures of the occupant. Besides, it was the extremely dry air of Egypt that was a great aid to results, as Egyptologists well know.

The better modern embalmer does his work quickly, at a small cost, and in a sanitary manner, and it is no discredit to the Egyptians that his work is vastly superior. The statement that the ancient Egyptians were the greatest of all embalmers is an error that should not be perpetuated, and that does not become true by repetition.

After properly pointing out the distinction between somatic and cellular death, Dr. Ross makes the following remarkable statement: "The first event that happens after an animal is slaughtered is that

the blood coagulates. Everybody knows that when blood is shed in a living animal it clots and so stops bleeding. But when an animal dies, the coagulation is general and universal throughout the whole system of blood vessels. This general coagulation occurs within three minutes. The hitherto fluid blood is changed into a firm, stringy mass or clot, from which a straw-coloured fluid exudes, called serum. Owing to the formation of the solid clot in the blood vessels, the former supple body of the animal becomes stiff—a rigid corpse, a condition known as rigor mortis."

The errors here must be patent to everyone who has had the least experience with these matters, and especially to butchers and to embalmers and to physicians. Thus in his "Clinical Hematology," Dr. John C. Da Costa says: "In normal blood the formation of the fibrin network becomes apparent within two or three minutes *after exposure to the air*, and the process is completed within seven or eight minutes" (the italics are mine). Perhaps Dr. Ross was thinking of shed blood. Then the time of coagulation is very variable, being rapid in some diseases (chlorosis, pneumonia, scarlet fever), and slow or inhibited in others (hemophilia, jaundice, pernicious anæmia, yellow fever). But this all refers to shed or extra-vascular blood. Within the body the coagulation is usually long delayed, the actual time depending on many factors, but generally running into hours.

Now as to rigor mortis, a consideration of the facts set forth in such an authority as "Chemical Pathology," by Dr. H. Gideon Wells, will show that the matter is not quite as simple as has been assumed by Dr. Ross. Rigor mortis is caused by a lasting contraction of the muscles, which become stiff and harder than in life, lose elasticity, and exhibit a turbid whitish appearance. Its onset and duration are both extremely variable, being hastened by heat and exercise prior to death, and retarded by cold. Clamping the abdominal aorta of a live rabbit will produce it, as will also certain poisons (quinine, monobromacetic acid), but renewing the circulation or perfusing with salt solution will remove it. Oxygen may delay or prevent it. Consideration of the work of Halliburton, von Fürth, Mangold, Krogh and others indicates that the coagulation of the blood itself has little to do with it, if anything. Probably one of the main factors is the formation of lactic or some other acid which influences the turgidity of the muscle colloids and is not swept out because the circulation has stopped.

The experimental facts mentioned on p. 58 remind one of the phenomenon called "skin-slip," and open up interesting possibilities as to the existence of autolytic as well as bacterial processes in the dead body.—Yours, etc.,

JEROME ALEXANDER

New York,
Feb. 8, 1924

SIR,—Referring to Dr. H. C. Ross's paper on the "Epilation of Skins" (*Chem. & Ind.*, 1924, p. 55), I should not have thought it worth while to criticise this paper had not the scientific correspondent of the *Leather World* taken the paper seriously.

I do not know why Dr. Ross should use the word "epilation" instead of the usual word "depilation," which is in common use. He speaks as though his medical knowledge places him in a class apart from the chemist, but it seems probable that chemists know more about the reactions which take place in the body than many medical men, who have little time to study chemistry.

Dr. Ross's theory is very wonderful, and his temerity is great, seeing that he had no knowledge of tanning except a superficial one gained by a few months' work in a modern tannery, and with this equipment he sets up his knowledge against that of men who have spent their lives at the work.

Dr. Ross says (p. 56) "in medicine little is known about un-hairing." I agree with this if his article represents the state of medical knowledge.

He also states that "Thrombin is a proteoclastic enzyme, acting in a similar manner to 'sapro-protease' (a fine sounding name for bacterial trypsin),' and that 'sapro-protease' becomes one hundred times more active in the presence of lime." Neither of these statements is true. I used to believe that old limes contained considerable quantities of enzymes derived from bacteria, but when these were looked for, they were not found to be present. As a matter of fact, old limes contain extremely small quantities of enzymes. I have examined hundreds of samples of old limes, and if Dr. Ross's statements were correct, it would have been quite easy to demonstrate the presence of these powerful enzymes. It is to be noted that Dr. Ross ignores the work of Stiasny on liming (*J.S.L.T.C.*, 1919, 129), the "Report on Liming Control," issued by the S.L.T.C., the paper by Wood and Law (*J.S.C.I.*, 1916, 585), in which it is shown that ammonia and sulphur compounds derived from the hair alone by chemical action are sufficient to unhair; see also the recent paper on the "Bacteria in Lime Liquors," by L. Collett, (*J.S.L.T.C.*, 1923, 418.)—Yours, etc.,

JOSEPH T. WOOD

Turney Brothers, Ltd.,
Trent Bridge Leather Works, Nottingham
February 22, 1924

Dr. Jacques Loeb, head of the Division of Physiology in the Rockefeller Institute for Medical Research, who died in Bermuda recently, had an international reputation as a physiologist. His work covered a wide range being related largely to the inter-relation of nervous action with chemical reactions. He did much to show that chemical conceptions can be applied to explain the peculiar "physical" properties of colloid materials, and that the behaviour of these is comparable with that of crystalloids when determined under proper conditions.

PERSONAL AND OTHER ITEMS

BAYER 205 AND FOURNEAU 309

(From a Correspondent)

Some years since the Bayer Company produced a synthetic material which appeared to be remarkably efficient as a cure for sleeping sickness; this was called Bayer 205; the composition and constitution of this new remedy were kept secret because it appeared that the substance is the key to tropical Africa and that the German Government must "be required to safeguard this discovery for Germany; its value is such that any privilege of a share in it granted to other nations must be made conditional upon the restoration to Germany of her colonial Empire."

It was indicated at the time (this Journ., 1922, 41, 368 R) that it was only possible to hide the identity of Bayer 205 because of the non-existence in this country of an efficient co-operation between the organic chemists and the Medical Research Councils.

In the Annual Report of this Society for 1921 (Vol. VI., p. 537) Dr. H. King stated that Bayer 205 appeared to belong to the group of ureas formed by the action of carbonyl chloride on the corresponding amino-derivative of the substance produced by the introduction, twice, of *p*-nitrobenzoyl chloride into H-acid. This is now confirmed by Fourneau and his co-workers who announce in the *Comptes Rendus* dated February 11, 1924, that Fourneau 309 seems to be identical with Bayer 205. The compound prepared by Fourneau is a symmetrical urea of meta-amino-benzoyl-meta-amino-paramethyl-benzoyl-1-naphthylamine-4.6.8-trisulphonate of sodium; the constitution of which certainly resembles the formula suggested by Dr. King. M. Fourneau and his associates are to be congratulated on their success and thanks are also due to Dr. King, who, your readers will remember, is in charge of the Department of Biochemistry and Pharmacology in the National Institute for Medical Research at Hampstead.

* * *

Mr. F. S. Sinnatt, M.B.E., M.Sc.Tech., has resigned his lectureship in fuels in Manchester University to take up the post of Assistant Director of the Fuel Research Board.

Mr. A. Chaston Chapman, F.R.S., who is retiring from the presidency of the Institute of Chemistry, is to be succeeded by Prof. G. G. Henderson, Regius Professor of Chemistry in the University of Glasgow.

Dr. C. K. Ingold, lecturer in organic chemistry in the Imperial College of Science and Technology, has been appointed professor of organic chemistry in the University of Leeds, as from October 1 next, on the retirement of Prof. J. B. Cohen, F.R.S. Dr. Ingold, who carried out valuable work for the Chemical Warfare Committee during the war, is the author of numerous papers dealing with tautomerism and other problems of the structure of organic compounds.

BRITISH INDIA

Sugarcane Crop of 1923-24

The final memorandum of the sugarcane crop, based on reports received from provinces, which contain, on an average, 99 per cent. of the total area under sugarcane in British India, estimates that the area sown is 2,882,000 acres, as against 2,740,000 acres last year. This area does not include Mysore, from which information is not forthcoming. The total yield (again excluding Mysore) is estimated at 3,240,000 tons, as against 3,044,000 t. last year. These estimates show an increase of 7 per cent. in area, and of 8 per cent. in yield compared with 1922-23. The condition of the crop is reported to be generally good.—(*Ind. Tr. J., Feb.* 7, 1924.)

FRANCE

Metallurgy in 1923

The position of French metallurgy at the beginning of 1924 shows much improvement. The average monthly production of cast iron and steel in 1913 was 43,400 and 390,000 tons respectively, whereas the respective figures for 1923, including the production of Lorraine, are below these averages by only 80,000 t. for cast iron and 40,000 t. for steel. The number of blast furnaces alight has decreased from 166 in January, 1923, to 125 in January, 1924, the total number of blast furnaces being 219. The production of cast iron was 520,700 t. in 1913, 5,128,608 t. in 1922 and 5,299,586 t. in 1923. Steel production which was 4,687,000 t. in 1913 became 4,471,278 t. in 1922 and 4,976,869 t. in 1923. In Lorraine, the production in 1923 was 1,867,164 t. of cast iron and 1,576,059 t. of steel. Considering the production of 564,655 t. of cast iron and 525,509 t. of steel in December 1923, the annual production could amount to 6,800,000 t. of cast iron and 6,300,000 t. of steel, an attainable output as it corresponds only to the utilisation of 119 blast furnaces, 51 being in working order but held in reserve, and 43 under construction or repair. Exports totalled 592,086 t. of cast iron and 1,847,238 t. of iron and steel compared with imports of 63,541 t. of cast iron and 663,876 t. of iron and steel.

Production of Potash and Salt in December, 1923

During 1923, the French production of potash totalled 1,338,333 tons, equivalent to 27,741 t. of K_2O. The output of salt increased slightly from 1768 t. to 102,899 t.

GENERAL

Nitrate Position

According to the *Manchester Guardian* the nitrate position is improving, for at the sale last week by the Association of Nitrate Producers, applications were received for 329,000 tons, at 19s. 3d. per 100 kg. for 95 per cent. and 20s. per 100 kg. for the 96·1 per cent. nitrate. Only 200,000 t. was released, however, but a further 50,000 t. has been offered for delivery also in June.

REVIEWS

Einfache und Fraktionierte Destillation in Theorie und Praxis. By Prof. C. von Rechenberg. Pp. xv+814. *Leipzig: Schimmel & Co.*, 1923. *Price: paper*, 17 *gold marks; bound*, 18 *gold marks*.

Readers of Prof. v. Rechenberg's treatise, *Theorie der Gewinnung und Trennung der aetherischen Oele durch Destillation*, will welcome the appearance of this book, which is described in the preface as a second edition of a part of the earlier volume.

The first hundred pages of the book are devoted to a consideration, mostly theoretical, of such subjects as vaporisation and solution, methods of proving the purity of a single substance, vapour pressures and boiling points, dissociation, specific heat, heat of vaporisation, vapour density, volatilisation of solids and measurement of temperature. The most important methods of determining the vapour pressures and boiling points of pure substances are then very fully and clearly described, and about 160 pages are occupied by tables of the vapour pressures at different temperatures and the boiling points under different pressures of nearly five hundred substances, bibliographical references for each substance being given in the following 37 pages.

Relations between the temperature and pressure of saturated vapours are next discussed, and the methods of calculating boiling points by the rules of Ramsay and Young and of Dühring are explained. It is pointed out that the vapour pressure curves of many pairs of liquids intersect, and the points of intersection—temperature and pressure—are given for a large number of liquids.

The properties of mixtures, including pairs of non-miscible liquids, are dealt with in the second part of the book. As might be expected, the subject of steam distillation is very fully and ably treated, and there is an interesting discussion of the vexed question as to the relative efficiency of steam distillation and plain distillation under reduced pressure.

A few pages are devoted to a consideration of the solubility of liquids in liquids and of critical solution temperatures, and then follows a detailed description of the measurement of the vapour pressures and boiling points of mixtures and of the composition of the liquid and vapour phases of a solution. The older researches on these subjects are well and fully described, but it is unfortunate that the important investigations of Rosanoff and his co-workers have been overlooked.

After describing the work of Konowalow, on mixtures of the lower alcohols and fatty acids with water, the formation of azeotropic mixtures is explained and their bearing on the distillation of mixtures is discussed. Tables of binary and ternary mixtures of minimum boiling point and of binary mixtures of maximum boiling point are given, and there is a clear account of the methods of determining the composition of such mixtures and of separating the components of an azeotropic mixture by distillation with a third substance.

The third part of the book is devoted to simple and fractional distillation on the large scale and in the laboratory. There is, first, an excellent account of the steam distillation of ethereal oils, followed by a description of the distillation of the tars from brown coal and ordinary coal and of petroleum. Under the last named head, the cracking of oils is briefly discussed. The various forms of apparatus employed for fractional distillation on the large scale are described in detail, and a considerable number of still-heads devised for use in the laboratory are figured and described.

There is finally a table of boiling points of elements and compounds arranged in alphabetical order and occupying some 48 pages.

The index, so far as names of authors are concerned, is not so complete as it might be; for example, there is a nearly full-page illustration of Zawidski's well-known apparatus for determining the composition of the liquid and vapour phases of a mixture, but Zawidski's name does not appear in the index.

The book is well printed, the illustrations are clear and good, and the author is to be congratulated on the production of an excellent and useful treatise.

SYDNEY YOUNG

Systematic Survey of Rubber Chemistry. By C. W. Bedford *and* H. A. Winkelmann. *Pp.* 325. *New York: The Chemical Catalog Co., Inc.*, 1923. *Price* $7.0.

The long sub-title to this volume is liable to create some misconception as to its scope, for, as the authors state in an explanation of its objects, the following subjects, namely, Analysis of Rubber, Synthetic Rubber, Physical Properties of Rubber, Rubber Testing, Rubber Botany, Diseases of Rubber Trees, Reclaimed Rubber, have been omitted, and articles dealing with them have been included only where they contain data relative to molecular structure, ageing, accelerators or similar subjects. In the same way we find that the introductory chapters "summarising the present status of rubber chemistry" consist of two articles, the one by Dr. L. B. Sebrell on "Organic Accelerators of Vulcanisation," the other on "Theories of Vulcanisation" by Dr. W. J. Kelly. Both of these articles, it may be said, are critical and excellent as regards manner and matter, and the conclusion reached by Dr. Kelly that vulcanisation is a purely chemical process, and his reasons for this view, will be read with more than general interest. The "survey" is arranged in three main divisions: Author Index, Subject Index, and Patent Index. The first constitutes a bibliography with the authors listed alphabetically. The works are set out in approximately chronological order, with a reference number for each article or group of patents. This reference number is used for cross-indexing between the various divisions of the survey. For example *Smith G.* (23) would refer to the tenth item under G. Smith in the Author Index. The Subject Index, arranged alphabetically, correlates the data relative to the various subjects treated, and the abstracts of the subject matter are to be considered as indicative of the nature of the work and not as

condensations of data. In other words, it is not sought to make a reference to the original publication unnecessary. A valuable feature of the references is that these are not confined to the original (frequently more or less inaccessible) but embrace abstracts, discussions and the like contained in technical or trade journals and in books. The first edition of a work of a more or less encyclopædic nature must necessarily contain a number of imperfections and omissions, and the authors, conscious of this, ask readers to make note of such errors for the benefit of future editions. It is evident that the preparation of Messrs. Bedford and Winkelmann's volume has involved an immense amount of patient and critical labour, and it should prove a boon to all of those who are in any way seriously interested in the chemistry or technology of rubber.

PHILIP SCHIDROWITZ

PARLIAMENTARY NEWS

HOUSE OF COMMONS

The Proposed British and German Dyestuffs Agreement

Replying to Mr. Turner, Mr. Webb stated that proposals for an arrangement have been for some time under discussion between the British Dyestuffs Corporation and the Interessen-Gemeinschaft. As the Board of Trade was not a party to these negotiations, and as the discussions had not terminated, no conclusions had been laid before the Board, but should a draft agreement be submitted, it would require the serious consideration of the Government, and the question of making a statement to the House would be considered without delay.—(Feb. 15.) Mr. Webb said, in reply to Mr. Waddington, that he was aware that the appointments of a limited number of research chemists had been terminated within the past three months, owing to a re-organisation of the research work of the Corporation. With regard to Mr. Waddington's statement that the Corporation has hitherto refused to appoint to the directorate persons with technical and scientific knowledge of dyestuffs manufacture, he understood that an invitation to join the Board of the Corporation was now under consideration by a distinguished scientist.—(Feb. 19.)

Ammonium Sulphate (Supplies)

Answering Mr. F. Martin, Mr. Buxton said that he was aware that in some districts the supply of ammonium sulphate for immediate delivery in the spring of last year was not large. He was advised that the supplies available this year would be sufficient, but said that the matter would be kept under consideration.—(Feb. 18.)

Trade Facilities (Money)

At the Committee of the whole House, under Standing Order No. 71A, the motion was proposed: That it is expedient to amend the Trade Facilities Acts, 1921 and 1922, (1) by increasing from fifty million pounds to sixty-five million pounds the limit on the aggregate capital amount of the loans the principal or interest of which may be guaranteed thereunder; and (2) by extending to March 31, 1925, the period within which guarantees may be given under the Trade Facilities Act, 1921.

White Lead in Paint

In reply to Mr. G. White, Mr. Shaw said that the question of sanctioning the Convention on the use of white lead in paint was under consideration by the Government, and the decision would be announced as soon as practicable.—(Feb. 14.)

Anglo-Persian Oil Co.

Replying to various questions, Mr. Snowden said that the Government had no intention of re-considering the decision not to sell the shares in the Anglo-Persian Oil Co., as it would not have been in the national interest to part with them to a combine, especially as Naval interests, for which the original investment in an independent oil company was made, would have been seriously prejudiced.—(Feb. 14.)

Microscope Stains

Mr. Graham, in reply to Mr. Keens, said that bottles containing stains for use in microscopic work, which "necessarily have to be imported from Germany," may be delivered to the various research departments of hospitals and other laboratories without being opened by the Department of Customs and Excise, provided it was indicated in the Customs entry that the alcoholic strength was not to be tested, and the appropriate duty was paid.—(Feb. 14.)

Dyestuffs

Answering Mr. Waddington, Mr. Alexander said that the quantity of coal-tar dyestuffs of United Kingdom manufacture exported during 1913 was 60,733 cwt., valued at £206,109, an average of £3 7s. 10d. per cwt. The exports in 1923 amounted to 126,187 cwt., valued at £1,031,903, or an average of £8 3s. 7d. per cwt.—(Feb. 14.)

German Reparation (Recovery) Act

Mr. Graham, answering Mr. Harmsworth, said that the negotiations with representatives of the German Government on the subject of the Reparation Recovery Act had resulted in an agreement to reduce the rate of the levy from 26 per cent. to 5 per cent., in respect of goods imported on or after February 26. In order to guarantee that no part of the levy shall be charged to British importers, the German Government had agreed to arrange for the compensation of the German exporters at a later date, and to make it a punishable offence to charge any part of the levy to the British importer. Customs receipts in respect of all goods imported prior to February 26 (*i.e.*, those at the rate of 26 per cent.) would be reimbursed by the German Government in Gold Bonds. Further details in regard to these Gold Bonds would be published in the next issue of the *Board of Trade Journal*.—(Feb. 25.)

COMPANY NEWS

BRITISH ALIZARINE CO., LTD.

The net profit for 1923 is £44,072, and, with £36,550 brought forward, it is proposed to write off £20,000, carry forward £42,914 and pay a dividend of 5 per cent.

JOSEPH CROSFIELD & SONS, LTD.

The balance at credit of profit and loss, amounting to £331,269 for the year ended November 30, 1923, has been appropriated as follows :—£20,000 to dividend on the 5 per cent. cumulative pre-preference shares ; £30,000 on the 6 per cent. cum. pref. shares ; £65,000 on the 6½ per cent. cum. pref. shares ; £112,500 on the 7½ per cent. "A" cum. pref. shares ; and £100,000 on the ordinary shares at the rate of 10 per cent. The carry-forward totals £3769.

BRADFORD DYERS' ASSOCIATION, LTD.

After making sundry deductions, trading profits for 1923 are £1,032,152, and the net profits £739,227, £448,369 being brought forward. It is proposed to bring the reserve to £1,125,000 by adding £125,000, to pay a final dividend on the ordinary shares of 4s. per share, making 5s. (25 per cent.) per share for the year and to carry forward £473,477.

LANTARO NITRATE CO., LTD.

An interim dividend is declared of 5 per cent. (5s. per share) for 1924. No dividend has been paid since 1919, when 16 per cent. (tax free) was distributed, but the capital was increased in 1923 to £4,000,000 and a bonus was given of 3 new shares for every 7 held.

BORAX CONSOLIDATED, LTD.

At the annual meeting on February 19, the chairman, Lord Chichester, said that the financial position of the company was strong. Second mortgage debenture stock amounting to £297,784 had been issued to provide money for increasing the manufacturing capacity of the company. A compromise had been made with the Angora Government, so that shipments from the Turkish mines would be resumed. The accounts were passed. The net profit to September 30, 1923, was £442,753 (£417,900 in 1921-22), on an issued share capital of £2,550,000, debentures amounting to £1,916,450, and reserves to £1,053,131. To commemorate the completion of 25 years of activity, holders of deferred ordinary shares will receive a bonus of 2½ per cent. in addition to a dividend of 12½ per cent.

UNITED ALKALI CO., LTD.

A dividend is announced of 6 per cent. less tax on the ordinary shares, making 10 per cent. for 1923, leaving £96,000 to be carried forward. The last report covered 1921 and 1922, and the total dividend for that period was 10 per cent. and the carry forward £386,735. Out of this sum, a capital bonus equal to 50 per cent., and requiring £300,000 was distributed to ordinary shareholders.

WILLIAM GOSSAGE & SONS, LTD.

The accounts for the year ended November 30 last show, after providing for all charges, a credit balance of £174,826, of which £22,500 is allocated for dividends on the 5 per cent. first cumulative preference shares, £48,750 for the 6½ per cent. cumulative preference shares, and £100,000 for the ordinary shares at 20 per cent., leaving £3,576 to be carried forward.

REPORT

REPORT ON THE ECONOMIC AND FINANCIAL CONDITIONS IN ECUADOR, DATED SEPTEMBER, 1923. *By* R. C. MICHELL, *Chargé d'Affaires, Quito. Department of Overseas Trade. Pp.* 23. *H.M. Stationery Office*, 1923. *Price* 9*d.*

Since the publication of the last report on Ecuador (*cf. Chem. and Ind.*, 1923, 352) the economic situation of the country has gone from bad to worse. Excessive imports have led to a serious state of affairs and the Government has appealed to the country to develop further its natural resources. It is hoped to find foreign capital to aid this development. These large importations were made without respect of the ability of the buyers to pay and it became very difficult to obtain the necessary drafts owing to Government control of the exchange. The market is most unhealthy and British exporters receiving orders from Ecuador are advised to stipulate cash remittances to accompany orders. Imports in 1921 were valued at S/23,486,183 (£1=10 sucres at par, but about 25 now). Of this total the United States supplied 38 per cent. and Great Britain 30 per cent. The principal items were textiles, 26% ; foodstuffs, 11% ; hardware, 10% ; machinery, etc., 9% ; clothing, 5% ; minerals, etc., 5% ; drugs, 4%.

Exports in 1921 amounted to S/33,968,899, the principal items being cocoa, representing 60% ; ivory nuts, 13% ; and coffee, 9%.

The manufacturing industries of the country are small. There is a cement factory which, if it proves successful, will save the country some half-million sucres at present annually for imported cement. The main article produced in the country is cocoa, and the poor crops gathered in the last few years have been the cause of the exchange trouble. The decrease in output seems likely to continue.

The country is not rich in available mineral resources. In 1922 about 4000 oz. fine of gold and 70,000 oz. fine of silver, valued at S/40,400 and S/100,000 respectively were exported. Oil is found in parts of the country ; for the six months ending June 30, 1923, the average monthly output of oil was 4720 gallons of kerosene and 6872 gal. of gasolene. Lignite is found in some parts and three veins of anthracite are reported in the province of Chimborazo. There is evidence of the existence of other mineral deposits, such as manganese, mercury, platinum, etc., but transport difficulties prevent their development.

MARKET REPORT

This Market Report is compiled from special information received from the Manufacturers concerned.

Unless otherwise stated the prices quoted below cover fair quantities net and naked at sellers' works.

GENERAL HEAVY CHEMICALS

The demand for heavy chemicals is well sustained, but there are no fundamental changes in prices to report.

Acetic Acid, 40% tech. ..	£24 per ton. Fair inquiry.
Acid Hydrochloric ..	3s. 9d.—6s. per carboy d/d., according to purity, strength and locality.
Acid Nitric 80° Tw. ..	£21 10s.—£27 per ton makers works according to district and quality.
Acid Sulphuric	Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations: 140° Tw., Crude Acid, 65s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
Ammonia Alkali ..	£6 15s. per ton, spot, delivery. General export demand good, particularly from the Continent.
Bleaching Powder ..	Spot £11 d/d.; Contract £10 d/d. 4 ton lots.
Bisulphite of Lime ..	£7 per ton, packages extra.
Borax, Commercial—	
Crystal	£25 per ton.
Powder	£26 per ton. (Packed in 2-cwt. bags, carriage paid any station in Great Britain.)
Calcium Chloride ..	£5 17s. 6d. per ton d/d.
Potash Caustic	£30—£33 per ton.
Potass. Bichromate ..	5½d. per lb.
Potass. Chlorate	3d.—3½d. per lb.
Salammoniac	£32 per ton d/d.
Salt Cake	£4 10s. per ton d/d.
Soda Caustic 76% ..	£17—£19 10s. per ton, according to quality.
Soda Crystals	£5 5s.—£5 10s. per ton ex railway depots or ports.
Sod. Acetate 97/98% ..	£24 per ton.
Sod. Bicarbonate ..	£10 10s. per ton carr. paid. In
Sod. Bisulphite Powder 60/62%	£19—£20 10s. per ton according to quantity. f.o.b., 1-cwt. iron drums included.
Sod. Chlorate	3d. per lb.
Sod. Nitrate refd. 96% ..	£13 5s.—£13 10s. per ton ex Liverpool. Nominal.
Sod. Nitrite, 100% basis ..	£27 per ton d/d.
Sod. Sulphide conc. 60/65	About £15 per ton.
Sod. Sulphite, Pea Cryst.	£15 per ton f.o.r. London, 1-cwt. kegs included

RUBBER CHEMICALS

Antimony sulphide ..	Expected to advance in sympathy with the crude metal.
Golden	5½d.—1s. 3d. per lb., according to quality.
Crimson	1s. 3d.—1s. 6d. per lb., according to quality.
Arsenic Sulphide, Yellow	1s. 11d. per lb.
Cadmium Sulphide ..	4s. per lb.
Carbon Bisulphide ..	£24—£26 10s. per ton according to quantity.
Carbon Black	Prices continue low but expect to advance in the Spring. T or three case lots can now bought at 5½d. per lb. ex wha For direct shipment in qua tity the price is about per lb. c.i.f.
Carbon Tetrachloride ..	£56 per ton, drums free.
Chromium Oxide ..	1s. 3d. per lb.
Indiarubber Substitutes, White and Dark	5d.—7d. per lb. Dearer owing increased cost of rape seed Good demand.
Lamp Black	40s. per cwt., barrels free.
Lead Hyposulphite ..	7½d. per lb.
Lithopone	£22 10s. per ton.
Mineral Rubber "Rubpron"	£15 10s. per ton f.o.r. London.
Sulphur	£10—£12 per ton, according quality.
Thiocarbanilide	2s. 9d. per lb.
Vermilion, pale or deep ..	3s. 4d.—3s. 6d. per lb.
Zinc Sulphide	7½d.—1s. 8d. per lb., according quality.

WOOD DISTILLATION PRODUCTS

All acetates command a good trade and there appears more healthy prospect in the charcoal market.

Acetate of Lime—	
Brown	£14 10s. per ton d/d. Deman active.
Grey	£22 per ton.
Liquor	9d. per gall. 32° Tw.
Charcoal	£7 5s.—£9 per ton, according t grade and locality. Market quiet
Iron Liquor	1s. 7d. per gall. 32° Tw. 1s. 2d. „ „ 24° Tw.
Red Liquor	10d.—1s. per gall. 14/15° Tw.
Wood Creosote	2s. 7d. per gall. Unrefined.
Wood Naphtha—	
Miscible	5s. 6d. per gall. 60% O.P. Du market.
Solvent	5s. 6d. per gall. 40% O.P. Du market.
Wood Tar	£5—£6 per ton according to grad Demand not very brisk. Ampl supplies.
Brown Sugar of Lead ..	£42 per ton. Demand more active

TAR PRODUCTS

Acid Carbolic—	
Crystals	8½d. per lb. Some business pass ing at lower prices.
Crude 60's	1s. 10d.—2s. per gall. Firmer, with more inquiry.
Crude 60's	1s. 10d.—2s. per gall. Little busi ness passing, but more inquiry.
Acid Cresylic, 97/99 ..	2s.—2s. 3d. per gall. Steady business.
Pale 95%	1s. 10d.—2s. 2d. per gall. Good demand.
Dark	1s. 11d. per gall. Steady business.
Anthracene Paste 40% ..	4d. per unit per cwt. Nominal price. No business.
Anthracene Oil—	
Strained	9d.—10d. per gall. Very quiet.
Unstrained	8½d.—9d. per gall.
Benzole—	
Crude 65's	10½d.—1s. per gall. ex works in tank wagons

Standard Motor .. .. 1s. 4½d.—1s. 6d. per gall. ex works in tank wagons.
Pure .. .. .. 1s. 8½d.—1s. 10d. per gall. ex works in tank wagons.
Toluole—90% .. .. 1s. 4½d.—1s. 7d. per gall.
Pure .. .. 1s. 8d.—1s. 11d. per gall.
Xylol coml. .. .. 2s. 3d. per gall.
Pure .. .. 3s. 3d. per gall.
Creosote—
Cresylic 20/24% .. 11½d. per gall. Few inquiries.
Middle Oil .. .. } 8½d.—9½d. per gall. according to grade and district. Market very firm. Demand good.
Heavy .. .. }
Standard Specification }
Naphtha—
Crude .. .. .. 9d. per gall. } More inquiry. Prices show upward tendency.
Solvent 90/160 .. 1s. 1d.—1s. 3d. }
Solvent 90/190 .. 1s. 1d.—1s. 3d. }
Naphthalene Crude—
Drained Creosote Salts £6—£8. Fair business.
Whizzed or hot pressed £8—£14 per ton. Price nominal. No business.
Naphthalene—
Crystals .. .. £16 10s. per ton.
Flaked .. .. £17 per ton.
Pitch, medium soft .. 52s. 6d.—62s. 6d. per ton, f.o.b. Market weak. Few sellers.
Pyridine—90/140 .. 14s.—14s. 6d. per gallon. Fewer inquiries.
Heavy .. 11s.—12s. Steady with fair business.

INTERMEDIATES AND DYES

Business in dyestuffs has improved appreciably with orders being given for larger quantities. Prices of intermediates made directly from pure benzol have been raised, owing to the increased cost of the latter.

In the following list of Intermediates delivered prices include packages except where otherwise stated.

Acetic Anhydride 95% .. 1s. 6d. per lb.
Acid H. .. .. .. 4s. 6d. per lb. 100% basis d/d.
Acid Naphthionic .. 2s. 5d. per lb. 100% basis d/d.
Acid Neville and Winther 5s. 11d. per lb. 100% basis d/d.
Acid Salicylic, tech. .. 1s. 6d. per lb. Better demand.
Acid Sulphanilic .. 10½d. per lb. 100% basis d/d.
Aluminium Chloride, anhyd. .. .. 1s. per lb. d/d.
Aniline Oil .. .. 7½d.—8½d. per lb. naked at works.
Aniline Salts .. .. 7½d.—9d. per lb. naked at works.
Antimony Pentachloride 1s. per lb. d/d.
Benzidine Base .. .. 4s. 6d. per lb. 100% basis d/d.
Benzyl Chloride 95% .. 1s. 3d. per lb.
p-Chlorphenol .. .. 4s. 3d. per lb. d/d.
p-Chloraniline .. .. 3s. per lb. 100% basis.
o-Cresol 29/31° C. .. 5½d.—6d. per lb. Demand quiet.
m-Cresol 98/100% .. 2s. 1d.—2s. 3d. per lb. Market quiet.
p-Cresol 32/34° C. .. 2s. 1d.—2s. 3d. per lb. Market quiet.
Dichloraniline .. .. 3s. per lb.
Dichloraniline S. Acid .. 2s. 6d. per lb. 100% basis.
p-Dichlorbenzol .. .. £75 per ton.
Diethylaniline .. .. 5s. per lb. d/d., packages extra, returnable.
Dimethyaniline .. .. 2s. 5d. per lb. d/d. Drums extra.
Dinitrobenzene .. .. 9d. per lb. naked at works.
Dinitrochlorbenzol .. £84 10s. per ton d/d. Advanced in sympathy with benzol.
Dinitrotoluene—48/50° C. 8d.—9d. per lb. naked at works.
66/68° C. 1s. 2d. per lb. naked at works.
Diphenylamine .. .. 3s. 3d. per lb. d/d.
Monochlorbenzol .. .. £63 per ton.
α-Naphthol .. .. 2s. 6d. per lb. d/d.
β-Naphthol .. .. 1s. 1d. per lb. d/d.
α-Naphthylamine .. 1s. 5d. per lb. d/d.
β-Naphthylamine .. 4s. per lb. d/d.
m-Nitraniline .. .. 5s. 3d. per lb. d/d.
p-Nitraniline .. .. 2s. 5d. per lb. d/d.
Nitrobenzene .. .. 5½d.—5¾d. per lb. naked at works.
o-Nitrochlorbenzol .. 2s. per lb. 100% basis d/d.
Nitronaphthalene .. .. 11½d. per lb. d/d.
p-Nitrophenol .. .. 1s. 9d. per lb. 100% basis d/d.
p-Nitro-o-amido-phenol.. 4s. 6d. per lb. 100% basis.
m-Phenylene Diamine .. 4s. 6d. per lb. d/d.
p-Phenylene Diamine .. 10s. 6d. per lb. 100% basis d/d.
R. Salt .. .. .. 3s. per lb. 100% basis d/d.
Sodium Naphthionate .. 2s. 7d. per lb. 100% basis d/d.
o-Toluidine .. .. 7d.—8d. per lb.
p-Toluidine .. .. 3s. 10d.—4s. 5d. per lb. d/d.
m-Toluylene Diamine .. 4s. 6d. per lb. d/d.

PHARMACEUTICAL AND PHOTOGRAPHIC CHEMICALS

Acid, Acetic 80% B.P. .. £52 per ton.
Acid, Acetyl Salicylic .. 3s. 6d.—3s. 9d. per lb. Steady demand.
Acid, Benzoic .. .. Commercial acid dearer at 2s. 9d. per lb. B.P. quality remains scarce at 4s. per lb.
Acid, Boric B.P. .. Cryst. £54 per ton. Powder £58 per ton. Carriage paid any station in Great Britain.
Acid, Camphoric .. .. 18s.—20s. per lb.
Acid, Citric .. .. 1s. 5½d. per lb., less 5% for ton lots. Market firm.
Acid, Gallic .. .. 3s. per lb. for pure crystal. Steady market.
Acid, Pyrogallic, Cryst. .. 6s. per lb., for 28 lb. lots.
Acid, Salicylic .. .. Cheaper at 2s. 1d. per lb. for quantity.
Acid, Tannic .. .. 3s. 3d. per lb. for B.P. quality.
Acid, Tartaric .. .. 1s. 1d.—1s. 1½d. per lb. less 5%. Firmer with more demand. Continental acid offered at 1s. per lb. less 5% c.i.f. U.K. port.
Amidol .. .. .. 9s. per lb. d/d.
Acetanilide .. .. 3s. per lb. Weak.
Amidopyrin .. .. 13s. 6d. per lb. Demand negligible
Ammon. Benzoate .. 4s. per lb. English make.
Ammon. Carbonate B.P. £35 per ton.
Atropine Sulphate .. 12s. 6d. per oz. for English make. Market neglected.
Barbitone .. .. .. 16s. 6d. per lb.
Benzonaphthol .. .. 6s. per lb. Firmer.
Bismuth Salts .. .. A steady market. Prices according to quantity:
Bismuth Carbonate .. 12s. 9d.—14s. 9d. per lb.
" Citrate .. .. 11s. 4d.—13s. 4d. "
" Salicylate .. 10s. 2d.—12s. 2d. "
" Subnitrate .. 10s. 9d.—12s. 9d. "
Borax B.P. .. .. Crystal £29, Powder £30 per ton. Carriage paid any station in Great Britain.
Bromides— Per lb.
Potassium .. .. 9d.—10d. } Steady market.
Sodium .. .. 9½d.—10d. }
Ammonium .. .. 11d.—1s. }
Calcium Lactate .. 2s. 9d. per lb. for best English make. Market firm.
Chloral Hydrate .. .. 3s. 9d. per lb.
Chloroform .. .. 2s. per lb. for cwt. lots.
Creosote Carbonate .. 6s. 6d. per lb. Little demand.
Guaiacol Carbonate .. 13s. per lb. for small stocks available. More inquiry. available. Slightly weaker.
Hexamine .. .. 3s. 9d.—4s. per lb. for foreign makes. Firmer.
Homatropine Hydrobromide .. .. 30s. per oz.

Iron. Ammon. Citrate, B.P.	1s. 11d.—2s. 3d. per lb., according to quantity.
Magnesium Carbonate—	
Light Commercial	£36 per ton net.
Magnesium Oxide—	
Light Commercial	£75 per ton, less 2½%.
Heavy Commercial	£26 per ton, less 2½%.
Heavy Pure	1s. 6d.—2s. 3d. per lb., according to quantity. Steady market.
Menthol—	
A.B.R. recryst. B. P.	55s. per lb.
Synthetic	26s.—35s. per lb., according to quantity. English make. Steady demand.
Mercurials	Prices reduced. Market quiet.
Red oxide	4s. 9d.—4s. 10d. per lb.
Corrosive sublimate	3s.—3s. 1d. "
White precip.	4s. 1d.—4s. 2d. "
Calomel	3s. 5d.—3s. 6d. "
Methyl Acetanilide	20s. per lb.
Methyl Salicylate	2s. 9d.—2s. 11d. per lb. for carboys. Slightly easier.
Methyl Sulphonal	24s. per lb. Scarce.
Methylene di-tannin	7s. 6d. per lb. In good demand.
Paraformaldehyde	3s. 6d. per lb., without much inquiry.
Paraldehyde	1s. 6d.—1s. 8d. per lb.
Phenacetin	7s. per lb. Dull.
Phenazone	7s. 9d. per lb. for cwt. lots. Considerable competition.
Penolphthalein	7s. 6d. per lb.
Potass. Bitartrate—	
99/100% (Cream of Tartar)	88s.—90s. per cwt., less 2½%. Firm market. Inquiry good.
Potass. Citrate	1s. 8d.—2s. per lb.
Potass. Ferricyanide	3s. per lb.
Potass. Iodide	16s. 8d.—17s. 5d. per lb., according to quantity. Demand continues.
Potass. Metabisulphite	7½d. lb., 1-cwt. kegs included.
Potass. Permanganate	8½d.—9d. per lb. for B.P. crystal English make.
Quinine Sulphate	2s. 3d.—2s. 4d. per oz., in 100 oz. tins. Steady market.
Resorcin	6s. 3d. per lb.
Salol	4s. per lb. Rather dull.
Silver proteinate	10s. per lb.
Sod. Benzoate, B.P.	3s. 3d. per lb. In more plentiful supply.
Sod. Citrate, B.P.C., 1923	1s. 9d.—2s. per lb., according to quantity. Much firmer in common with other citrates.
Sod. Hyposulphite—	
Photographic	£14—£15 per ton, according to quantity, d/d. consignee's station in 1-cwt. kegs.
Sod. Metabisulphite cryst.	37s. 6d.—60s. per cwt. nett cash, according to quantity.
Sod. Nitroprusside	16s. per lb. Less for quantity.
Sod. Potass. Tartrate (Rochelle Salt)	76s. 6d.—81s. 6d. per cwt., according to quantity. Prices reduced.
Sod. Salicylate	Powder 2s. 9d.—2s. 11d. per lb., Crystal at 2s. 10d.—3s. per lb. Market weaker.
Sod. Sulphide—	
Pure recryst.	10d.—1s. 2d. per lb., according to quantity.
Sod. Sulphite, anhydrous	£27 10s.—£28 10s. per ton, according to quantity, 1-cwt. kegs included. In large casks £1 per ton less.
Sulphonal	18s. 6d. per lb.
Tartar Emetic	1s. 4d. per lb.
Thymol	13s. 6d.—14s. 6d. per lb. for good white crystal from ajowan seed. Distinctly firmer.

PERFUMERY CHEMICALS

Acetophenone	12s. 6d. per lb.	
Aubepine	13s. 6d. "	
Amyl Acetate	3s. "	
Amyl Butyrate	7s. 3d. "	
Amyl Salicylate	3s. 6d. "	
Anethol (M.P. 21/22° C.)	3s. 9d. "	
Benzyl Acetate from Chlorine-free Benzyl Alcohol	3s. 3d. "	
Benzyl Alcohol free from Chlorine	3s. 6d. "	
Benzaldehyde free from Chlorine	3s. 3d. "	
Benzyl Benzoate	3s. 9d. "	
Cinnamic Aldehyde Natural	18s. 6d. "	
Coumarin	21s. "	
Citronellol	19s. "	
Citral	10s. "	
Ethyl Cinnamate	10s. "	
Ethyl Phthalate	3s. 9d. "	
Eugenol	10s. "	Cheaper.
Geraniol (Palmarosa)	35s. "	Cheaper.
Geraniol	10s.—17s. 6d. per lb.	
Heliotropine	8s. 6d. per lb.	
Iso Eugenol	15s. 9d. "	
Linalol ex Bois de Rose	20s. "	
Linalyl Acetate	20s. "	
Methyl Anthranilate	9s. "	Advanced.
Methyl Benzoate	6s. "	
Musk Ambrette	52s. 6d. "	
Musk Xylol	19s. "	
Nerolin	4s. "	
Phenyl Ethyl Acetate	10s. "	
Phenyl Ethyl Alcohol	16s. "	
Rhodinol	62s. 6d. "	Cheaper.
Safrol	1s. 10d. "	
Terpineol	2s. 9d. "	Advanced.
Vanillin	26s. 6d. per lb.	

ESSENTIAL OILS

Almond Oil, Foreign S.P.A.	14s. 6d. per lb.	
Anise Oil	1s 11d. "	
Bergamot Oil	14s. 6d. "	
Bourbon Geranium Oil	29s. 6d. "	
Camphor Oil	75s. per cwt.	
Cananga Oil, Java	9s. 4½d. per lb.	
Cinnamon Oil, Leaf	5¼d. per oz.	
Cassia Oil, 80/85%	9s. 6d. per lb.	
Citronella Oil—		
Java 85/90%	4s. 10d. "	
Ceylon	3s. 7½d. "	
Clove Oil	8s. 7½d. "	Cheaper.
Eucalyptus Oil 70/75%	2s. 3d. per lb.	
Lavender Oil—		
French 38/40% Esters	24s. 6d. per lb.	
Lemon Oil	3s. 1d. "	
Lemongrass Oil	2½d. per oz.	
Orange Oil, Sweet	12s. 6d. per lb.	
Otto of Rose Oil—		
Bulgarian	34s. per oz.	
Anatolian	26s. per oz.	
Palma Rosa Oil	18s. 6d. per lb.	Cheaper.
Peppermint Oil—		
English	70s. per lb.	
Wayne County	17s. 9d. per lb.	Advanced.
Japanese	14s. 6d. per lb.	Advanced.
Petitgrain Oil	9s. 6d. per lb.	

TRADE NOTES

Official Trade Intelligence.

The Department of Overseas Trade (Development and Intelligence, 35, Old Queen Street, London, S.W. 1) has received the following inquiries for British goods. British firms may obtain further information by applying to the Department and quoting the specific reference number.

Canada: Drugs, (205); *Norway*: Earthenware, (211); *Peru*: Drugs, (220); *Porto Rico*: Cement, (22033/F.W./M.C.12); *Sweden*: Chemicals, dyestuffs, (216); *United Kingdom*: Illuminating oils (The Secretary, Trinity House, Tower Hill, London, E.C. 3); *United States*: Steel, (217); Creosote, (22087/F.W./C.C./2); Brass, (21955/F.W./E.C./2).

Trade Information

A Vacuum Pump of extremely interesting design has been put on the market by the Central Scientific Co., of 460, E. Ohio Street, Chicago, under the name of the "Cenco Hyvac Pump." As the result of trials carried out by Prof. C. T. Krupp and C. S. Palmer, of the Laboratory of Physics, University of Illinois, it was concluded that the Cenco Hyvac Pump was quite rapid, reaching a surprisingly high vacuum and that it was therefore well suited to be used as a force pump to any large throated rapid-acting mercury vapour pump. This conclusion was reached after the pump had been in almost continuous uso over a long period. According to the makers the pump produces a vacuum of 0·001 mm. without the use of a preliminary or backing pump, and they claim that it constitutes the smallest, most efficient and most economical outfit for obtaining a vacuum of 0·001 mm. that has ever been produced. Measuring 4½ by 4½ by 7⅜ in., on a base 9 by 18 in., the pump runs at 240 revolutions per minute, requires only 1/12 h.p. to operate it and weighs only 16¼ lb. It is supplied mounted or unmounted, with or without an electric motor, the price unmounted being $50, which includes the provision of a pulley and a supply of oil especially selected for high vacuum work. It is of interest to call attention to this pump in view of the modern demand for efficient vacuum pumps that will produce a high vacuum and maintain it during long periods of continued use.

Messrs. Manlove, Alliott and Co., Ltd., have sent us copies of two circulars, ono of which illustrates some of the many varieties of plant supplied by this firm for the chemical industry, *e.g.*, filter presses, stearine presses, evaporating plant, oil-refining plant, drying machines and centrifugal machines. The other circular illustrates hydro-extractors and washing and ironing machines designed more particularly for the laundry trade. Messrs. Manlove, Alliott states that these circulars refer to but few of many different types of apparatus and the firm's services are at the disposal of clients whether for advice or experimental work. Copies of the circulars and further information can be obtained from Messrs. Manlove, Alliott and Co., Ltd., at Bloomsgrove Works, Nottingham.

The Technical Advertising Service, whose work was recently reviewed in these columns, is now completely installed in its new offices at 52, Bedford Square, London, W.C. 1 (Telephone: Museum 64; Wire: Systemized, West Cent. London).

Imports of Medicines from Great Britain

The *Journal Officiel* has published a notice relating to the importation into France of certain medicines from Great Britain. According to the Law of April, 1923, medicines of foreign origin and coming under the heading 316 of the Customs Tariff (not including serums, vaccines, etc.) may be imported into France, even if not registered in official pharmacopœias, provided the labelling satisfies the conditions prescribed by law and when such importation takes place from countries which offer similar advantages to France. After consideration of the regulations concerning the importation of medicines into Great Britain, it has been decided to allow the importation of medicines from Great Britain.

French Fertiliser Trade in 1923

The French imports of fertilisers in 1923 were:—Mineral superphosphates, 66,773 metric tons, bone superphosphates 6593 t., basic slag, 41,682 t., nitrate of soda, 268,435 t. (262,358 t. from Chile), nitrate of lime and calcium cyanamide, 25,169 t. The export included 129,102 t. of minoral superphosphates, and 234,385 t. of basic slag.

PUBLICATIONS RECEIVED

THE LIFE OF SIR WILLIAM CROOKES, O.M., F.R.S. *By* E. E. FOURNIER D'ALBE, D.Sc., F.INST.P. *With a foreword by Sir Oliver Lodge, F.R.S., D.Sc., LL.D. Pp. xix+412. London: T. Fisher Unwin, Ltd.*, 1924. *Price* 25*s*.

THE CHEMISTS' YEAR BOOK, 1924. *Edited by* F. W. ATACK, M.Sc., *assisted by* L. WHINYATES, A.M.C.T. *Pp.* 1147. *Manchester: Sherratt and Hughes*, 1924. *Price* 21*s*.

THE MODERN SOAP AND DETERGENT INDUSTRY, INCLUDING GLYCEROL MANUFACTURE. *By* G. MARTIN, D.Sc., PH.D. *Vol. I. Theory and Practice of Soap Making. PP. xii+234. London: Crosby, Lockwood and Son*, 1924. *Price* 36*s*.

LOW TEMPERATURE CARBONISATION. *By* S. N. WELLINGTON *and* W. R. COOPER. *Pp. ix+238. London: C. Griffin and Co., Ltd.*, 1924. *Price* 25*s*.

A TEXT-BOOK OF INORGANIC CHEMISTRY, *edited by* J. NEWTON FRIEND, D.Sc. *Vol. VII., Part I.* OXYGEN, *by* J. NEWTON FRIEND *and* D. F. TWISS. *Pp. xxv+370. London: C. Griffin and Co., Ltd.*, 1924. *Price* 18*s*.

TRATTO DI CHIMICA GENERALE, ED APPLICATA ALL' INDUSTRIA. *Vol. I.* CHIMICA INORGANICA. *By* DOTT. ETTORE MOLINARI. *Part I. 5th edition, revised and enlarged. Pp. xv.+680. Milan: Ulrico Hoepli.* 1924. *Price L.*40.

DRAINAGE INVESTIGATIONS AT ABERDEEN. *By* PROF. JAMES HENDRICK, *B.Sc. Pp.* 11. *Reprinted from "The Scottish Journal of Agriculture." Vol. VII., No.* 1. *January*, 1924.

PUBLICATIONS OF THE IMPERIAL MINERAL RESOURCES BUREAU. *Mineral Industry of the British Empire and Foreign Countries. H.M. Stationery Office,* 1924:

COAL-MINING ACCIDENT STATISTICS, 1912—1922. *Pp.* 75. *Price* 2s. PYRITES, STATISTICS, 1919—1921. *Pp. iv*+15. *Price* 1s.

STATISTICAL INFORMATION, *compiled by* SPERLING AND Co. *Pp.* 33. *London: Basildon House, E.C.* 2.

PUBLICATIONS OF THE DEPARTMENT OF THE INTERIOR, *Bureau of Mines. Washington: Government Printing Office,* 1923 *and* 1924.

ANALYSES OF OHIO COALS. *Pp. v*+40. *Technical Paper,* 344. *Price* 5 *cents.*

CHANGE HOUSES IN THE LAKE SUPERIOR REGION. *By* C. E. KINDALL. *Pp. iv*+31. *Technical Paper,* 289. *Price* 15 *cents.*

THIRTEENTH ANNUAL REPORT BY THE DIRECTOR OF THE BUREAU OF MINES TO THE SECRETARY OF THE INTERIOR FOR THE FISCAL YEAR ENDED JUNE 30, 1923. *Pp.* 21. *Price* 5 *cents.*

IRON ORE, PIG IRON AND STEEL IN 1922. *By* E. F. BURCHARD *and* H. W. DAVIS. *Mineral Resources of the United States,* 1922. *Part I. Pp.* 341—376. *No.* I: 21.

PRODUCTION AND BRIQUETTING OF CARBONISED LIGNITE. *By* E. J. BABCOCK *and* W. W. ODELL. *Bulletin No.* 221. *Pp. vi*+82. *Price* 20 *cents.*

RECOVERY OF GASOLINE FROM UNCONDENSED STILL VAPORS. *By* D. B. DOW. *Technical Paper,* 310. *Pp. v*+53. *Price* 15 *cents.*

USES OF WATER IN THE OIL-SHALE INDUSTRY, WITH PARTICULAR REFERENCE TO ENGINEERING REQUIREMENTS. *By* J. J. JAKOSKY. *With a chapter on The Sanitation of Oil-Shale Camps by* A. L. MURRAY. *Technical Paper,* 324. *Pp. vi*+57. *Price* 10 *cents.*

SELF-CONTAINED MINE RESCUE OXYGEN BREATHING APPARATUS. *A Handbook for Miners. By* D. J. PARKER, G. S. MCCAA, *and* E. H. DENNY. *Pp. xiv.* 139. *Price* 20 *cents.*

REPORT ON THE FINANCIAL AND ECONOMIC CONDITIONS IN URUGUAY, DATED SEPTEMBER, 1923. *By* A. E. CLEUGH, *H.M. Vice-Consul, Montevideo. Department of Overseas Trade. Pp.* 30. *H.M. Stationery Office,* 1924. *Price* 1s.

It is unfortunately not possible to record any improvement in the position of Uruguay since 1922 (*cf. Chem. and Ind.,* 1923, 1118). The bad financial condition of the country must be improved by the raising of loans, increase in taxation, and development of industries. The last-named object is difficult of realisation owing to Uruguay's lack of fuel and raw materials such as iron. The country is vitally dependent on the demand for meat in European markets and this shows signs of improving. Trade returns and Customs receipts show a gradual but consistent increase; there is no question of a "boom" in prospect, but even with depressed foreign exchanges traders will be dealing with stable conditions. The first six months of 1923 showed a decided improvement over the corresponding period in 1922; in the former, imports were valued at $19,844,861 and exports at $40,038,827, in the latter, imports, $25,018,276, exports, $57,661,425 (at par $1=51·1·16d.; June, 1923, 42¾d.). The figures for imports are for customs purposes; for actual values the figures should be multiplied by 1·9 approximately.

Of the imports the United Kingdom provided in the first six months of 1923 $6,116,356, the U.S.A. being next in importance with $5,121,724. The stocks which had accumulated are now becoming exhausted and the exchange, though adverse, is fairly stable, both helpful factors in the import trade. Items of imports in the first six months of 1923 included "anilines," 4800 tons; 293,500 gal. tinplate, 319,000 t.; malt, 123,000 t.; olive oil, 222,000 t.; coal, 292,000 t.; fuel oil, 6,417,000 t.; gasoline, 870,000 gal.; kerosene, 2,530,000 gal.; naphtha, 2,133,000 gal.

The principal exports were frozen meat, and the other products of the cattle rearing industry, such as hides, wool, etc. There are no manufacturing industries in the country, even for supplying the home market, though some minor ones might be established if the tariffs at present in force could be modified to help the importation of raw materials and machinery.

THE INSTITUTION OF STRUCTURAL ENGINEERS

The Institution of Structural Engineers is arranging to hold an International Cement Congress at the International Building Exhibition, Olympia, London, on Tuesday and Wednesday, April 22 and 23, 1924.

It is proposed that the following and probably other subjects shall be discussed during the course of the Congress:—

1. Ciment fondu in practice.
2. Surface dust on concrete floors in factories.
3. Cement in sea water.
4. Cement in concrete roads.
5. Preparations to withstand oil.
6. The influence of size and shape in compression test blocks.
7. Microscopy of cement.
8. Porosity of concrete blocks.
9. The use of sea water in mixing cement.

The papers in these subjects will be grouped and printed in advance so that when the Congress meets a group of papers may be taken as read and discussed without waste of time.

The hours of meeting of the Congress will be 11 to 1 and 3 to 5 on each day.

The Council of the Institution believes that this Congress will do much towards the solution of problems which confront chemists, engineers, manufacturers and others connected with the cement industry.

The Council of the Society of Chemical Industry has nominated Dr. Geoffrey Martin and Dr. David Prentice as its delegates to the Congress.

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EDITORIAL

IN all ages and, doubtless, in all countries some day has been set apart for the celebration of a new year. The celebration is invariably a festival, a day of rejoicing, a time when we look back on happy hours and look forward to fresh periods of happiness. The young have few real anxieties or real troubles, but trifling disappointments affect them deeply, and they are easily distressed by insignificant or imaginary causes; so it happens that as we grow older we get happier, we outgrow the times when our lives are regulated and ordered by parents, schoolmasters and other educators of youth; hospitality is better to give than to receive, and those who entertain a party of young people experience a more lasting pleasure than their guests. Dear and desired come the blessed hours, bringing gifts to all and sundry; some receive an undue share of the good things of this world, but the others are as fortunate or perhaps more so. Those who seek much are in want of much; it is good when tho gods distribute their gifts with sparing hand. Philosophers have for many centuries advised us not to look too far ahead, to consider the present rather than the distant future. Did not one of them in his Rules against Low Spirits tell us to take short views of human life not further than dinner or tea? New Year's resolutions do not appeal to us. "You will live and enjoy yourself to-morrow! Perhaps you are too late to do it to-day; the wise did it yesterday."

* * *

Looking back during the last year of our Journal we have found many things to cheer and encourage us. Chemistry is fresh and vigorous; our leaders have made such progress in the science that they can spare much to bestow upon the solidest and sublimest points of controversy and new invention, as an old writer hath it; we feel ourselves not degenerated nor drooping to a fatal decay, but waxing young again, entering the glorious ways of truth and prosperous virtue, destined to become great and honourable in these latter ages. If any of our readers feel that the Journal should be better, they will find editorial sympathy; the better the articles are that are sent to us, the more pleased are our readers and ourselves; it is to you we appeal for any improvement, your literary destiny is in your own hands and you can make it as exalted as you desire, *nos te nos facimus*, you may say to yourselves. Voltaire wrote to some critic: "*Le Siècle de Louis XIV vous paraît écrit d'un style ridicule, à la bonne heure : vous écrivez bien mieux, et j'en suis fort aise.*" To our readers we may say as a New Year's Greeting: "This is your Journal, make it as good as possible, we on our side will be as helpful as we can."

* * *

We acknowledge very gladly the help we have received from the Federal Council for Pure and Applied Chemistry, the Association of British Chemical Manufacturers, the Chemical Society and the Institution of Chemical Engineers, who have all made official use of this Journal for publication. The two important meetings at Cambridge last June stand out as landmarks in the history of Chemical Societies; we have celebrated the hundredth anniversary of the alkali trade and the fiftieth anniversary of the founding of Messrs. Brunner Mond & Co.; we have recorded with deep regret the deaths of several prominent chemists who have taken a large part in building up our science, and we have witnessed and sometimes taken part in some controversial discussions which clarify the minds of the writers as well as the readers. The year 1923 has perhaps contributed more than any other year to the knowledge of atoms and molecules and their effect on one another. We are reaping the harvest sown by Ramsay, the Curies, Moseley, Soddy, Rutherford, Dauvillier, Perrin, Bohr, Lewis and Langmuir. Future generations will say of such men: "Their's was the giant race before the flood," and will envy us for living in such exciting times.

* * *

We are glad to publish a communication on the smoke problem. It is a perfect scandal that in this country and at this time there should be whole counties overhung by smoke and many score of towns whose ugliness is made worse by reason of soot and the other forms of dirt which result from our primitive methods of burning coal. We enjoy as all of us do, the open hearth and its cheerful aspect but in our own fireplaces we burn a fuel from which most of the volatile constituents have been removed and we get all the advantages of the open hearth and a smokeless fuel. If this practice became general we should find a notable improvement in the atmosphere of our great towns. We who understand, or are supposed to understand, the effects of combustion should set an example to our less enlightened brethren.